M14/4/BIOLO/SP3/ENG/TZ2/XX/M

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

MARKSCHEME

May 2014

BIOLOGY

Standard Level

Paper 3

14 pages

Option A — Human nutrition and health

1. (a) 0.5 kg *(units required)* ***[1]***

(b) increase / positive trend / towards gain in body mass ***[1]***

(c) is effective at maintaining mass as final mass is equal to initial mass;
only group not showing weight/mass re-gain (after 26 weeks);
shows weight loss / maintenance (with fluctuations) in early weeks;
last weeks (from week 18) show positive trend; ***[2 max]***

(d) excess carbohydrates converted/stored as fat/lipids;
source of obesity / gain in weight;
may increase risk of diabetes / other related health risk factor;
other nutrients may be deficient; ***[2 max]***

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

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

(b) (i) dairy products / (oily) fish / egg yolk / liver / other verified source ***[1]***
Do not award marks for any supplements.

(ii) malignant melanoma results from repeated/prolonged exposure to UV;
sunlight contains some UV;
(moderate) daily exposure to sunlight stimulates skin to produce vitamin D;
vitamin D may help prevent osteoporosis/rickets/weak bones/low immunity/some cancers/cardiovascular disease;
risk balanced by having moderate exposure to sunlight/sunbathing at safe times/using sunblock/clothes;
supplements to provide vitamin D; ***[3 max]***

3. (a) appetite control centre in brain is stimulated by hormones/ghrelin/leptin/PYY336/insulin;
produced by pancreas/small intestine after eating;
(produced) by adipose tissue in response to fat storage;
stretch receptors in stomach send message to brain;
makes the person feel they have eaten enough; ***[3 max]***

(b) food miles are a measure of distance between production and consumption;
high food miles increases transport;
causes air pollution / traffic congestion / increases greenhouse gas emissions;
local foods not found all year round, so a balanced diet might not be achieved with locally available foods;
buying local products supports local economy;
local foods are fresh/do not require preservatives; ***[3 max]***

Option B — Physiology of exercise

4. (a) $25\,L\,min^{-1}$ *(units required) (allow a range between 24 and 26 $Lmin^{-1}$)* ***[1]***

(b) both increase as ventilation rate increases;
both initially show a rapid increase which later levels out;
cardiac output increases with work rate at a decreasing rate; ***[2 max]***
Do not accept answers suggesting that cardiac output decreases as heart rate increases.

(c) $150\,L\,min^{-1}$; *(units required)*
the definition of VO_2 max is maximum oxygen uptake in one minute / maximum work rate so corresponds to highest data point for ventilation rate / *OWTTE*; ***[2]***

(d) stroke volume increases cardiac output only up to (about) 40 $Lmin^{-1}$ ventilation rate;
heart rate increases cardiac output at all work rates/up to Vmax; ***[2]***

5. (a) (i) any correctly labelled Z line on the image ***[1]***

(ii) any correctly labelled dark band on the image ***[1]***

(b) relaxed / not contracted ***[1]***

(c)

fast	***slow***
maximum work rate over short period / strength	sustained activity / stamina;
lower myoglobin	higher myoglobin;
(can pass on to) anaerobic respiration	aerobic respiration;
moderate blood supply	good blood supply;

[2 max]

*Award **[1]** for each pair of statements up to **[2 max]**.*
Answers do not need to be shown in a table format.

(d) liver ***[1]***

6. (a) warm-up is gradual increase in activity/stretching;
increases muscle blood flow/temperature/heart rate/dilation of (body) blood vessels/production of adrenalin;
prevent injuries;
benefit inconclusive / stretching prior to exercise controversial; ***[2 max]***

(b) exercise increases the need for oxygen (to muscular tissue);
increase in volume allows more air / oxygen in lungs;
increase in ventilation rate allows more gas exchange/oxygen and carbon dioxide to be exchanged;
increase in ventilation volume/rate allows more oxygen in blood (to meet increased muscle need);
sufficient oxygen allows aerobic respiration/prevents oxygen debt / insufficient oxygen means anaerobic respiration; ***[3 max]***

Option C — Cells and energy

7. (a) reaction rate increases ***[1]***

(b) reaction rate decreases;
this happens at all $_{L}$-DOPA concentrations; ***[2]***

(c) increase in substrate/$_{L}$-DOPA concentration increases reaction rate ***[1]***

(d) reduces the production of melanin (so would prevent food from browning);
there may be other factors in the browning of plants/oxidation;
may change the taste/smell/appearance/texture / may be toxic;
more effective at lower concentration of $_{L}$-DOPA/higher concentrations of HK; ***[2 max]***

8. (a) (i) chloroplast ***[1]***

(ii) stroma ***[1]***

(b) action spectrum is quantity of photosynthesis for each wavelength;
absorption spectrum is quantity of light absorbed (by a pigment) for each wavelength;
absorption spectra of each pigment add up/correlate to make action spectrum / *OWTTE*; ***[2 max]***
Accept the above marking points in a clearly drawn correctly labelled graph.

