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MARKSCHEME

May 2010

BIOLOGY

Standard Level

Paper 3

19 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. 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. 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. Indicate this with **ECF** (error carried forward).

10. 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. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover page.

Option A — Human nutrition and health

A1. (a) (i) middle ear infection ***[1]***

(ii) gastroenteritis ***[1]***

(b) significantly fewer visits to the doctor (for middle ear infections and gastroenteritis) for infants fed breast milk only;
less medication prescribed (for middle ear infections) for infants only breastfed / excess prescriptions for those not exclusively breastfed;
less hospitalization (for gastroenteritis) for infants only breastfed / excess hospitalizations for those not exclusively breastfed;
little effect on frequency of lower respiratory infections for only breastfed infants compared with partially breastfed infants;
significantly fewer follow-up visits (for middle ear infections) for infants fed breast milk only; ***[2 max]***

(c) breast milk contains maternal antibodies / lack of antibodies in artificial milk;
antibodies provide protection against some viral and bacterial infections / passive immunity;
breast milk has white blood cells/macrophages to fight infection;
breast milk has nutrients in correct proportions so easier to digest/less likely to cause gastroenteritis; ***[2max]***

A2. (a) carbohydrate: 1760 kJ (per 100 g) fat: 4000 kJ (per 100 g) protein: 1720 kJ (per 100 g) ***[1]***
Accept values per gram – units required.
Must have correct figures.

(b) may lead to obesity (which is risk factor for many health problems);
NOT weight gain
(obesity leads to) increased risk of coronary heart disease/gall bladder disease/high blood pressure/diabetes/excess strain on joints; *Accept CHD*
may lead to increase in blood cholesterol/low density lipoprotein/LDL/lipid levels;
deposits impede blood flow / cause diameter of blood vessel to decrease / atherosclerosis / degeneration of artery walls;
health consequences depend on type of fat ingested – high saturated fat; ***[3 max]***

(c) lack of blood plasma proteins;
leading to tissue fluid retention/swollen abdomen;
lethargic/little interest in surroundings;
thin muscles/flaky appearance of skin/sparse hair with lack of pigmentation;
physical and mental development retarded; ***[2 max]***

A3. (a) *e.g.* cod liver oil / fish liver oil / oily fish (accept correctly named example) / egg yolk / fortified cereal / ONE named dairy product (*i.e.* milk/cheese/ yoghurt) ***[1]***
*Allow any **two** sources for the mark. Reject fish alone.*

(b) UV light/sunlight on skin causes chemical production of vitamin D;
UV too low in winter in high latitudes;
vitamin D stored in liver so can make enough to last several months/through winter;
UV light can damage skin and cause skin cancer so exposure needs to be limited;
use of sun-block will inhibit vitamin D production;
covering skin with clothing prevents UV reaching skin; *Accept reference to cultural/religious customs.* ***[3 max]***

A4. distance food transported from site of production to the consumer;
used to assess environmental impact of food / local food has lower impact;
does not take into account number of trips from source/other costs such as machinery used/fertilizers/pesticides;
transportation associated with CO_2 emissions, with some transport producing more than others (*e.g.* planes);
during famine, transport of food justifiable whatever food miles / on humanitarian grounds; ***[2 max]***

Option B — Physiology of exercise

B1. (a) age / gender / diet / health or lifestyle / initial fitness levels ***[1]***
*Allow any **three** factors for the mark.*

(b) as workload increases heart rate increases / positive relationship (but only to a point);
graphs level off/plateau/reach maximum of approximately 180 beats minute $^{-1}$;
increase is not linear / s-shaped curve / slow increase at low workloads; ***[2 max]***

(c) (i) 130 –115 = 15 beats minute $^{-1}$ (decrease after training) ***[1]***
Allow 14–18 beats minute^{-1}. Units required.

(ii) training group showed lower heart rate/beats minute $^{-1}$ (at workloads below 180 W);
higher workloads (180 W+) seemed to show little or no difference/heart rate the same;
training increases the maximum intensity at which exercise can be done; ***[2 max]***

B2. (a) (i) biceps and triceps correctly labelled; (biceps = muscle on right, triceps = muscle on left) ***[1]***
Both needed for mark.

(ii) (cartilage is hard but flexible) able to absorb mechanical shocks / allows bones to pivot or move smoothly ***[1]***

(b) ATP binds to myosin heads;
ATP binding causes cross bridges to break/heads detach from binding site;
ATP broken down/hydrolysed to ADP + Pi, causing myosin heads to change angle/become "cocked";
myosin heads attach to binding sites on actin filament further along sarcomere;
ADP + Pi released and myosin heads push actin filament along/power stroke occurs; ***[3 max]***
Allow ONE mark if there is a general understanding of the role of ATP in the sliding of filaments but without specific details.

