



MARKSCHEME

November 2011

BIOLOGY

Standard Level

Paper 3

18 pages

*This markscheme is **confidential** and for the exclusive use of examiners in this examination session.*

*It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of IB Cardiff.*

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 shown 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 **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. When marking indicate this by adding **ECF** (error carried forward) on the script.
10. Do not penalize candidates for errors in units or significant figures, unless it is specifically referred to in the markscheme.

Option A — Human nutrition and health

A1. (a) 10(%) (allow responses in the range of 9 to 11%) [1]

(b) 25.0–29.9 / above 25 and below 30 [1]
Do not accept 30 as this is classed as obese.

(c) more women exercise than men; both show an increase (between ages 16 to 25); similar trend lines over time / slightly greater increase in women; women have greater increases and decreases/greater variability while men gradually increase/stays level; [2 max]
Award any one of the above marking points if shown as a valid numerical comparison.

(d) (hypothesis is supported) as the greater percentage of men are overweight and they exercise less than women / *vice versa*;
(hypothesis is supported) lowest percentages of overweight ages (18 and 20) correspond with peaks of exercise;
(hypothesis is not supported) as even though both men and women exercise more over time the percentage overweight also increases;

(hypothesis is not supported) other named factor which influences being overweight; { (e.g. availability of cheap high energy foods / large portion sizes / increasing use of vehicles for transport / changes from active to sedentary occupations / genetics)

BMI does not consider muscle mass/bone structure/bone density; only narrow range of ages considered; [3 max]

A2. (a) (i) fibre [1]

(ii) monounsaturated fat; fats contain more energy than carbohydrates or proteins; fats contain 4000kJ per 100g/9 kcal per 100g; more monounsaturated fat present than other fats; [2 max]

(b) saturated and unsaturated fats differ in number of single and double carbon-carbon bonds/ratio of hydrogen to carbon atoms in fatty acid chains; saturated fat – carbon atoms all joined by single bonds / have no double bonds / have no increase in number of hydrogen atoms possible; monounsaturated fat – one double bond in carbon chain / could add two hydrogens in the carbon chain; polyunsaturated fat – two/more double bonds in the carbon chain; saturated fatty acid chains tend to be straight while mono/polyunsaturated have kinks/bends; [3 max]

- A3.** (a) Andean: (carbohydrates in) potatoes/maize;
Central American: (carbohydrates in) beans/rice/maize;
Asian: (carbohydrates in) rice/noodles;
South Asian: (carbohydrates and protein in) pulses/legumes/wheat;
European: (carbohydrates in) wheat/bread/potatoes;
Arabian: (carbohydrates in) wheat/ bread /rice;
African: (carbohydrates in) maize/cassava;
Inuit: (protein and fat in) meat/fish; **[2 max]**
Allow any valid ethnic group (not a country) with the dietary source of energy which is carbohydrates in most cases.
- (b) supplies essential nutrients lacking in diet / nutrients added by manufacturers;
benefits lower socio-economic groups as common foods are consumed by most people / reduces the need to purchase supplements;
prevents nutritional deficiencies/deficiency diseases;
named example of mineral/vitamin supplementation; (*e.g. iodine in salt*) **[3 max]**

Option B — Physiology of exercise

- B1.** (a) VO_2 max is the maximal rate of oxygen consumption/uptake by the body [1]
- (b) fat: 58(%); (allow responses in the range of 57 to 59%)
CHO: 42(%); (allow responses in the range of 41 to 43%) } (both needed) [1]
- (c) fat contributes most energy/63 (± 1)% at lower level of exercise intensity;
contribution of fat as an energy source decreases as exercise intensity increases /
negative correlation;
contribution of CHO as an energy source increases as exercise intensity increases
/ positive correlation;
fats and carbohydrates used equally / crossover point is 41 % VO_2 max;
little difference between men and women; [3 max]
- (d) at lower exercise intensity (more) oxygen available for aerobic respiration;
(stored) fat will supply energy when oxygen is available;
as exercise intensity increases anaerobic respiration increases;
less oxygen available (in anaerobic respiration) means more CHO metabolism/
less fat metabolism (at higher exercise intensity); [2 max]
- B2.** (a) I. humerus
II. cartilage / synovial fluid / capsule } (both needed) [1]
- (b) over stretching/partial tear of ligaments;
due to abnormal movement at joint;
joint may loosen/become unstable;
swelling / pain / bruising; [2 max]
- (c) both joints are freely movable;
hip joint allows motion in many directions/three planes and knee joint allows
movement in one direction/plane;
both joints allow flexion and extension;
hip joint allows abduction/adduction/circumduction/rotation while knee joint
does not; [2 max]

