M13/4/BIOLO/SP3/ENG/TZ1/XX/M

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MARKSCHEME

May 2013

BIOLOGY

Standard Level

Paper 3

17 pages

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 <u>underlined</u> 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) high (vitamin C) causes a positive change (in BMD) whereas medium/low causes negative change;
inversely proportional (for relative change);
if Vitamin C intake increases, BMD increases; ***[1 max]***

(b) positive change/reduced loss for femoral neck at all levels whereas only at high intake for spine;
higher values for femoral neck for each intake categories;
inversely proportional for both;
no overlap between range/standard deviation / clear distinction of protective effect between femoral neck and spine (for high/all intake categories); ***[2 max]***

(c) *Implications:*
high intake results in positive value (for all locations);
protective effect proportional to intake;

Limitations:
proportion of vitamin C intake from supplements / influence of other factors not stated;
only a few bone locations measured / sample size unknown / high medium and low not defined; ***[2 max]***
At least one implication and one limitation required.

A2. (a) (i) chemical substance found in foods that is used in the (human) body ***[1]***

(ii) amino acid that can be synthesized in the body (from other nutrients/amino acids) ***[1]***

(b) (i) energy value of 100 g protein ≈ 1720 kJ / energy value of protein ≈ 17 kJ/g;

$$2\,\text{g protein} \times \left(\frac{\text{energy value / ECF kJ of 100 g protein}}{100\,\text{g protein}} \right) = 34.4\ \text{kJ/ECF kJ value;}$$ ***[2]***

Answer range 34–35 kJ/ECF kJ.
For calculation note error carried forward.
Units required. If no units deduct a mark and indicate in scoris U –1.

(ii) wheat and rice almost equivalent for energy value;
rice has only slightly less kJ/energy from fat/protein / more from carbohydrate;
considering food miles / availability may be decision factor for choice; ***[2 max]***

(c) dietary cholesterol correlated to blood cholesterol/fatty acids;
high blood cholesterol is an important risk factor (but not the only cause);
some cholesterol required for normal synthesis of body molecules;
genetic factors play an important role in determining cholesterol levels;
other environmental factors (smoking) play a role in determining cholesterol levels; ***[2 max]***

A3. (a) 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 centre responds to levels of lipid/sugar in the blood; ***[2 max]***

(b) high amount of one nutrient may cause deficiency in another one;
excess protein not stored as protein by the body / converted to fat;
results in weight/mass loss in many people (due to fat/carbohydrate deficiency);
health problems such as kidney stones/other health problems;
high protein as part of a weight/mass loss diet; ***[3 max]***

Option B — Physiology of exercise

B1. (a) 142–117/25 mm Hg *(Units required)* ***[1]***

(b) pressure at systole/diastole / diastolic/systolic pressure increases;
pressure at diastole/diastolic pressure does not change much;
time between heartbeats decreases / heart beats/rate faster; ***[2 max]***

(c) *Arguments supporting the need for adjustment:*
(blood) pressure increased but then decreased later in flight;
time between heartbeats (at rest) increased then decreased / heart rate decreased then increased;

Arguments not supporting the need for adjustment:
(blood) pressure/time between heartbeats/heart rate does not change (much) in space;
data is from a few trained astronauts and may not reflect general population / *OWTTE*;
data for more extended periods of time not included (so difficult to evaluate); ***[3 max]***
*Award **[2 max]** if only one perspective is presented.*

B2. (a) the physical condition of the body that allows it to perform exercise of a particular type / *OWTTE* ***[1]***

(b) (i) connect bones to bones / enable joint movement/flexibility/articulation/ prevent dislocation ***[1]***

(ii) complete/partial separation/damage/breaking of the ligament ***[1]***
Do not accept tearing of ligament.

(c) insufficient oxygen/anaerobic cell respiration;
results in buildup of lactate/oxygen required to remove lactate; ***[1 max]***

(d) increased (muscle) cell respiration releases more CO_2/decreases pH (in blood);
detected by (respiration centre in) brain/medulla;
signal sent to respiratory muscles to contract at a faster rate;
more oxygen carried by the blood / needed for aerobic (cell) respiration; ***[2 max]***

B3. (a) *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;
light and dark bands; ***[2 max]***

(b) calcium/Ca^{2+} frees myosin binding sites on actin/thin filament;
ATP (linked to myosin head) hydrolysed to ADP + P(i);
myosin head cocked/assumes high energy configuration;
myosin head binds to actin / forms a cross-bridge;
actin filament slides towards center of sarcomere / dark band;
combined sliding of actin filaments shortens muscle fiber / muscle;
ATP binds to myosin head and breaks cross-bridge; ***[4 max]***
Accept answers with properly annotated diagrams.

