



MARKSCHEME

November 2012

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 the IB Assessment Centre.*

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.
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) $\text{BMI} = \frac{\text{mass in kg}}{[\text{height in m}]^2}$ *or* $\text{BMI} = \frac{\text{mass}}{\text{height}^2} \text{ kg m}^{-2}$ [1]
- (b) (i) 125 (kg) (*accept answers in the range of 122 (kg) to 128 (kg)*) [1]
- (ii) 5 (kg) (*accept answers in the range of 4 (kg) to 6 (kg)*) [1]
- (c) (i) *the woman:* 11 (kg m^{-2}); (*accept answers in the range of 11.0 to 11.2*) } (*both*
the man: 31 (kg m^{-2}); (*accept answers in the range of 31.0 to 32.0*) } (*needed*) [1]
- (ii) *the woman:* anorexic / eating disorder / starvation / illness;
the man: overeating / lack of exercise / very muscular; [2]
Do not accept “obesity”, “glandular disorder” (too vague).
Award [1 max] if “appetite control centre does not function properly” is mentioned.
- (d) appetite control centre (in brain) makes person feel full/satiated/hungry;
 function is both nervous and hormonal;
after eating (centre) responds to hormones/insulin from pancreas / hormones/PYY from small intestine / hormones from adipose tissue/leptin in response to fat storage;
 (centre) responds to hormone/ghrelin released from empty stomach;
 part (of the centre) responds to levels of lipid/sugar in the blood; [2 max]
- A2.** (a) (i) unsaturated have at least one (carbon-carbon) double bond/ } (*both*
 some double bonds and saturated have none/only single bonds } (*needed*) [1]
- (ii) *cis*-hydrogen atoms are bonded to carbon atoms on same side } (*both*
 of double bond and *trans*-hydrogen atoms are bonded on } (*needed*) [1]
 opposite sides
Award marks to a clearly drawn, correctly labelled diagram.
- (b) (i) wound healing / formation of collagen / prevent scurvy / antioxidant / enzyme co-factor [1]
Ignore any reference to “prevents colds” as this is in the stem and mark the first function given after this.
Do not accept “increases immune system”.
- (ii) possibility of rebound malnutrition as body excretes too much;
 no consequence as excess is excreted/not stored;
 psychological/psychosomatic side-effects; [1 max]

- A3. (a) avoids allergies to proteins in cows' milk/soya;
appropriate proportion/type of nutrients; *(accept correct example of nutrient)*
promotes bonding between mother and baby;
naturally sterile / safer in poor water areas;
helps mother to lose weight after pregnancy;
(passive) immunity/antibodies against disease;
(frequent) breastfeeding can act as a natural birth control method (allowing more time between children);
lower mortality rates for breastfed babies; **[3 max]**
Ignore any references to benefits of bottle feeding or cost.

- (b) (dietary recommendations needed) to reduce blood glucose levels as target/
body/muscle cells less sensitive to insulin / not enough insulin produced;
reduce intake of (saturated) fats, to reduce weight;
reduce the intake of sugar/simple carbohydrates, causes rapid increase in blood glucose concentration;
eat more high fibre foods, satisfy appetite, but cannot be broken down;
regular/many small meals, to avoid (rapid) rise in glucose after a big meal;
eat complex carbohydrates/carbohydrates with a low glycemic index, digested and absorbed more slowly; **[3 max]**
To award the mark, answers require recommendation with a reason.

