M10/4/BIOLO/SP3/ENG/TZ2/XX/M+

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MARKSCHEME

May 2010

BIOLOGY

Standard Level

Paper 3

16 pages

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. 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.

9. 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 — Human nutrition and health

A1. (a) higher BMI increases risk of type II diabetes / risk increases as the BMI increases;
greater risk for women than for men / men have a lower risk than women;
values above $25\,kg\,m^{-2}$ increase the risk of diabetes exponentially / BMI below $25\,kg\,m^{-2}$ shows minimal risk; ***[2 max]***

(b) 21 % *(allow answers in the range of 20 % to 22 %)* ***[1]***

(c) indicated by marks on the graph on the vertical axis or on the line of the woman 8 % to 33 % *(allow 1 % error at either end)* ***[1]***
Information must be indicated on the graph.

(d) moderate portions of food to avoid fluctuations in blood sugar levels;
regular mealtimes to avoid fluctuations in blood sugar levels;
include unrefined carbohydrates because they are more slowly absorbed; *(accept reverse for refined)*
include carbohydrates with a low glycemic index; *(accept reverse for high)*
include fibre-rich foods to slow absorption of sugar;
limit saturated/trans fats/cholesterol because diabetes increases risk of coronary heart disease; ***[4 max]***

A2. (a) human milk contains human proteins while artificial milk contains soya/bovine proteins / more proteins in artificial milk;
in human milk, fatty acids are derived from human butterfat rather than vegetable oils;
human milk has antibodies/provides immunity but artificial milk does not;
human milk contains lactose whereas artificial milk does not;
artificial milk contains more iron; ***[2 max]***

(b) Asian groups: rice;
Pacific Islanders: cassava;
African groups: cassava;
European: wheat/potatoes;
Euro-American groups: wheat/potatoes;
Native Americans: corn/maize;
Andean groups: potatoes/rice;
other verifiable examples can be used; ***[2 max]***
More specific ethnic group names would be appropriate.

(c) too much fat may result in weight gain/obesity;
(obesity) increases risk of coronary heart disease;
another health-related risk *e.g.* type II diabetes / atherosclerosis / arteriosclerosis / high blood pressure;
inadequate consumption of other essential nutrients; ***[3 max]***

A3. (a) fatty fish *e.g.* mackerel/tuna/sardines/herring *etc.*;
liver;
eggs;
fortified dairy products; ***[1 max]***

(b) sunlight stimulates skin to synthesize vitamin D;
less sun exposure/insufficient vitamin D leads to skeletal deformities/rickets;
UV radiation increases the incidence of skin cancer/melanoma;
vegans/vegetarians are more likely to lack vitamin D so need more exposure to sunlight; ***[2 max]***

Option B — Physiology of exercise

B1. (a) $63.2\,\text{ml}\,\text{min}^{-1}\,\text{kg}^{-1}$ ***[1]***

(b) ventilation rate (increases more);
heart rate $\frac{(177-126)}{126}\times 100 = 40\%$ and ventilation rate $\frac{(42.9-26.0)}{26.0}\times 100 = 65\%$; ***[2]***
To award the second mark both the heart rate and the ventilation rate are needed.

(c) $4.42\,\text{l}\,\text{min}^{-1}$ ***or*** $4.42\times 10^{3}\,\text{ml}\,\text{min}^{-1}$ ***or*** $4424\,\text{ml}\,\text{min}^{-1}$ ***[1]***

(d) no data was collected while the subject was at rest;
intervals of data collection are not regular;
only one subject has been used / data is insufficient for generalizations;
data collection was not continued beyond 13:17 to verify that the final data reading is actually the VO_2 max / no plateau phase reached; ***[2 max]***

B2. (a) (i) the volume of blood pumped out of the heart with each contraction ***[1]***

(ii) the volume of blood pumped from the heart per time/minute ***[1]***

(b) stroke volume increases which reduces the number of beats required to maintain cardiac output ***[1]***

