



MARKSCHEME

May 2013

BIOLOGY

Standard Level

Paper 3

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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) *highest:* Affar; } (both needed) [1]
lowest: Tigray;
- (b) evidence of high malnutrition rates / some areas with many mothers below 18.5 BMI;
 large range/15–40 % range (in mothers below 18.5 BMI);
 many/6 regions in the range of 20–30 % / many/5 regions in the range of 22–25 % (are below 18.5 BMI); [2 max]
 lowest in Addis and highest in Affar/Gambela;
- (c) hypothesis not supported; (do not award if unqualified)
 no clear relationship / as malnutrition (mothers below 18.5 BMI) increases, there is no clear change in percentage male offspring;
 however, male birth percentage is usually higher than female (above 50 %) regardless of BMI / 9 of the regions are above/2 regions are below; [2 max]
- (d) no data about sex of the mothers’ other children;
 BMI below 18.5 means individual is underweight but not necessarily malnourished;
 the number of mothers sampled in each region is not known;
 no comparison between town and country;
 no information about age of mothers; [1 max]
- (e) food shortages / famine / insufficient food / poor food quality / warfare / epidemics / poverty [1]
- A2.** (a) (i) a chemical substance found in foods that is used by the body [1]
 (ii) an essential amino acid cannot be synthesized by the body but a non-essential amino acid can / *OWTTE* [1]
- (b) locally available foods may lack iodine;
 iodine is essential for normal thyroid activity/the production of thyroid hormone (thyroxin);
 iodized salt reduces incidence of goiter/can reverse goiter condition;
 supplementation helps pregnant mothers guard against brain damage in unborn; [2 max]
- (c) polyunsaturated fatty acids are preferable to saturated fatty acids;
 decreases risk of cardiovascular disease;
 provide (concentrated) energy / can lead to obesity; [2 max]

- A3.** (a) rice contains carbohydrates whereas fish contains protein/fats;
carbohydrates have less energy per gram than fats / similar/slightly more than protein;
carbohydrates contain approximately 1760 kJ per 100 g, protein 1720 kJ per 100 g and fats 4000 kJ per 100 g / fats contain (more than) twice as much energy per 100 g; *[2 max]*
- (b) high calorie / fatty food;
cheap high-energy food;
large portions / overeating;
lifestyles with less physical activity;
economic growth / increases in wealth; *[2 max]*
- (c) antibodies/natural immunities are passed on to infants;
bonding between mother and child;
composition of breast milk is better suited to the infant / no allergic reaction (to breast milk) / naturally sterile; *[1 max]*

Option B — Physiology of exercise

- B1.** (a) 50(%) [1]
- (b) reduces glycogen levels [1]
- (c) (i) both lower the glycogen level;
much greater reduction with 6000 m programme;
 no moderate (glycogen) levels exist after 6000 m programme / far more with
 no glycogen; [2 max]
- (ii) lower levels after 6000 m programme because more energy needed for
 longer swim;
 lower levels after 6000 m programme because the pace of swimming was
 faster;
 blood systems cannot supply glucose as fast as it is used during intense
 exercise;
 slow (type I) muscle fibres only have moderate stamina so are not ideal for
 faster swimming;
 less aerobic in 6000 m programme / *vice versa*; [2 max]
- (d) no measurement of glycogen levels in fast/type II muscle fibres;
 no mention of sample number/sex;
 data shows no SD or SE; [1 max]
- B2.** (a) muscle fibre is (partially) contracted;
 thick and thin filaments show considerable overlapping;
 narrow/reduced light bands between Z lines / *OWTTE*; [2 max]
- (b) for 8–10 seconds creatine phosphate regenerates ATP;
 anaerobic respiration produces ATP until lactate too high/for about 2 minutes/
 800 m of running; [2]
- (c) ATP breaks cross-bridges (between myosin and actin);
 ATP resets/activates/changes position of/cocks myosin heads;
 ATP provides energy to move actin/causes sliding of filaments; [2 max]
- B3.** (a) cartilage;
 synovial fluid;
 joint capsule (prevents fluid from leaking); [2 max]
- (b) stroke volume is how much blood the heart pumps out with each contraction/beat
 whereas cardiac output is the volume of blood the heart pumps per minute [1]
Accept cardiac output = stroke volume × heart/pulse rate or OWTTE.
- (c) (i) the brain [1]
- (ii) repay oxygen debt / oxygen needed to convert lactate into pyruvate [1]

Option C — Cells and energy

- C1.** (a) 3.2 (arbitrary units) (*accept answers within the range of 3.1 to 3.3*) [1]
- (b) all have a peak at (approximately) 450 nm;
all emit light over a similar range of wavelengths;
A emits more than B which emits more than C / *OWTTE*; [2 max]
- (c) fluorescence rises then falls [1]
- (d) identification of stage of ripening [1]
Accept any other reasonable suggestion.