(c)

oxidation is the	loss	*of electrons or the*	gain;	*of oxygen*
reduction is the	gain	*of electrons or the*	gain;	*of hydrogen*

[2]

*Award **[1]** for each correct row.*

(d) structure – collagen;
movement – actin/myosin;
transport – hemoglobin;
enzyme – catalase/ATP synthase/endonuclease;
immunity/defence – immunoglobulin/antibody;
hormones – insulin; ***[1 max]***
Accept any other valid examples, excluding membrane proteins.
*Award **[1]** for a function with a named example.*

9. (a) polar amino acid interacts with phospholipids to control position of protein within membrane;
polar amino acid creates (hydrophilic) channels through membranes;
polar amino acid creates the interaction between enzyme and substrate/specificity of active site in enzymes;
affects solubility of proteins as non-polar proteins do not dissolve in water / *vice versa*; ***[2 max]***

(b) pyruvate is decarboxylated / carbon dioxide removed;
oxidized by removal of hydrogen;
reduced NAD produced and used in oxidative phosphorylation/electron transport chain;
acetyl group combines with coenzyme A;
acetyl CoA is formed in order to enter Krebs cycle; ***[3 max]***

Option D — Evolution

10. (a) 15 (teeth) *(allow a range from 14 to 16)* ***[1]***

(b) (both) have more teeth in the upper jaw;
P. hecqui has more teeth on the upper and lower jaw than *P. elaviae*;
the difference between the number of teeth in the upper and lower jaw is greater in *P. elaviae*;
greater variation in number of teeth in *P. hecqui* / overlap in error bars in upper and lower jaw in *P. hecqui* but not *P. elaviae*; ***[2 max]***

(c) common ancestor occupied different geographical regions / each group received different selection pressures;
adaptive radiation/divergent evolution;
eventually the two groups became separate species / speciation occurred;
(ancestor of) *P. elaviae* occupied deep whereas (that of) *H. microlepis* occupied shallow water;
P. elaviae and *H. microlepis* teeth adapted to different food sources; ***[3 max]***

11. (a) (i) protruding (upper) jaw / larger teeth;
large (eye)brow ridges;
absence of/low forehead;
smaller cranium (volume) / smaller brain; ***[1 max]***

(ii) 2.0 to 1.7×10^6 years ago/million years ago/mya *(units required)* ***[1]***
Accept answers within the range of the 2.0 to 1.7 giving correct units.

(b) (i) all the genes in an interbreeding <u>population</u> (at a certain time) ***[1]***

(ii) geographical isolation – land feature prevents parts of population to interbreed;
hybrid infertility – hybrids cannot interbreed between themselves/members of original population;
temporal isolation – parts of population do not breed at same time;
behavioural isolation – parts of population do not breed because of behavioural differences; ***[2 max]***

(c) comets / meteorites/meteors ***[1]***
Do not accept asteroids.

(d) self replicating;
can act as catalysts;
(store) genetic information; ***[2]***

12. (a) *H. sapiens* has not changed much genetically since it appeared / genetic evolution requires many generations/thousands of years for impact;
genetic evolution is due to inheritance of genes / allows for development of brain while cultural changes passed on through learning;
most changes are cultural / occur faster than genetic evolution / have a faster cumulative effect greater than genetic evolution; ***[2 max]***

(b) species is a group of organisms able to produce fertile offspring;
reproduction of fertile hybrids is possible between close species (so definition does not apply) / explained example to that effect (*eg.* wolf and dog);
most hybrids are infertile (so shows definition applies) / explained example to that effect (*eg.* horse and donkey); ***[2 max]***

Option E — Neurobiology and behaviour

13. (a) (incubation time) 50 % / 1 hour ***[1]***

(b) (i) 18 to 20 (hours) ***[1]***

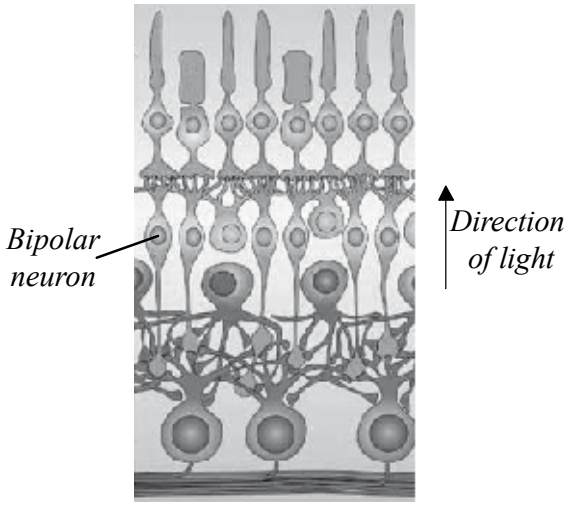
(ii) higher earlier in the afternoon to prevent the eggs from overheating;
higher in the night to keep the eggs warm/prevent cooling;
higher at night to protect from predators; ***[2 max]***