Option B — Physiology of exercise

- B1.** (a) 60 (beats min⁻¹) (*accept answers in the range of 58 to 64 (beats min⁻¹)*) [1]
- (b) (i) (heart) rate 80 (at 25 W) and (heart) rate 140 (at 250 W) (difference =) 60 (beats min⁻¹) (*both needed*) [1]
- (ii) greater as trained rower should have larger stroke volume / each (heart) beat more efficient / *OWTTE* (*accept converse*) [1]
- (c) cardiac output similar; trained stroke volume larger but heart rate lower / untrained stroke volume smaller but heart rate higher / *OWTTE*; (*accept converse*) [2]
- (d) the blood supply to the brain would not change – brain activity remains (relatively) constant; the blood supply to the skin would increase – so that more heat can be lost; *Both the change and brief explanation required for each mark.* [2]
- B2.** (a) glycogen acts as a carbohydrate/glucose store; myoglobin stores oxygen; [2]
- (b) *Award [1] for each structure clearly drawn and correctly labelled.*
 Z lines;
 thin actin filaments shown attached to Z lines;
 thick myosin filaments with heads;
 (two) light bands and dark bands; [3 max]
Award [2 max] for a poorly drawn or inaccurate diagram.
- B3.** (a) torn muscles – excessive stretching (causes muscle/muscle fibres to tear);
 sprain – stretching/minor tearing of ligament;
 torn ligament – ligament can tear completely;
 dislocation – bones can move out of alignment;
 intervertebral disc damage – soft centre of disc bulges out through tear in disc wall; [3 max]
Do not accept “bone fractures”.
If more than three injuries are addressed, only mark the first three.
- (b) lack of controlled trials to show effectiveness / evidence for effectiveness is thin/anecdotal;
 psychological preparation – getting body mentally ready for physical activity;
 prevent injuries – (warmed up) muscles/(stretched) tendons/ligaments may be less vulnerable to injury;
 improving performance – more blood flow to muscles, more oxygen supply; [3 max]

Option C — Cells and energy

- C1.** (a) negative correlation / as temperature increases the CO₂ absorption decreases / inverse relationship **[1]**
- (b) $4.6(\mu\text{mol m}^{-2}\text{ s}^{-1})$ **[1]**
Accept answers in the range of $4.3(\mu\text{mol m}^{-2}\text{ s}^{-1})$ to $4.9(\mu\text{mol m}^{-2}\text{ s}^{-1})$.
- (c) both show a decrease in CO₂ absorption/net photosynthesis as temperature rises;
 at each temperature the 700 ppm CO₂ sample shows greater rate;
 at higher temperatures the 700 ppm CO₂ sample can continue to photosynthesis /
 at higher temperatures the 400 ppm CO₂ sample loses CO₂/goes to net respiration;
 the 700 ppm CO₂ trendline/net photosynthesis is (slightly) steeper;
 at high temperatures/above 43 °C CO₂ absorption at 400 ppm CO₂ goes below zero
 while it never goes below zero at 700 ppm CO₂;
 more variation/greater scatter of results at 700 ppm CO₂; *(accept converse)* **[3 max]**
- (d) carbon dioxide is a limiting factor at 400 ppm CO₂ as rate increases at same temperature with increased CO₂ **[1]**
- (e) ATP and NADPH₂/NADPH + H⁺ *(both needed)* **[1]**
- C2.** (a) tertiary is the specific 3D structure (determined by the primary structure);
 giving rise to the specific shape of the active site;
 (tertiary structure) enables enzymes to bind (effectively) to substrate;
 determines whether some enzymes have broad or narrow specificity;
 inhibitors/cofactors can affect tertiary structure and therefore function; **[2 max]**
- (b) inhibitor is the product of the last reaction in a metabolic pathway;
 inhibits the enzyme that catalyses the first reaction;
 prevents build up of unnecessary product/only produced when needed;
 the inhibitor binds (reversibly) to the allosteric site (different from active site);
 this alters the shape of active site (so substrate will not fit); **[3 max]**
To award [3] answers must mention allosteric sites.

C3. (a) *Award [1] for two correct labels.*

- outer membrane;
 - inner membrane – showing folding to cristae;
 - cristae – shown as shelf-like infoldings of inner membrane;
 - matrix;
 - intermembrane space;
 - (70S) ribosomes – shown as small dots, not too large;
 - (naked) loop of DNA;
- Award [2 max] for a poorly drawn or inaccurate diagram.*

[3 max]

- (b) matrix is site of reactions of Krebs cycle;
thin intermembrane space to build up high proton concentration/[H⁺];
ATPase enzymes on inner membrane to produce ATP as protons pass back to matrix;
folded inner membrane / cristae to increase surface area (for electron transport chain);
ribosomes to make enzymes (required for Krebs cycle);

[3 max]

