



MARKSCHEME

May 2008

BIOLOGY

Standard Level

Paper 3

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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. 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.
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.

Option A — Diet and Human Nutrition

- A1.** (a) vitamin B₁₂ / cyanocobalamin **[1]**
- (b) (relatively high percentage) did not meet RDA in any category;
ten-year-olds eating breakfast at school have the lowest percentage not reaching RDA / those not eating breakfast have highest percentage;
stating numerical difference; **[2 max]**
- (c) ten-year-olds eating breakfast at school are more likely to reach the RDA for most minerals and vitamins / nutrients;
given data is inconclusive since other nutrients (carbohydrates, proteins and fat)/ meals (lunch, dinner) are not included;
given data is inconclusive since it is a limited/select population;
for some nutrients (vitamin E/folic acid/niacin/iron) it is better to eat breakfast at home; **[2 max]**
- A2.** (a) component of food that performs a physiological function in the body / chemical substance that must be supplied to the body (from its environment) **[1]**
- (b) (i) *Award [1] for any three of the following.*
red meat / fish / seafood / poultry / eggs / dairy products / legumes (peas/beans) / nuts / cereals / mycoprotein / tofu **[1 max]**
- (ii) provide amino acids (building blocks) to make other proteins / other examples of proteins (*e.g.* enzymes);
(under extreme conditions) can provide energy;
to make other molecules (*e.g.* DNA / nucleotides); **[2 max]**
- (c) stimulates wall of digestive tract to secrete mucus;
aids in smooth passage of food/substances through digestive tract/peristalsis / undigested food provides bulk to prevent constipation/hemorrhoids;
(possible) defence against colon cancer as toxins spend less time in intestine / absorbs water and dilutes bile salts;
(soluble) fibre reduces cholesterol levels as less fat absorbed;
bulk in stomach, reduces obesity as it decreases appetite;
reduces sugar absorption so decreases diabetes; **[2 max]**
To award full marks explanations are needed. Do not accept lists.

- A3.** (a) vegetarians eat all foods except animal flesh whereas vegans eat only foods from plants/microorganisms / do not eat any foods derived from animals (animal flesh, dairy products, eggs, honey, *etc.*) **[1]**
- (b) rickets is caused by a vitamin D (calciferol) deficiency;
sources of vitamin D (calciferol) are milk, fish liver oil and exposing the skin to sunlight;
vegans do not consume dairy products making them more likely to develop rickets;
vegans who expose their skin to a lot of sunlight are less likely to develop rickets;
vegans supplement their diets with vitamin D / other supplements; **[3 max]**
- (c) malnutrition occurs when a diet is not appropriate for the needs of an individual;
food supplies (providing essential nutrients) are disrupted/stopped during drought/
flooding/other natural disasters;
political turmoil can reduce food production / increase food prices / interfere with
food transportation;
malnutrition requires long-term disruption of food supply;
malnutrition can be caused by poverty as only one type of food eaten;
diseases (*e.g.* dysentery, diarrhea) can lead to malnutrition;
too much money can lead to overeating and thus obesity; **[3 max]**

Option B — Physiology of Exercise

- B1.** (a) $3.3(\pm 0.2)\text{mmol L}^{-1}$ (*units required*) [1]
- (b) both lower blood plasma lactate concentration;
active recovery lowers blood plasma lactate concentration more than passive recovery / faster reduction;
neither active recovery nor passive recovery reduces blood plasma lactate concentration to starting level; [2 max]
- (c) initial blood plasma lactate concentration lower for active recovery;
permitting higher initial exercise intensity / muscle performance;
from 35 to 50 minutes active recovery still shows advantage;
blood plasma lactate concentration for last five minutes are the same / final blood plasma lactate concentrations are the same; [3 max]
- (d) liver [1]
- B2.** (a) (adrenaline) converts glycogen to glucose in liver;
increases heart rate and force of contraction so more blood is supplied to muscles;
diverts blood flow from skin, gut and kidneys to muscles;
dilates blood vessels in muscles so they receive more blood;
blood contains glucose and oxygen needed for energy metabolism by muscles;
causes fatty acid release into blood for oxidation by muscles for energy; [2 max]
- (b) *Award [1] for each row of paired differences.*
- | | |
|------------------------|------------------------|
| <i>slow (tonic):</i> | <i>fast (twitch):</i> |
| contract slowly | contract rapidly; |
| resist fatigue | fatigue easily; |
| much myoglobin | low myoglobin; |
| aerobic metabolism | anaerobic metabolism; |
| very good blood supply | moderate blood supply; |
| lots of glycogen | little glycogen; |
| high stamina | low stamina; |
| more mitochondria | less mitochondria; |
- [2 max]