- B3.** (a) physical condition of the body that allows a particular exercise to be carried out / *OWTTE* [1]
- (b) both increase;
to meet increased aerobic (cell) respiration needs;
to supply needed oxygen and remove excess carbon dioxide; [2 max]
- (c) erythropoietin stimulates the production of red blood cells/increased red blood cell count;
oxygen transport capacity increased resulting in better muscle performance;
gives advantage over athletes that do not use it;
erythropoietin produced naturally by body so difficult to test for abuse;
increased blood viscosity / increased risk of blood clotting/heart attack/stroke;
results in exclusion/banning from competition; [3 max]
Award [2 max] if only risks are evaluated.

Option C — Cells and energy

C1. (a) $0.8 \text{ mol dm}^{-3} \text{ s}^{-1}$ $\left\{ \begin{array}{l} \text{(allow responses in the range of } 0.7 \text{ mol dm}^{-3} \text{ s}^{-1} \text{ to} \\ 0.8 \text{ mol dm}^{-3} \text{ s}^{-1} \text{)} \end{array} \right.$ [1]

(b) small/insignificant increase in oxygen;
much larger increase in lactate; [2]

(c) some ATP provided by anaerobic respiration because lactate levels rise;
ATP production by glycolysis is high/about 50 % of ATP demand;
ATP also provided by oxidative phosphorylation in aerobic respiration;
sample number too low to make definite conclusion; [3 max]

C2. (a) I. granum / grana $\left\{ \begin{array}{l} \\ \text{(both needed)} \end{array} \right.$ [1]
II. stroma

(b) large surface area of grana/thylakoids for light absorption/electron transport chains;
(small) space inside thylakoids for accumulation of protons;
(fluid) stroma contains enzymes/chemicals for light-independent reactions;
presence of DNA/ribosomes means production of specific proteins possible;
different photosynthetic pigments absorb different wavelengths of light;
starch grains store excess carbohydrates from photosynthesis; [3 max]

(c)

<i>oxidation</i>	<i>reduction</i>
involves loss of electrons	involves gain of electrons;
(frequently) involves gaining oxygen	(frequently) involves losing oxygen;
(frequently) involves losing hydrogen	(frequently) involves gaining hydrogen; [2 max]

Responses do not need to be shown in a table format.

C3. (a) collagen / fibroin / fibrin / elastin / keratin / myosin [1]
Award [1] for any two named examples. Allow any other valid example.

(b) unbound substrate does not fit active site / lock and key hypothesis not supported;
enzyme undergoes conformational changes/changes shape/moulded/hand and glove when substrate binds;
induced-fit allows broader specificity/range of substrates/range of environmental conditions; [2 max]
Accept any of the above points shown in a clearly annotated diagram.

(c) metabolic pathway is a series of enzyme-catalysed reactions;
end-product acts as inhibitor of enzyme at beginning of pathway;
allosteric site for inhibitor to bind / allosteric enzyme with two different binding sites;
more inhibition if end-product concentration rises;
prevents an excess of production/build-up of intermediate products; [3 max]

Option D — Evolution

- D1.** (a) 1977 / 1978 [1]
N.B. Some responses are interpreting this as a change between years.
- (b) both species increased (relative) beak size at the beginning of the study/ between the years 1973/1974 to 1977/1978;
no similarity in trend for both species after 1977/1978/1979 / no relationship between the two species in the years of increase and decrease;
more occurrence of decrease in (relative) beak size in *G. fortis* whereas *G. scandens* showed more increases in (relative) beak size;
G. fortis shows wider fluctuation in (relative) beak size than *G. scandens*; [3 max]
Do not accept year by year comparisons.
- (c) changes in environment/rainfall/ocean currents/migration / drought;
change in food supply;
hybridization/crossbreeding between species;
natural selection / selection pressure; [2 max]
- D2.** (a) deep-sea hydrothermal vents;
volcanoes;
extraterrestrial locations;
clay surfaces;
solutions within deep ice caps; [2 max]
- (b) some prokaryotes became capable of photosynthesis;
producing oxygen which accumulated in the atmosphere;
water used as a source of oxygen; [2 max]
- (c) gradualism is the slow change from one form to another;
requires long periods of time with relatively constant rate of change;
with punctuated equilibrium short periods of rapid evolution occur followed by long periods without change;
punctuated equilibrium fits with sudden environmental change/violent environmental conditions/volcanic eruptions/meteor impact;
in punctuated equilibrium, adaptations needed to cope with new environmental conditions/directional selection;
fossil record does not support gradualism / mass extinctions support punctuated equilibrium;
if no change in environment, then natural selection would oppose changes in gene pool; [4 max]