Option C — Cells and energy

C1. (a) 0.08 mmol m^{-2} *(Accept answers between 0.07 and 0.09 mmol m^{-2}. Units required.)* ***[1]***

(b) 22.5 (%) *(Percentage symbol is not required. Accept answers between 22.0 and 23.0)* ***[1]***

(c) to absorb the same quantity of light (as high intensity) ***[1]***

(d) (hypothesis is supported as) there is an increase in chlorophyll/nitrogen content for the three species at lower light intensity;
(hypothesis is not supported as) total leaf nitrogen decreases in low light for *Alocasia* and *Phaseolus* but not for *Spinacia*/remains the same for *Spinacia*;
greatest difference in *Alocasia* / smaller differences in the other two species;
chosen species may not be representative of all plants;
(hypothesis is not supported as) increase in nitrogen may be due to stroma protein; ***[3 max]***
Reject unqualified answers suggesting only that there are insufficient data.

C2. (a) (i) secondary (structure) / α helix ***[1]***

(ii) fixes/adds carbon/CO_2 to RuBP ***[1]***

(b) unbound substrate does not fit active site/lock and key hypothesis not supported;
enzyme undergoes conformational changes/changes shape/moulded/when substrate binds;
induced-fit allows broader specificity/range of substrates/range of environmental conditions; ***[2 max]***

(c) inhibitor binds to enzyme at different location than active site;
this causes a change in the shape/conformational change of active site;
thus preventing the substrate from binding to the active site / resulting in a decrease of enzyme activity/speed of reaction; ***[2 max]***

C3. (a) takes place in cytoplasm;
glucose is phosphorylated/two molecules/moles of ATP used;
one hexose sugar/glucose is converted into two three-carbon/3C molecules/hydrolysis;
pyruvate is formed/oxidation of glucose to pyruvate;
small yield/net gain of two ATP;
net gain of two NADH + H^+;
does not require/use oxygen/anaerobic process; ***[3 max]***

(b) each photosynthetic pigment has a different absorption spectrum;
as light of different wavelengths is absorbed differently;
absorption spectra combine to create the action spectrum / action spectrum shows how much photosynthesis occurs at each wavelength;
so plant can use a wider range of wavelengths for photosynthesis;
appropriate labelled diagram of absorption and action spectra;
action spectrum takes into account "in vivo"/actual environmental conditions; ***[3 max]***

Option D — Evolution

D1. (a) yield (much) higher for all numbers of cycles than without catalyst;
maximum reached at 4 cycles;
yield at 7 cycles lower than at 4 cycles; ***[2 max]***

(b) both (histidine and glycine) show catalytic activity;
histidine more effective/greater % yield than glycine (after 4/7 cycles);
glycine more effective (than histidine) after 1 cycle;
effectiveness of glycine decreases after 4 cycles whereas of histidine remains high; ***[3 max]***

D2. (a) (i) time required for half/50 % of atoms of an element in a sample to decay/transform into another element / *OWTTE* ***[1]***

(ii) ratio of ^{40}Ar to ^{40}K of a sample calculated;
compared to ratio in actual organisms;
half-life of ^{40}K is 1.25×10^9 years;
decrease proportional to number of years of decay / used to measure the age of fossils millions of years old; ***[2 max]***

(b) early photosynthetic prokaryotes used photosynthesis;
(water used as source of hydrogen) oxygen released as waste product;
concentrations built up over (a relatively short) time;
evidence that there was little free oxygen/no evidence for O_2-rich atmosphere before photosynthetic prokaryotes; ***[2 max]***

(c) stereoscopic vision/flattened face / with two eyes pointing in same direction;
rotating shoulder;
dental formula;
opposable thumb / grasping limbs;
nails instead of claws;
large brain;
single pair of mammary glands; ***[2 max]***

D3. (a)

convergent	*divergent*
different origin	same origin;
results in similar structures/ adaptations / analogy	results in different structures/ adaptations / homology;
both are processes happening over time as a result of environmental change/selection pressure;	

[2 max]

Reject unqualified statements to the effect that both are types of evolution.