- C2.** (a) name of protein; } (*both needed*) [1]
function of protein; }
- (b) enzymes speed up/catalyse metabolic reactions;
by reducing the activation energy;
each reaction (in the pathway) has a different enzyme;
metabolic pathways can be controlled by controlling which enzymes are produced;
end-products of a metabolic pathway act as inhibitors;
end-product inhibitors bind to/inhibit an enzyme at the start of the pathway; [4 max]
- (c) the link reaction produces acetyl CoA/acetyl group/CH₃CO;
acetyl group/CH₃CO joins with 4 carbon compound/OAA from cycle;
both occur in the (mitochondrial) matrix; [2 max]

- C3.** (a)
- | <i>oxidation</i> | <i>reduction</i> |
|-----------------------|--------------------------|
| loss of electrons | gain of electrons; |
| oxygen (often) gained | oxygen (often) lost; |
| hydrogen (often) lost | hydrogen (often) gained; |
| energy lost | energy gained; |
- [2 max]

- (b) ATP;
NADH / H⁺;
three-carbon (atom) compound/pyruvate; [1 max]
Award [1] for any two of the above.
- (c) increase the surface area of inner (mitochondrial) } (*note: mitochondria*
membrane; } *is in the stem*)
allow electron transport because of embedded protein electron carriers;
facilitate proton pumping because of high surface to volume ratio/increased
surface area;
increase ATP production because of ATP synthase/synthase embedded in
membrane; [3 max]

Option D — Evolution

- D1.** (a) 11° (accept answers in the range of 10.5° to 11.5°) [1]
- (b) 6° (accept answers up to 7°) (working not required) [1]
- (c) mean/average of Swartkrans less than larvae;
range of Swartkrans less than larvae;
no overlap between the two in terms of widths of scratch marks / widest Swartkrans
less width than the narrowest larvae; [2 max]
Do not accept responses stating numerical values only.
- (d) *from the photograph:*
(*A. robustus*) ate termites because the pattern of scratch marks on the tool are of
similar angle;
- from the graph:*
(*A. robustus*) ate termites because the ranges of widths/means of angles/widths are
more similar; [2]
- (e) 1.4 to 1.8 million years ago (accept answers within this range) [1]
- D2.** (a) $^{14}\text{C} / ^{40}\text{K}$ [1]
- (b) opposable thumb / grasping limbs;
mobile arms / flexible shoulder blades;
forward-facing eyes / stereoscopic vision; [2 max]
- (c) more meat in diet correlates with larger brain size in hominids;
meat has much protein, fat and energy needed by brain to grow;
hunting animals requires more intelligence than gathering food/foraging / hunting
favours natural selection of larger brain; [2 max]
- D3.** (a) to demonstrate that organic compounds could have spontaneously formed on the
(surface of) early Earth [1]
- (b) RNA molecules could have acted as catalysts/enzymes/ribozymes;
RNA could have replicated itself;
allowing inheritance of characteristics/catalysts / reproduction / formation of
simple polypeptides; [2 max]
- (c) meaning of species has changed over time / no longer just based on morphological
features/phenotype;
species members also resemble each other in physiology/biochemistry/DNA
sequences/use of habitat/behaviour;
but species can evolve and features change/species gradually split up;
definition now based on ability to interbreed/produce viable, fertile offspring;
gene flow among populations of the species maintains the species' uniqueness;
some interspecific hybrids are fertile making categorization difficult;
further accurate discussion point about species definition; [3 max]

Option E — Neurobiology and behaviour

E1. (a) 6 months [1]

(b) no clear trend in the inner layer whereas there is a decrease in the outer layer;
 outer layer is higher (than inner layer) at 2 months and lower at 18 months;
Accept any other correct comparisons. } *(do not accept statements that are not comparisons)*

(c) volume of neurons remains the same;
 synapse density in the outer but not the inner layer decreases with age;
 number of neurons may not be reduced even with fewer synapses; [2 max]

(d) smell perception may fall in aging humans;
 changes in smell perception may change food eating habits/reduce quality of life;
 ageing human brains may lose synapses but not neurons (as previously thought);
 losing synapses in one part of the brain may be repeated in other parts of the brain; [2 max]

E2. (a)

<i>ganglion cells</i>	→
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bipolar cells	→
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<i>rods and cones</i>

[1]

(b) optic nerves from right eye and left eye/cross meet at the optic chiasma;
 right brain (hemisphere) processes information from the left visual field from both eyes / *vice versa*;
 enables (brain) perception of depth and size; [2 max]
Do not award marks for answers suggesting that all impulses from the left eye pass to the right side of the brain and vice versa.