B3. (a) *Award [1] for every two of the following clearly drawn and correctly labelled.*

cell body;
nucleus;
dendrites;
axon (elongated);
Schwann cell;
myelin sheath;
nodes of Ranvier;
synaptic knobs;

[3 max]

(b) voluntary muscle control originates in (motor area) of cerebral cortex;
motor neurons (and interneurons) carry signal from central nervous system;
to synapses with muscle fibres / at neuromuscular junctions;
transmission of signal over synapse is electrochemical / requires neurotransmitters;
muscle tension detected by proprioceptors / sensory neurons;
provide feedback to brain for further action;
involuntary muscle control originates in medulla oblongata/cerebellum;

[4 max]

Option C — Cells and Energy

C1. (a) (i) carbon dioxide and water **[1]**
Need both to receive the mark.

(ii) heat / energy **[1]**

(b) starch is broken down transforming into sugar;
 chlorophyll is broken down so bananas change from green to yellow;
 increase in respiration causes water release and CO₂ formation; **[2 max]**

(c) reduce heat of cargo/refrigerate (bananas) to slow respiration rate;
 lower oxygen / raise nitrogen/carbon dioxide level in cargo atmosphere to inhibit
 respiration rate;
 shorten transport distance/time so less time to over ripen; **[2 max]**

C2. (a) *Award [1] for each row of structural features.*

mitochondrion	chloroplast
both contain DNA and RNA;	
both contain ribosomes;	
both have double membranes;	
no pigments	contains pigments;
matrix	stroma;
inner membrane folded (cristae) / no thylakoids	no folds (cristae) / thylakoids;
both have electron transport system	
does not have NADPH	has NADPH

[3 max]

(b) ADP is phosphorylated to ATP through addition of inorganic phosphate;
 by enzyme ATP synthetase/synthase;
 when H⁺ ions (protons) diffuse;
 through channels in ATP synthetase/synthase;
 from high H⁺ concentration in mitochondrial intermembrane space;
 to low H⁺ concentration in mitochondrial matrix; **[3 max]**

- C3.** (a) light-dependent and light-independent reactions/Calvin cycle **[1]**
Do not accept “light” and “dark” reactions.
- (b) graph with two peaks showing trough in between;
axis label: relative rate of photosynthesis and wavelength in nm (from 400 to 700+);
major peaks at 450 and 780 nm / violet/blue and red;
trough at about 540 nm / green; **[3 max]**
- (c) limiting factors control the rate of reaction/photosynthesis;
rate of photosynthesis will increase with increasing light;
if temperature and CO₂ levels remain constant;
rate begins to slow down and level off;
because maximum number of chlorophyll molecules are absorbing the photons;
light is limiting factor only when the other factors are present in excess; **[2 max]**

Option D — Evolution

- D1.** (a) direct proportion / size increases with age (throughout lifetime) [1]
- (b) 25/26 days [1]
- (c) eleven/ten generations [1]
- (d) (i) small size allows coral reef gobies to hide from predators;
small size of fish limits egg size; [1 max]
- (ii) more generations per year;
short life span/expectancy so more chances to reproduce; [1 max]
- (iii) high frequency of new generations allows continuous natural selection of
most fit (best-adapted) individuals;
grow too large for coral area; [1 max]
- D2.** (a) *Award [1] for two of the following.*
petrification / fossilization / preservation in amber / ice / peat / mummified
(dehydration) [1]
- (b) mutations occur over time in a genome/DNA/gene;
mutations occur at a relatively constant rate;
differences in DNA can lead to differences in amino acid sequences;
e.g. in humans the β -chain of hemoglobin / cytochrome *c* / other example / is more
similar to primates than other mammals;
more precision seen in genes with reliable rate of change;
number of substitutions in gene / mtDNA / Y chromosome can be graphed against
branch points / changes in fossil / archaeological record; [3 max]
Award [2 max] if no example is given.
- (c) organisms with common ancestry found in areas geographically separated have
different adaptations / divergent evolution;
e.g. Darwin’s finches in the Galapagos Islands / New World monkeys in America
and Old World monkeys in Africa / marsupials in Australia;
Wallace’s Line is an example of geographical distribution of organisms due to
evolution;
similar adaptations of unrelated organisms in similar habitats / convergent evolution;
e.g. streamlined shape of dolphins and fish; [2 max]