D3. (a) frequency of an allele/specific variation of a gene as a proportion/percentage of all copies of the gene

[1]

(b)

<i>cultural</i>	<i>genetic</i>
is the product of learning	is the cumulative changes in genetically inherited characteristics;
no change in allele frequency in gene pool	change in allele frequency in gene pool;
relatively important in recent human evolution	more important in earlier human evolution/ less important with modern medicine/food/ sanitation;
very rapid / can happen during a life-time	requires many generations / much slower;
passed between non-related individuals	only passed from parent to offspring;
nurture / acquired	nature / inherited;
modern technology hastens this	modern biotechnology has potential to hasten this;

[3max]

Responses do not need to be shown in a table format.

Option E — Neurobiology and behaviour

- E1.** (a) 12 cm s^{-1} (*units required*) [1]
- (b) 32 (%) [1]
- (c) at all velocities (of water flow) larvae swim both with and against current;
maximum (swimming) velocity is same (12 cm s^{-1}) at all velocities (of water flow)/going with or against current;
as velocity (of water flow) increases fewer larvae swim } (*accept correct numerical*
against current; } (*comparisons*)
at higher velocity (of water flow)/ 6.3 cm s^{-1} more larvae swim at faster net speeds; [2 max]
- (d) (data supports hypothesis as) some larvae able to swim against current at all (water flow) velocities;
(data supports hypothesis) since few larvae have net velocity of 0 cm s^{-1} most of them are actively swimming /not just moving with the current;
(data inconclusive) as more larvae swim along with the current at both velocities; [2 max]
- E2.** (a) I: sensory neuron } (*both needed*) [1]
II: motor neuron }
- (b) sensory receptors transfer stimulus energy into electrochemical energy;
mechanoreceptors respond to touch/pressure/movement/sound waves;
thermoreceptors respond to temperature changes;
chemoreceptors detect chemicals/molecules;
photoreceptors respond to electromagnetic stimulation/light; [2 max]
- (c) sound waves are (funneled through the ear canal) causing ear drum to vibrate;
vibrations of ear drum cause the bones of the middle ear/ossicles/malleus, incus and stapes/hammer, anvil and stirrup to move;
lever system of middle ear bones increases pressure on the oval window;
vibrations are transmitted from oval window through (fluid-filled) cochlea;
stimulation of hair cells/mechanoreceptors in cochlea;
vibrations are transformed into nerve impulses/action potentials;
impulse sent to brain along auditory nerve; [4 max]

- E3.** (a) innate behaviour develops independently of the environmental context/genetically inherited and learned behaviour develops as a result of experience / *OWTTE* [1]
- (b) young birds learn birdsong from parents/other adults;
young birds removed from parents capable of own song;
basic song template may be inherited;
learned birdsong is louder/richer; [2 max]
- (c) (cocaine causes) dopamine build up in synapses / continuous neurotransmitter presence;
increased energy/alertness/feeling of euphoria/pleasure;
user becomes isolated/suspicious/less productive / alienates family and friends;
cocaine addiction/use may lead to crime/robbery to buy cocaine; [2 max]

Option F — Microbes and biotechnology

- F1.** (a) rapid initial uptake (to approximately 75 % uptake);
rate of uptake slows and plateaus (at approximately 85 % uptake after 90 minutes);
only 90 % of cadmium ions absorbed (however long the contact time) / reaches maximum at 120 min; [2 max]
- (b) 64 (%) (allow responses in the range of 62 to 66 %) [1]
- (c) can remove almost 100%/98 % cadmium ions at pH 5 therefore very efficient;
A. fumigatus able to remove cadmium ions at pH values tested;
removal of cadmium ions more efficient at higher pH/weak acid;
strongly acidic/very low pH may inhibit/reduce uptake of cadmium ions by *A. fumigatus*;
pollution causing acidification of water may make removal more difficult;
A. fumigatus common therefore may be convenient/easy to use / *OWTTE*;
cadmium is not actually removed as it may pass along food chains / be released when *A. fumigatus* dies / unknown impact on environment; [2 max]
- (d) easier to store/collect/transport dead/dried material;
prevents overgrowth of *A. fumigatus*;
reduce BOD and allow other organisms to use more resources/live in water; [1 max]
- F2.** (a) letter X labelled anywhere on the arrow between Nitrate (NO₃) and Nitrogen (N₂) [1]
- (b)
- | | <i>habitat</i> |
|---------------------|---|
| <i>methanogens</i> | anaerobic environments / digestive tracts of animals / swamps / rice fields / tundra; |
| <i>thermophiles</i> | hot springs / hydrothermal vents / volcano vents / geysers; |
| <i>halophiles</i> | Dead Sea / salt lakes / evaporated salt water ponds; |
- [3]
- (c) creates a hypertonic solution/high solute concentration;
water moves out of cells by osmosis / cells dehydrate;
bacteria/moulds/microorganisms cannot survive; [2 max]