(c) (i) I: pinna;
 II: ear drum / tympanic membrane; } *(both needed)* [1]

(ii) cilia/hair/hair bundles of hair cells vibrate with (cochlear) liquid/fluid movement [1]

- E3.** (a) (i) a change in the environment (internal or external) that is detected by a receptor and elicits a response / *OWTTE* [1]
- (ii) excite and inhibit (*both needed*) [1]
- (b) taxis is (innate) movement toward or away from stimulus [1]
- (c) dopamine stimulates brain's reward system/pathways / addiction requires dopamine excess in brain;
inhibitory drugs/benzodiazepines/alcohol/drugs decrease neuron activity that inhibits dopamine release so brain becomes addicted;
excitatory drugs/cocaine/amphetamines/nicotine block removal of dopamine stimulating brain (reward system);
genetic component involved;
genetic tendency for addiction influenced by social factor/example of social factor (*eg* peer pressure, poverty, social deprivation, trauma, mental health problem/culture); [3 max]

Option F — Microbes and biotechnology

- F1.** (a) 55°C (*units required*) [1]
- (b) 30 litres (*accept answers in the range of 28.8 to 30.0 litres*)
Working not required. [1]
- (c) good because it kills/is free of bacteria;
no bacteria between 80° and 60° even at higher flow rates;
not good as it would use too much energy/be expensive to heat water; [2 max]
- (d) the slower the flow rate, the lower the temperature [1]
- (e) water purifier is effective in removing bacteria;
no bacteria in 12/15 test sites, regardless of temperature or flow rate;
flow rate is less important than temperature;
no information about how contaminated the water was before various treatments;
no information about how effective the water purifier is in removing other harmful
bacteria/substances; [2 max]
- F2.** (a) capsid / naked or enveloped capsid;
nucleic acid / DNA or RNA;
number of strands on nucleic acid / single or double strands; [2 max]
- (b) Gram staining is used to classify bacteria/Eubacteria;
cell wall structure determines how Gram stain is received;
bacteria termed as Gram-positive or Gram-negative;
Gram-positive bacteria appear purple;
Gram-negative bacteria (stain less intensely and) appear pink/red; [3 max]
- (c) most attempts have been unsuccessful/caused harm or death/caused emotional
trauma/conflicts of interest/ethical issues;
might alleviate (genetic) condition / correct a (genetic) defect; [2]
- F3.** (a) lack of oxygen / anaerobic conditions;
excess water / bog/marsh conditions; [1 max]
- (b) high salt content;
extreme temperature (high or low);
extreme pH conditions; [1 max]
- (c) high salt concentration prevents growth of microbes/kills microbes;
withdraws water from microorganisms;
through osmosis; [2 max]

Option G — Ecology and conservation

- G1.** (a) grasses [1]
- (b) (i) feeding time on grasses (slightly) reduces / feeding time on bushes increases [1]
- (ii) feeding time on grasses (greatly) reduces / feeding time on bushes increases [1]
- (c) feeding is similar without predators;
more feeding on grass by adults with predators; [2]
- (d) instars are more protected from predators/camouflaged when feeding in bushes;
adults can escape predator attacks more easily/camouflaged when feeding in grasses;
adults are bigger and less easily captured; [1 max]
Accept other reasonable responses.
- (e) grasses because at warm temperatures (almost all stages of) grasshoppers spend (proportionally) more time feeding on bushes than grasses [1]
- G2.** (a) niche is an organism's ecological role/mode of existence;
niche is how organism uses abiotic and biotic resources;
depends on where organism lives/habitat;
depends on organism's nutrition/feeding activities;
depends on interactions (competition/herbivory/predation/mutualism) with other organisms; [3 max]
- (b) two species cannot exist in same identical niche / only one species can occupy a niche;
because of competition for same resources;
one species will win competition/survive and one species will lose/migrate/die out; [2 max]
- (c) competition from/predation by alien species;
Also allow:
name of species and what caused it to become extinct; [1]
*The named species must be **extinct** and not endangered.*
eg:
passenger pigeon (became extinct when) hunted as a source of food;
Note: dinosaur is not a named species.
- (d) it allows comparison of the biodiversity in two different (local) communities /abiotic conditions;
it allows comparison of the biodiversity at two different times in the same community / longitudinal study / change in the environment; [1 max]

- G3.** (a) gross production is sum total of all organic matter produced whereas net production is total left after subtracting amount used for respiration **[1]**
- (b) (increased) mutation rates;
(increased) (skin) cancer;
(increased) sunburn/skin wrinkles/eye cataracts; } *(answers must suggest an increase in incidence)*
reduced crop production/photosynthesis rates;
unpredictable effects on ocean phytoplankton affecting world primary production; **[3 max]**
-