- D3.** (a) *Phylum:* Chordata;
Order: Primates; **[1 max]**
Need both to receive the mark.
- (b) genetic evolution involves physical changes in the human genome which become inherited/passed on by chromosomes;
cultural evolution involves changes in human thinking/behaviour/skills/learning which appear in groups of people and can be passed from one generation to the next / passed on by word of mouth/books/actions; **[2]**
- (c) changes in genotype have led to our cultural evolution;
our special phenotypic advantages/traits include upright walking and larger brain size;
these physical traits have permitted intelligent behaviour / social interaction / many behavioural adaptations;
evolution of culture (art, science, language) has been more recent / rapid than genetic evolution;
further cultural evolution (genetic engineering) may hasten changes in our genetic evolution; **[3 max]**
Allow any other suitable examples.

Option E — Neurobiology and Behaviour

- E1.** (a) female/natural extract **[1]**
- (b) at all doses less effective than female extract;
as doses increase from 10^{-5} to 10^{-2} μg greater positive response occurs;
as doses increase from 10^{-2} to 10^2 μg response decreases;
best response is at 10^{-2} μg ; **[3 max]**
- (c) (positive) taxis because male cockroach moves towards stimulus **[1]**
Do not award marks for "taxis" unqualified.
- (d) chemoreceptor **[1]**
- (e) use most effective dosage of blattellaquinone / 10^{-2} μg ;
put blattellaquinone into traps to capture cockroaches;
put blattellaquinone into insecticides to kill cockroaches; **[2 max]**
- E2.** (a) *Award [1] for every three of the following clearly drawn and correctly labelled.*
sclera;
cornea;
pupil;
choroids;
iris;
lens;
ciliary body / muscles;
retina;
fovea;
optic nerve;
aqueous/vitreous humors; **[2 max]**
- (b) all rods contain rhodopsin whereas cones either contain blue, green or red pigment;
rods are sensitive to dim light whereas cones are activated by bright light;
rods are found throughout entire retina but cones are primarily found in the fovea;
rods monochrome vision and cones colour vision; **[2 max]**

- E3.** (a) natural selection allows the best-adapted animals to survive;
adaptation can include behaviour such as mating / hunting / migrating /
communication *etc.*;
e.g. in a nest of chicks, the chick which can call louder and gape more obviously
is likely to be fed more by its parents and survive;
the alleles responsible for successful behaviour eventually pass to offspring; [2 max]
- (b) when an animal learns to associate a reward with a certain kind of behaviour / trial
and error learning / associative learning [1]
- (c) *Award [1] for any three of the following.*
honey bees;
ants;
termites;
chimpanzees;
naked mole rats;
hyenas,
lions;
other suitable examples; [1 max]
- (d) acquire information from past experiences to adapt to new situations;
can obtain better food/shelter/increase mating chances;
learns to avoid dangerous situations;
cooperation between individuals may increase survival;
Award [1] for one explained example of learned behaviour e.g.
habituation / classical conditioning / imprinting / imitation / problem solving; [2 max]