(b) *Polyploidy:*

having more than 2 (complete) chromosome sets/ description of polyploidy;
happens through chromosome mutation / non-disjunction;
occurs more frequently in plants than animals;

Contribution to speciation

polyploids cannot reproduce with original species / meiosis fails / chromosomes cannot pair;
creates reproductive barrier;
but can self-fertilize / reproduce with similar individuals;
thus forming a new species;
new species formed by sympatric speciation; ***[4 max]***

Option E — Neurobiology and behaviour

E1. (a) 0.8 *(Accept answers from 0.75 to 0.85.)* ***[1]***

(b) increases neuron activity;
increase over three days/increase of about 75%/of 50–100%;
then plateaus/levels off;
large variation on days 14 and 15; ***[2 max]***

(c) small sample so one measure can skew the average / higher average value due to only one measurement;
different birds respond differently/nothing being learned;
change in behaviour due to biotic/abiotic changes; ***[1 max]***

(d) hypothesis seems to be verified since all points after exposure to birdsong are higher;
learning phase (supported by changes on days 5–7);
experiment shows only one brain area activity / other factors may also be involved; ***[2 max]***

E2. (a) I iris
II vitreous humour
III choroid
IV fovea *(do not accept yellow spot)* ***[2]***
Award ***[1]*** *for every two correct answers.*

(b) (i) a change in the environment that is <u>detected by a receptor</u> (and elicits a response) ***[1]***

(ii) a <u>rapid/fast unconscious</u> response (to a stimulus) ***[1]***

(c) (dissolved) chemicals detected by taste buds (in the tongue and mouth);
(airborne) chemicals detected by (olfactory) receptors;
chemicals/ions/pH in blood (for example CO_2/glucose) detected by chemoreceptors (in carotid artery/medulla oblongata);
neuroreceptors detect neurotransmitters; ***[2 max]***

E3. (a) dopamine initiates depolarization of post-synaptic membrane;
cocaine binds to (transporter) carrier proteins/proteins in pre-synaptic membrane;
cocaine blocks reabsorption (of dopamine);
cocaine causes dopamine build up in synaptic cleft/space;
so stimulus continues/cocaine is excitatory; ***[3 max]***

(b) optic nerves carry impulses from eye to brain;
(nerve fibres in) optic nerves cross at optic chiasma;
neurons from right visual fields from both eyes go to left brain/vice versa;
visual areas in the brain can therefore judge distance;
produce 3D image/perceive depth; ***[3 max]***
Do not award marks for stating that all impulses from the left eye pass to the right side of the brain and vice versa.
Accept answers with properly annotated diagrams. Labelled diagrams with no explanation is worth ***[2 max]****.*

Option F — Microbes and biotechnology

F1. (a) $20\,g\,l^{-1}$ *(Accept answers from 20 to 21. Units required.)* ***[1]***

(b) at 30°C ethanol produced more quickly/increased rate of production/positive correlation ***[1]***

(c) (i) glucose ran out ***[1]***

(ii) cells are dying / enzymes denatured ***[1]***

(d) *Arguments against low temperature*
high temperatures kill *B. bruxellensis*;
high temperatures results in low acetic acid in wine;
high temperature results in low alcohol content;

Arguments for low temperature
rate of fermentation/use of glucose/alcohol production is higher;
no real arguments for low temperature as *B. bruxellensis* growth rate/acetic acid production high; ***[3 max]***

Must include at least one for and against point for full marks.

F2. (a) <u>anaerobic</u> fermentation of biomass/manure/suitable biomass material;
bacteria convert biomass into organic acids and alcohol;
bacteria produce CO_2 and H_2;
<u>methanogenic</u> bacteria produce methane;
by reducing/reacting CO_2 with hydrogen gas/ $CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$;
or directly from organic acids/acetate/ $CH_3COOH \rightarrow CH_4 + CO_2$; ***[3 max]***
Accept suitable word or chemical equations for the last two marking points.