(c) during exercise blood flow is different than at rest;
during exercise, blood flow to abdominal organs decreases;
during exercise, blood flow to skin/skeletal muscles/heart wall increases;
blood flow to the brain remains constant; ***[3 max]***

B3. (a) anaerobic respiration;
creatine phosphate; ***[2]***

(b) *pros*:
some natural occurring substances can vary according to body, so it would level out all athletes;
should be able to advance sport to the maximum possible level;
allows injured athletes to recover faster;
other reasonable argument;

cons:
(many performance-enhancing substances) have negative/unintended side-effects;
one named side-effect of a named substance;
give some athletes unfair advantages over others;
some are unnatural;
other reasonable argument; ***[4 max]***
*To award **[4 max]** responses require at least one pro and one con.*

Option C — Cells and energy

C1. (a) March *[1]*

(b) (at) 140 m (of water depth) because there is no photosynthesis (except slight in June and October) *[1]*

(c) increased light penetration due to decrease in phytoplankton numbers/cloudiness;
(as the summer season approached) the Sun would be directly overhead making deeper light penetration probable; *[1 max]*

(d) there is greater total production in March than in September;
the water at 100 m is relatively more productive in September than in March / the water at 100 m is unproductive in March, but is productive in September;
total production in March is approximately 28 to 29 $mg\,m^{-3}\,day^{-1}$ whereas in September it is approximately 8 $mg\,m^{-3}\,day^{-1}$;
the upper 40 m have their highest productivity in March and their lowest productivity in September; *[3 max]*

C2. (a) *Award marks for any of the following clearly drawn and correctly labelled.*
cristae;
inner membrane;
outer membrane;
intermembrane space;
matrix;
ribosomes;
DNA; *[4 max]*

(b) cristae provide surface area for oxidative phosphorylation;
inner membrane contains electron transport chains/ATP synthase (which carry out oxidative phosphorylation);
outer membrane separates the mitochondrion from the rest of the cell;
mitrochondrial DNA/ribosomes make (mitochondrial) proteins;
small volume intermembrane space allows for higher concentration of protons;
matrix has enzymes for the Krebs cycle; *[3 max]*

C3. (a) catalysts/digestion – amylase/protease/lipase/catalase;
defense – immunoglobin / fibrinogen;
structure – collagen;
movement – actin/myosin;
transport – hemoglobin;
synthesis – ligase/DNA polymerase;
hormonal communication – insulin/luteinizing hormone;
light detection – rhodopsin / plant phytochromes;
storage – ferritin/gluten/casein; ***[3 max]***
Accept any other valid responses.

(b) non-polar amino acids for hydrophobic part of the bilipid layer;
polar amino acids for hydrophilic environment;
polar amino acids allow hydrophilic channels;
integral proteins are held in place by polar amino acids; ***[2 max]***
*To award **[2 max]** both polar and non-polar should be addressed.*
Accept answers in the form of a diagram.

Option D — Evolution

D1. (a) (i) increases and then levels off ***[1]***

(ii) increases and then decreases ***[1]***

(b) at 12 years approximately 8 times larger (than initial);
$\frac{39-5}{5} \times 100$ / calculation of percentage increase;
about 680 % increase; *(allow answers in the range of 600 % to 760 %)* ***[2 max]***

(c) mutations cause variability in viruses;
greater diversity and divergence leads to variation in viruses;
the most successful forms are naturally selected;
those that survive reproduce more;
more difficult for production of new T-cells/lymphocytes/reaction of immune system; ***[2 max]***

D2. (a) varied members of a single species occupy a variety of niches / migration of a species to an area with a variety of niches;
natural selection/selection pressure will be different in various niches causing adaptation of groups to the varied niches;
results in many species from one ancestral species;
reproductive isolation enhances adaptive radiation;
adaptive radiation results in speciation; ***[3 max]***