Option F — Applied Plant and Animal Science

- F1.** (a) (i) phosphatase *[1]*
- (ii) saccharase *[1]*
- (b) (lowest) conventional without manure → conventional with manure → bioorganic
→ biodynamic (highest) *[2]*
Award [1 max] if only two are in the correct order.
- (c) both organic methods have the most positive effect on four/five factors;
biodynamic’s effect on phosphatase activity is high;
but cannot be sure that organic methods are best since data for effect on
physical/chemical/faunal is not given;
organic produce less pollution than conventional (by mineral fertilizers); *[2 max]*
- F2.** (a) *Award [1] for two of the following.*
*e.g. oak (*Quercus velutina*) – hardwood for firewood / rape seed (*Brassica rapus*) oil;*
*cotton (*Gossypium*) / flax (*Linum usitatissimum*) for linen;*
*bamboo (*Bambusa vulgaris*) / pine (*Pinus strobus*);*
*rose (*Rosa californica*) / tulip (*Tulipa*);* *[2 max]*
- (b) the net increase in plant biomass per unit leaf area per unit time *[1]*
- (c) auxin promotes bending of shoots towards light source;
uneven distribution of auxin affects cell growth;
cells receiving more auxin (dark side of plant) elongate faster than cells on bright
side;
side with longer cells (dark side of plant) causes plant to bend to light source; *[2 max]*
- (d) *Award [1] for two of the following.*
light can be regulated/artificial light;
temperature can be regulated;
control of water availability / humidity;
CO₂ level may be regulated;
Nutrients/fertilizers/growth stimulants can be easily added;
pest/disease control is easily managed;
protection against extreme weather conditions;
growth all year round; *[2 max]*

F3. (a) *Award [1] for three of the following.*
plowing / transport / food / fur and skins/clothing / pets / sport/hunting / detecting
bombs/people

[1]

(b) artificial insemination directs reproduction;
sperm of male with most desirable traits can be used to fertilize any female of
same species;
sperm can be stored for long periods / be sent internationally;
results in greater probability of offspring with desired traits;
vaccination helps eliminate / control disease in populations of farm animals;
healthier animals cost less to maintain / provide higher yield;
nutrient supplementation for optimum diet for livestock;
e.g. calcium to prevent hypocalcaemia in pregnant cattle;
Award [2 max] for each technique.

[4 max]

Option G — Ecology and Conservation

- G1.** (a) skiing/snowboarding / treading/walking on plants;
trees cut down to make piste; **[1 max]**
- (b) (i) ungraded pistes with artificial snow **[1]**
- (ii) herbs other than grasses **[1]**
- (c) machines destroy larger plants;
grading improves the conditions for grasses and legumes to grow; **[2]**
- (d) (i) water in artificial snow contains dissolved nutrients;
more irrigation in the area;
pH may suit local vegetation; **[1 max]**
- (ii) data does not support since artificial snow does not always give positive
mean difference;
less effect on grasses than natural snow; **[1 max]**
- G2.** (a) *Award [1] for any five of the following.*
temperature / water / light / soil pH / salinity / mineral nutrients / wind / herbivory /
length of growing season / presence of pollinators / dispersal ability / competition /
pollution / action of man / space **[1]**
- (b) every species exclusively occupies its own niche / species compete for a limited
resource;
one species (best adapted) will eventually eliminate the other species; **[2]**
- (c) predation occurs when one organism eats another living organism whereas
parasitism occurs when one organism derives nourishment from another organism
and harms that organism in the process;
predation *e.g.* hyenas eating a wildebeest and parasitism *e.g.* tapeworm infecting
various prey species (sheep, rabbit, human); **[2]**

G3. (a) Allow **[1]** for diversity index equation, if given correctly.

$$D = \frac{N(N-1)}{\sum n(n-1)};$$

Simpson index measures species richness / diversity in an area;
can be used to evaluate an area for possible conservation activities;
taken at various intervals over time it can indicate whether or not conservation
measures are effective;

[2 max]

(b) *in situ* means keeping endangered species in natural habitats;
less expensive since basic requirements for maintaining endangered species would
not have to be met;
less stress on endangered species since they would not have to be moved;
endangered species more likely to reproduce in natural surroundings;
other organisms in ecosystem would be protected;
maximum genetic variation of species can exist;
natural evolution and adaptive processes can occur;
natural symbiotic relationships can exist;
new diseases/pest will not threaten natural defences;
not always possible because numbers are too low / habitat destruction;

[4 max]