Option D — Evolution

- D1.** (a) 600 to 1150(cm^3) **[1]**
 Accept answers in the range of 575–625 to 1125–1175 (cm^3).
 Do not accept answers only giving the difference (eg: 550(cm^3)).
- (b) *Australopithecus* is shorter than *H. erectus*;
Australopithecus has a greater range in height than *H. erectus*;
Australopithecus has a smaller brain size than *H. erectus*;
Australopithecus has a very small range in brain size compared to *H. erectus*; **[2 max]**
 Accept converse. Do not accept numbers only.
- (c) (*hypothesis appears to be supported by the data as*)
H. sapiens has the greatest height and the largest brain size / *H. floresiensis* has smallest height and smallest brain size;
 the diagram shows a positive correlation/trend;
 (*hypothesis not supported by the data as*)
H. erectus and *H. sapiens* almost the same height but different brain size /
Australopithecus and *H. floresiensis* different height but similar brain size;
Australopithecus has large height range but a small brain size range;
 fossil record incomplete/possible limited specimens;
 no causal connection established; **[3 max]**
- (d) jaw projection/size;
 teeth size;
 brow ridge size;
 receding/slant of forehead
 flatness of the face;
 position of hole for spinal cord/foramen magnum; **[1 max]**
Comparing elements not necessary.

Option E — Neurobiology and behaviour

- E1.** (a) 20(KHz) **[1]**
- (b) 28(dB); *(accept answers in the range of 26(dB) to 30(dB))* **[1]**
- (c) as the frequency increases so does minimum loudness (that can be detected);
 the minimum loudness required to hear a sound remains (nearly) constant over the first 8(KHz) / slight decrease } *(accept 6(KHz) to 8(KHz))*
 initially from 0 to 2(KHz);
 from 8(KHz) onwards the minimum loudness increases } *(accept 6(KHz) to 8(KHz))*
 with frequency;
 from 16(KHz) onwards a greater rate of increase in minimum loudness; **[2 max]**
- (d) as age increases the minimum loudness/decibels required to hear sound increases across all frequencies;
 51 to 70 (years age) group requires the greatest minimum loudness across the whole frequency range;
 11 to 30 (years age) group requires the least minimum loudness across the whole frequency range;
 the two younger age groups shows a decrease in the ability to hear sounds after 8(KHz) whereas the 51 to 70 decrease from the start;
 all show (similar) difficulty in hearing sounds after 16(KHz); **[2 max]**
- (e) sound (waves) vibrate eardrum/tympanic membrane;
 movement is magnified by ossicles/middle ear bones;
 oval window vibrates / fluid in cochlea moves and moves hairs in cochlea;
 different frequencies detected by different parts of cochlea membrane and hair cells;
 these are connected to the auditory nerve; **[3 max]**
- (f) chemoreceptors / photoreceptors / thermoreceptors / baroreceptors **[1]**
Award [1] for three correct receptors.
- E2.** (a) innate behaviour develops independently of the environmental context, whereas learned behaviour develops as a result of experience **[1]**
*To award [1], answers need to address both innate and learned behaviour.
 Do not accept "instinct" as a description of innate behaviour.*
- (b) conditioned stimulus of sound/ringing bell / other stimulus used by Pavlov;
 replaces unconditioned stimulus of sight/smell of food;
 both result in conditioned response/production of saliva; **[2 max]**

E3. (a) Award **[1]** for every two correct responses.

<i>psychoactive drug</i>	<i>excitatory or inhibitory</i>
<i>alcohol</i>	inhibitory;
<i>amphetamines</i>	excitatory;
<i>benzodiazepines</i>	inhibitory;
<i>nicotine</i>	excitatory;

[2 max]

(b) THC binds to cannabinoid receptor;
blocks release of (excitatory) neurotransmitter;
therefore it is inhibitory;
euphoria/anxiety/short-term memory loss/impaired coordination/pain relief;
extended use leading to social dysfunction/addiction;

[3 max]