(b) in gradualism evolution occurs at a constant pace;
fossil records of gradual change with intermediate forms support this theory;
evolution of modern horse/another suitable example seems to support this view;
in punctuated equilibrium evolution proceeds rapidly for short periods of time intermittent with long periods of little change/stability;
gaps in the fossil record/lack of intermediate forms support the idea of punctuated equilibrium;
strata in the fossil record with appearance of many new species following a mass extinction supports the idea of punctuated equilibrium; ***[4 max]***

D3. (a) *Australopithecus afarensis/A. afarensis* had a relatively small skull with a low forehead/moderate sized brow ridges;
A. africanus/A. robustus evolved from *A. afarensis* with increases in cranial capacity/larger brow ridges/low forehead;
Homo habilis/H. habilis had a small cranial capacity/small brow ridges/ increased forehead;
H. erectus/H. neanderthalensis/H. sapiens followed *H. habilis* and show increased cranial capacity;
(as the *Homo* sp evolved) the forehead increased;
(as the *Homo* sp evolved) the orbital ridges decreased; ***[3 max]***

(b) improved diet quality correlated (positively) with hominid skull development/size;
improved diet quality provides energy to support a greater brain function;
change of habitat (in Africa) 2.5 mya may have prompted emergence of *Homo* sp;
change in diet to include meat increased brain size (of hominids);
cooking food enabled hominids to eat a wider variety of food; ***[2 max]***

Option E — Neurobiology and behaviour

E1. (a) 7.8 % *(allow answers in the range of 7.7 % to 7.9 %)* ***[1]***

(b) $\frac{15}{100} \times 80$;
$= 12$; ***[2]***

(c) group 1/control and group 4/alcohol users have small differences;
supports that the homozygous condition is not a risk factor in alcohol use;
group 1/control and group 2/problem users have large difference;
group 2/problem users have more chance of being homozygotes for the mutation;
group 1/control small difference with group 3/drug users only;
homozygous condition appears to be a risk factor in group 2/problem users of alcohol or drugs and in group 3/drug users;
numbers are very different in each population / small percentages; ***[3 max]***

(d) Homozygotes cannot inactivate cannaboids/THC, thus increased needs for drug or alcohol intake / chances of addiction ***[1]***

E2. (a) mechanoreceptors – pressure;
chemoreceptors – chemical substances/pH;
thermoreceptors – temperature;
photoreceptors – light;
mechanoreceptors/proprioceptors – stretching/pressure;
hydroreceptors – humidity; ***[2 max]***
Accept other appropriate receptors with a stimulus.

(b) retina/rod/cone cells convert light into impulses;
impulses pass to bipolar cells;
bipolar cells pass impulses to (sensory neurons of) the optic nerve;
at the optic chiasma, impulses cross over to the opposite optic nerve;
impulses continue to the thalamus where optical information is processed;
images form in the visual cortex; ***[4 max]***

E3. (a) learned behaviour occurs as a result of experience (while innate is independent of environment);
innate behaviour is controlled by genes/inherited (while learned is not inherited);
correct example of both; ***[3]***

(b) name of animal, how they learn and advantages for survival;
name of another animal, how they learn and advantages for survival; ***[2]***

e.g. grizzly bears by operant conditioning/practise how to catch salmon providing needed food supply;
goslings learn who their mother is/imprinting, avoid predators by staying near mother;

Option F — Microbes and biotechnology

F1. (a) (i) 2002 to 2003 ***[1]***

(ii) $18 - 7 = 11 \text{mg N kg}_{\text{soil}}^{-1} \text{yr}^{-1}$ *(allow 10 to 12 mg N kg_{soil}^{-1} yr^{-1})* ***[1]***

(b) *Nitrobacter*;
Nitrosomonas; ***[1 max]***

(c) ammonia used for nitrification so less ammonia at the end of a year;
decomposers (especially fungi) would have been destroyed (in a surface fire);
(leguminous) plants would have been destroyed (in a surface fire);
destruction of lower vegetation by the surface fire of the Moran site would not be available for ammonification;
lack of animal feces/decomposing plants and animals would reduce the available raw materials for ammonification; ***[3 max]***