(c) 4 to 6 / 6 to 8 / 8 to 10 / 18 to 20; *(any two time periods required for **[1]**)*
(times when) not sitting on eggs much; ***[2]***

14. (a) (i) correctly identified bipolar neuron ***[1]***

(ii) arrow pointing upwards ***[1]***

eg.:



(b)

rod cells	***cone cells***
use in dim light	use in bright light;
sensitive to all wavelengths	three types each sensitive to red, blue or green;
group of cells to one optic fibre	one cell to one fibre;
spread throughout the retina	concentrated in the centre / fovea;

[2 max]

*Award **[1]** for each correct row up to **[2 max]**.*
Answers do not need to be shown in a table format.

(c) (i) arrow indicating direction of impulse to the right ***[1]***

(ii) X: sensory neuron;
Y: relay neuron / associative neuron / inter neuron; } *(both needed)* ***[1]***

(iii) Z: grey matter ***[1]***

15. (a) (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/give sense of depth; ***[2 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.

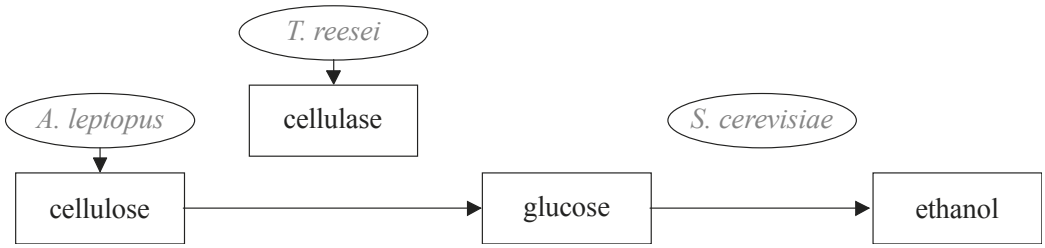
(b) (many) excitatory and inhibitory presynaptic neurons may be connected to postsynaptic neuron;
impulses from excitatory neurons increase release of excitatory neurotransmitter (in synaptic cleft);
impulses from inhibitory neurons increase release of inhibitory neurotransmitter in (synaptic cleft);
effects of neurotransmitters combine/cancel each other to alter (probability of) action potential/firing in postsynaptic neuron;
presynaptic neurotransmitters act at same time / add up in (very) short interval; ***[3 max]***

Option F — Microbes and biotechnology

16. (a) 1.0 (%) ***[1]***

(b) *Award **[2]** for 4 correct answers.*
*Award **[1]** for 2 or 3 correct answers.*
*Award **[0]** for 1 or no correct answer.* ***[2 max]***

eg.:

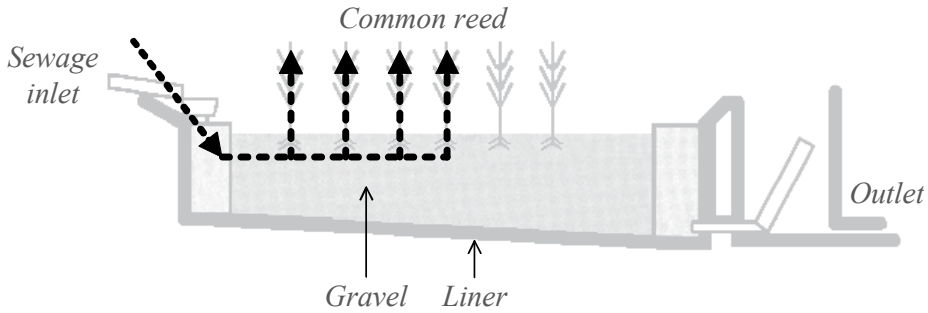


(c) both (generally) increase ethanol concentration as they increase;
cellulase has much greater effect than incubation time;
incubation time effect eventually decreases slightly; ***[2 max]***

(d) reduced incubation time would not change ethanol concentration much;
more product in less time (improves profit) / little increase in yield for a greater expense due to a longer period of incubation is not worth while;
changing cellulase concentration has greater effect on yield; ***[2 max]***
Do not accept "cellulose" instead of "cellulase".