(b) *Euglena* have a flagellum;
Paramecium have cilia; ***[2]***

F3. (a) Archaea have 70 S ribosomes whereas Eukarya have 80 S;
Eukarya have introns and histones while Archaea do not;
cell walls present in all Archaea but only in some Eukarya; ***[2 max]***
Comparison required for each mark.

(b) raw sewage contains pathogens;
can contaminate drinking water / cause disease/death;
nitrate fertilizers cause algal blooms/(aquatic) plant development;
algae release toxins that can contaminate drinking water;
more organic matter results / eutrophication;
more oxygen required to decompose organic matter / increase in BOD;
(leading to) death of aquatic animals/organisms;
recovery follows since algae/plants release more oxygen; ***[4 max]***

Option G — Ecology and conservation

G1. (a) (i) early succession species/examples of species /(numerical species numbers)/9 ***[1]***

(ii) *stress-tolerance value:* 34 *(Accept answers between 33 and 35)*
competitiveness value: 38 *(Accept answers between 37 and 39)* ***[1]***

(b) high ruderalism and (slightly higher) competitiveness in early succession;
(as time goes / succession stages advance) stress-tolerance increases;
competitiveness decreases;
ruderalism decreases/is more variable;
competitiveness least important factor / stress-tolerance most important factor;
exceptions for all categories; ***[3 max]***

(c) they can occupy the space/colonize in a very short time;
they do not need to be adapted to the area to grow;
fast reproduction/rapid growth;
low requirements/grow while in nutrient-poor soils;
low competition; ***[1 max]***

G2. (a) a biome is a geographical region where similar climate conditions give rise to similar vegetation (whereas) the biosphere refers to all areas of the Earth (atmosphere, hydrosphere, lithosphere) where living things can be found / *OWTTE* ***[1]***

Both parts (biome and biosphere) are needed to award the mark.

(b)

Biome	*Temperature*	*Moisture*	*Vegetation*
tropical rain forest	***hot; little fluctuation***	***wet***	***evergreen / stratified***
desert	variable daily and seasonally / extreme daily variations / some deserts cold and some deserts hot	very dry, very low rainfall/long periods without rain	few/scattered (with bare ground) / xerophytes
savanna	high/little seasonal fluctuations	dry/low rainfall/long dry season	grasses with scattered trees
grassland	cold to warm / seasonal fluctuations	medium dry / moderate rainfall / rainfall seasonal	mainly grasses
broadleaf / deciduous forest	moderate, seasonal variations / cool winters, warm summers	moist/moderate rainfall / rain throughout year	trees with broad leaves/deciduous / trees shed leaves (in winter)
coniferous forest / taïga	low temperatures, seasonal variation / very cold winters, short cool summers	moist / moderate rainfall / irregular rainfall	conifers
tundra	low temperatures / very long cold winters	little precipitation, mainly snow / higher for alpine	herbaceous with lichens and mosses / shrubs / dwarf trees

[3 max]

Points are awarded for temperature, moisture and vegetation.
*Award **[3]** for 8–9 correct points.*
*Award **[2]** for 6–7 correct points.*
*Award **[1]** for 3–5 correct points.*
*Award **[0]** for 2 or fewer correct points.*

(c) productivity decreased in general;
affects molecules related to photosynthesis / photosystems (in plants / plankton);
and nitrogen-fixation (bacteria / cyanobacteria);
effects on stages in food chain after producers;
UV damages DNA;
but organisms have repair mechanisms / damages may not be as important as expected;
has little effect on aquatic organisms; ***[2 max]***

G3. (a) consumer may have more than one food source;
organisms eaten may be at different trophic levels;
may change their trophic level over time;
different stages in life cycle might exist in different trophic level (*eg* frog);
example of organism (presenting such a difficulty); ***[2 max]***

(b) a process in which chemical substances become more concentrated at each trophic level;
valid named example (for example mercury, organophosphorous pesticides, DDT, TBT);
these substances cannot be broken down / are broken down slowly by metabolism;
are often stored in (adipose) tissues;
each organism consumes large quantities of the trophic level below it;
so substance accumulates/increases to reach toxic levels; ***[4 max]***
*If no example is given award **[3 max]**.*