Option F — Microbes and biotechnology

- F1.** (a) 30 (arbitrary units) (*accept answer in the range of 29 to 31 (arbitrary units)*) [1]
- (b) rapid increase at the beginning/up to around day 8;
stable phase between days 7/8 to 15;
keeps increasing (not as much) after plateau / gradual increase after day 15; [2 max]
- (c) increase in respiration means more bacteria are present;
increase in gene ratio means the numbers of bacteria with C23O gene are increasing;
more bacteria with C23O gene breaks down more hydrocarbons;
after day 30 proportion of bacteria with C23O gene decreases so no longer effective/required; [2 max]
- (d) halophiles [1]
- F2.** (a) naked capsid or enveloped capsid;
shape of capsid varies (from helical/cylindrical to spherical/icosahedron);
DNA or RNA;
single stranded or double stranded DNA or RNA; [2 max]
- (b) catalyses production of DNA from RNA / used for cloning DNA;
copies DNA from mature mRNA / cDNA has no introns;
(cDNA) can then be spliced into host DNA;
host bacteria have no means to remove introns;
used for diagnosing microbial diseases (rapidly);
named example (*eg* human insulin); [3 max]

F3. (a)

<i>Chlorella</i>	<i>Euglena</i>
cell wall	no cell wall;
no method of locomotion	flagellum / locomotion;
autotrophic only	heterotrophic and autotrophic;
spherical	elongated/slipper-shape/bean shape;

[2 max]

*Do not award marks for similarities as the question asks to distinguish.
A table format is not necessary.*

- (b) (i) saprotrophs/decomposers feed on/break down organic material;
requires high oxygen/aerobic environment;
nitrifying bacteria convert ammonia to nitrates;
trickle filter bed/reed bed systems optimize environment for saprotrophs;

[2 max]

- (ii) release of raw sewage would deprive rivers of oxygen;
increase in BOD/biochemical oxygen demand / water deoxygenated killing aquatic organisms;
algal blooms;
give rise to eutrophication;
pathogens/*E. coli*/toxins make water unfit for human consumption;

[3 max]

Option G — Ecology and conservation

- G1.** (a) 1550(m) *(accept answers in the range of 1450(m) to 1650(m))* [1]
- (b) (i) both show decrease in abundance as depth increases;
 both show similar/low abundance at depths greater than 3000(m); *(accept values in range 2500(m) to 3000(m))*
 for depths less than 2500(m) the abundance is (much) greater in the early period than in the late period; *(accept values in range 2000(m) to 2500(m))*
 the highest abundance occurs in the late period (although this is isolated); [2 max]
- (ii) overfishing / pollution / change in sea temperature / change in food sources [1]
- (c) no evidence that there are fewer species;
 difficult to compare as more trawls in the early period /early period of longer duration than late period;
 diversity may have increased from (around) 2000(m) to 4000(m) / outliers for greater species diversity are all late period;
 not enough details about time of year/duration of trawls; *(accept any other valid argument)* [2 max]
Do not accept answers stating only "not enough data".
- (d) competition and predatory/predation *(both needed)* [1]
- G2.** (a) no two species can occupy the same niche/role in an ecosystem;
 too much competition occurs until one is eliminated / one out-competes the other;
 competition is for habitat/nutrition/relationships/space/limited resources; [2 max]
- (b) (i) process by which chemical substances become more concentrated at each trophic level [1]
- (ii) name of chemical and top consumer affected; *(both needed)*
 consequence; [2]
eg:
 DDT, affecting bird of prey;
 fragile egg shells which did not hatch affecting population size;

G3. (a)

primary succession	secondary succession
on newly formed land	previously occupied land;
<i>eg</i> volcano	<i>eg</i> after forest fire;
no organic content	soil with organic content;
no organisms present at start	organism may be present at start;
slower/longer process	quicker process;

[3 max]

To award [3] an example must be provided.

A table format is not necessary.

- (b) temperature affects metabolism/enzyme activity/transpiration rate/germination / each plant species has an optimum temperature range;
 light affects rate of photosynthesis/(time of) flowering;
 soil pH affects absorption of minerals/enzyme activity / each plant has an optimum pH range / some plants require acid soil / some plants require alkaline;
 salinity affects the osmotic potential / most plants function in narrow range of salinity / salts affect the water uptake by the plants;
 mineral nutrients required for synthesis of organic molecules;
 presence of (suitable) pollinator/dispersal organisms to aid reproduction;
 distribution (number and type) of predators/herbivores/diseases/pathogenic organisms which harm plants;
 competition from other plants (for resources);
 other valid factor with brief outline;

[3 max]

Accept examples for each factor eg nitrates are necessary for protein synthesis.

Award [0] for a list of factors.