17. (a) (i) clear annotation indicating movement from (inlet to) gravel bed to reed ***[1]***

eg.:



(ii) decompose organic matter / release nitrates ***[1]***

(iii) nitrogen fixation / use N_2/nitrogen from atmosphere to produce NH_3/ammonia ***[1]***

(b) uses RNA (as a template) to produce/catalyse the production of DNA;
used in the production of DNA without <u>introns</u>; ***[1max]***

(c) *name of bacterium*: *Pseudomonas aeruginosa*;
characteristic of aggregate: produces toxins only when in aggregates;

or

name of bacterium: *Vibrio fischeri*;
characteristic of aggregate: is bioluminescent only when in aggregates; ***[1 max]***
Accept any other documented example.

18. (a) organism/food poisoning;
symptom;
method of transmission;
treatment; ***[3 max]***

eg.:
Clostridium botulinum/botulism;
weakness leading to (respiratory) paralysis;
contaminated prepared food kept in anaerobic conditions / example such as non-sterile cans/tins;
antitoxin/respirator;
Accept any other documented examples of diseases caused by contaminated food, but do not accept answers relating to pathogens entering by ingestion not specific to food poisoning.

*Award **[1 max]** if element is not related to the others.*
*Award **[2 max]** if organism name is not stated.*

(b) trigger an immune response;
vector/virus may spread to untargeted cells thus causing damage/disease;
virus may revert to original form causing (viral) disease;
can induce tumor if gene inserted in incorrect position;
may affect reproductive cells;
gene therapy often fails and this leads to disappointment / decades of experimentation have led to poor results; ***[3 max]***

Option G — Ecology and conservation

19. (a) 50 % ***[1]***

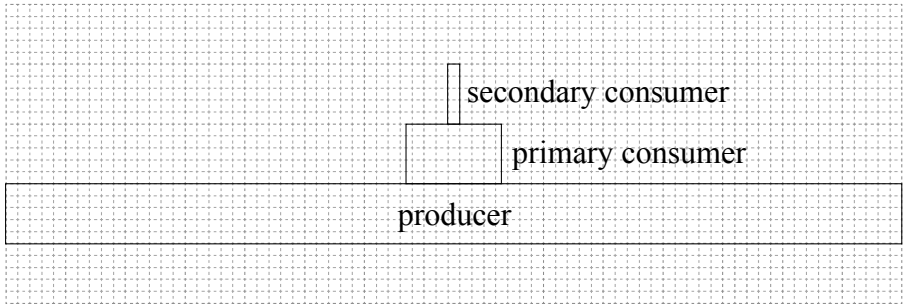
(b) the main food source for thick-lipped is insects while in thin-lipped it is algae;
thin-lipped eat more fish than thick-lipped;
they both eat the same amount/proportion of snails/plants;
only the thick-lipped eat crustaceans; ***[2 max]***
Do not accept lists of numerical data which do not compare.

(c) they do not live in the same place;
(thin lips) not suited/adapted to feeding on crustaceans; ***[1 max]***
Accept other reasonable responses.

(d) two species cannot occupy the same niche;
(not same species as) both Cichlids have different feeding habits;
feeding is a niche component so sufficiently different to be different species;
no information about their habitats/other niche components; ***[2 max]***

20. (a) correct shape of pyramid with base larger than primary consumer and secondary consumer smaller than the rest;
pyramid proportions very close to 80:10:1 / correctly labelled values with units (24000, 3000 and 300 $kJm^{-2}y^{-1}$);
correctly labelled levels; ***[3]***

eg.:



(b) (i) process in which chemical substances become more concentrated at each trophic level ***[1]***

(ii) (total) dry mass of organisms;
(total) dry mass of organic matter in ecosystem(s); ***[1 max]***

(c) the quadrat positions are determined randomly within (the area of) the field;
the number of plantain plants in the quadrat is counted each time;
the area of the quadrat and the field are measured; *(both needed)*
apply a formula; ***[2 max]***

21. (a) roots break down rock to create soil particles;
develop soil by adding litter/matter that decomposes;
absorb minerals deep in ground and accumulate them on top/in soil/litter;
prevent erosion by stabilizing soil with roots / retaining water that would otherwise run-off / adding organic matter that can retain water; ***[2 max]***

(b) ozone is produced in the (upper) atmosphere;
ozone absorbs ultraviolet radiation;
UV causes CFCs to dissociate;
byproducts react (repeatedly) with ozone to form (molecular) oxygen / destroy ozone;
allowing UV light to penetrate through atmosphere;
and cause damage within ecosystems/to biological molecules/cancer; ***[3 max]***