F2. (a) Eubacteria/bacteria: *E. coli* / *Pneumococcus* / another suitable example; *(scientific/common name acceptable)*
Archaea: methanogens / thermophiles / another suitable example;
Eukaryota: *Paramecium* / yeast / another suitable example; ***[3]***

(b) large diversity of the group categorized as prokaryotes prompted division into two domains;
similarities between Archaea more similar to Eukaryota than to Eubacteria;
facilitates study of origin/evolution of eukaryotes; ***[2 max]***

(c) Archaea have different rRNA to Eubacteria;
Eubacteria have no proteins associated with DNA whereas Archaea have / *vice versa*;
introns are present in some genes of Archaea, but are rare/absent from Eubacteria;
cell walls are made of peptidoglycan in Eubacteria but not in Archaea;
cell membranes are made of different molecules / Eubacteria have glycerol-ester lipids whereas Archaea have glycerol-ether lipids; ***[2 max]***

F3. (a) somatic (gene therapy) involves changes to body cells whereas germ line (gene therapy) involves changes to egg cells/gametes;
somatic cell changes are not passed on to offspring whereas germ line changes may be passed on to offspring;
somatic cell genes affect only a small proportion of the total cells in a body whereas the changes to germ line cells will be passed on to all cells of the offspring (as it develops); ***[2 max]***

(b) prevents/reduces symptoms of a disease so taking the risk is worthwhile;
immune response to the vector may cause damage to the recipient;
long-term effects to the patient are unknown;
impact on offspring of the treated person is unknown;
risk of "designer babies" which poses risks to social norms;
risk of consent during research trials being uninformed / other reasonable answer about research trials; ***[3 max]***

Option G — Ecology and conservation

G1. (a) (i) freshwater (ecosystem) ***[1]***

(ii) the rate is increasing (exponentially) ***[1]***
Do not accept answers containing only numerical statements.

(b) plants are purposely transported by people to new places for their use;
the ecosystem is changing/warming so new kinds of plants are now able to survive/compete with native plants;
only a few plants are aquatic so few would be expected in water;
fungal spores/seeds can travel more easily in air;
terrestrial ecosystems provide more suitable habitats; ***[1 max]***

(c) accidental transport of organisms (*e.g.* by vessels/boats);
purposeful importation for commercial reasons; ***[1 max]***

(d) *pros*:
may control a pest species (in an ecosystem);
economic/social benefits *e.g.* reforestation to reduce soil erosion / other reasonable examples;

cons:
competition reduces survival of native species;
upsets the balance between predators and prey;
leads to extinction of native species / reduces biodiversity; ***[3 max]***
Accept the above points in a discussion of particular examples.
*To award **[3 max]** responses require at least one pro and one con.*

G2. (a) pH of soil;
water /humidity;
light;
temperature;
salinity;
mineral nutrients;
competition;
altitude;
pollinating agents;
predators / parasites;
slope; ***[4 max]***

(b) adds humus to soil;
breaks down rock (through roots, chemicals, rhizoids);
holds soil/prevents erosion;
aerates soil;
provides shade;
reduces water content; ***[1 max]***

G3. (a) Simpson diversity index ***[1]***

(b) *name of ecosystem*:
e.g. (tropical) rainforest;

ethical reason:
every species has a right to life, regardless of whether it is useful/non useful to humans;
potential of undiscovered medicines;

ecological reasons:
better use of the rainforest may occur by respecting the existing balance in concert with the indigenous people;
native species are adapted to local conditions whereas invasive species are less likely to be in balance;
species in the rainforest are interdependent so loss of species threatens the rest of the community;
deforestation of rainforests increases soil erosion/silting of rivers/flooding/CO_2 atmospheric levels;

economic reasons:
ecotourism is a potential source of income;

aesthetic reasons:
loss of beauty of the system;
artists are inspired by the images/flowers/animals of rainforests;

heritage/cultural reasons:
maintenance of the rainforest preserves human cultural diversity; ***[5 max]***

*Do not award more than **[2 max]** for each category of reasons e.g. not more than **[2]** for ecological reasons.*