- F3.** (a) germ line therapy changes DNA in gamete/germ cell (so is passed on to offspring) and somatic therapy limited to changes in body cells / *OWTTE* [1]
- (b) viral vector used to replace defective gene in somatic cell;
virus genetically engineered to carry normal copy of gene;
normal gene expressed in body cells;
valid example; (*e.g. used to treat severe combined immune deficiency disease (SCID)*); [2 max]
- (c) used for producing DNA/genes for gene transfer;
transcribes (mature) mRNA to a single strand of cDNA;
cDNA produced has no introns;
host bacteria have no means to remove introns;
named example; (*e.g. production of human insulin*) [3 max]

Option G — Ecology and conservation

- G1.** (a) (i) 14 [1]
- (ii) trend is similar but differences/values at Konza are always higher;
 both show greater increase in non-grass abundance than grass abundance when single (large) herbivore species/buffalo/bison present;
 both have lower abundance when no (large) herbivore species/buffalo/ bison present than when single (large) herbivore species/buffalo/bison present; [1 max]
- (iii) grasses eaten by herbivore so increase less than non-grass abundance;
 herbivores spread seeds of different species between locations;
 herbivores change the habitat (*e.g.* by trampling/manure);
 herbivores prevent woody plants from growing and maintain grassland; [1 max]
- (b) Konza always has higher species diversity than Kruger;
 both increase in species diversity when a single (large) herbivore species/ buffalo/bison is present;
 Konza has greater increases than Kruger when a single (large) herbivore species/ buffalo/bison is present; [2 max]
Accept specific correct numerical comparison.
- (c) single (large) herbivore species/buffalo/bison appears to be better for plant community due to higher abundance and diversity;
 although multiple herbivore species/buffalo/bison result in less non-grass abundance than single species, it is higher than when no herbivore species are present;
 the numbers of single and multiple herbivore species/buffalo/bison are not given (so not enough information);
 no multiple herbivore species/buffalo/bison in Konza/only Kruger (so not enough information); [2 max]
- G2.** (a) temperature / water / light / soil pH / salinity / mineral nutrients [1]
Award [1] for any two abiotic factors.
- (b) regrowth following forest fire/fallow land/earthquake / other example of secondary succession [1]
- (c) fundamental niche is the potential mode of existence and realized niche is the actual mode of existence;
 fundamental niche depends on the adaptation of a species;
 competition/predation prevents a species from occupying its entire fundamental niche;
 realized niche is usually smaller than fundamental niche; [2 max]
- (d) organisms may fit into more than one trophic level;
 omnivores consume organisms from all levels of the food chain;
 there may be seasonal changes in trophic levels depending on food supply;
 some organisms alter diet with their life cycle (*e.g.* some amphibians); [2 max]

- G3.** (a) CFCs are broken down by ultraviolet (UV) light releasing chlorine / chloride ion reacts with ozone;
small amount of CFCs can break down large amounts of ozone/O₃;
thinning of O₃/ozone layer / reduces absorption of ultraviolet (UV) radiation; *[2 max]*
- (b) plant sources of pharmaceuticals lost if species become extinct / crops may be improved with alleles from wild plants;
ecotourism improves local economy/potential source of income/encourages local conservation;
interdependency of species may be disrupted / negative effects on food chains / native species adapted to local conditions whereas invasive species less likely to be in balance;
rainforest trees act as a carbon sink which is beneficial for global warming;
erosion/flooding/ silting of rivers occur with deforestation/removal of plants;
human indigenous population's ability to live sustainably within ecosystem might be affected / maintenance of rainforest preserves human cultural diversity;
loss of beauty of the system / artists are inspired by the images/flowers/animals of rainforests; *[3 max]*
-