B3. (a) volume of air taken in or out with each (rhythmic/quiet/resting) inhalation or exhalation ***[1]***

(b) reduced ventilation / breathing rate at rest;
maximum ventilation rate increases;
vital capacity may increase;
dilated/more open blood capillaries around the alveoli;
increased efficiency of gas exchange (in alveoli);
strengthen muscles used for ventilation (diaphragm and intercostals); ***[3 max]***

B4. warm-up routines are series of exercises/stretches done before the main work out;
cause muscle temperature to increase / stimulates blood flow;
more oxygen supplied so increased respiration / more vigorous / rapid contractions;
(thought to be) necessary to prevent damage to muscles/tendons;
little or no scientific evidence to support belief in need to warm up;
difficult to conduct controlled experiments without a placebo effect;
possible psychological preparation; ***[3 max]***

Option C — Cells and energy

C1. (a) (i) 12:00 *(Accept 12:00 to 13:00)* ***[1]***

(ii) photosynthesis in maize requires uptake of CO_2 and light as energy source;
sunlight intensity strongest at midday therefore rate of photosynthesis is highest at this time;
light is limiting factor for photosynthesis so increased intensity increases photosynthesis;
high rate of photosynthesis means high exchange rate of CO_2; ***[2 max]***

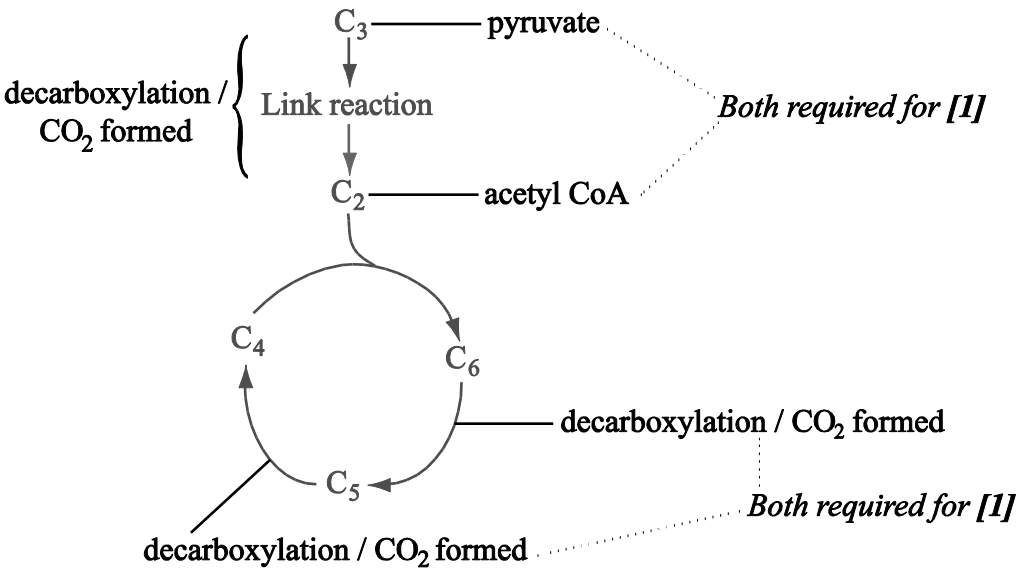
(b) 31 ºC ***[1]***

(c) data does not support idea that rising CO_2 levels will increase growth rates in maize;
(at all temperatures) there appears to be no difference between exchange rate at current or elevated CO_2 levels;
temperature has larger effect on growth of maize;
so if rising CO_2 levels causes more of a greenhouse effect/larger temperature increase, this will affect growth of maize; ***[2 max]***

C2. (a) enzymes/biological catalyst – amylase/protease/lipase/catalase;
defence/immunity – immunoglobin/antibody;
structure – collagen;
movement – actin/myosin;
transport – hemoglobin;
synthesis – ligase/DNA polymerase;
hormonal communication – insulin/luteinizing hormone; *MUST be proteinaceous*
food stores – casein in milk;
pigments – opsin; ***[2 max]***
Accept any other valid responses.

(b) polar amino acids have hydrophilic R groups, non-polar have hydrophobic R groups;
non-polar amino acids in centre of water-soluble proteins stabilise their structure;
non-polar amino acids cause proteins to remain embedded in membrane;
polar amino acids on surface of proteins make them water-soluble;
polar amino acids create hydrophilic channels/protein pores in membranes;
enzyme active site specificity depends on amino acids present/polar and non-polar amino acids can play a role in substrate interactions at the active site; ***[3 max]***

C3. (a) (i) and (ii)



(iii) $NADH + H^+ / FADH_2 / ATP$ (or GTP) ***[1]***

(b) matrix of mitochondrion ***[1]***

C4. metabolic pathway is a series of reactions carried out in a particular sequence;
products of one reaction become substrates for the next;
each reaction is enzyme-catalyzed (and thus represents point of control);
some enzymes are allosteric;
allosteric control / end-product inhibition/negative feedback;
end-product acts as inhibitor of enzyme at beginning of pathway;
product binding changes the conformation of the active site so substrate of the pathway can no longer bind; ***[3 max]***

Option D — Evolution

D1. (a) as latitude increases so does wing size / direct relationship / positive correlation ***[1]***
Do not accept directly proportional as line does not pass through origin.

(b) (i) at higher latitudes/above 45º European species have larger wings than American species/largest wing sizes seen in European flies;
European flies show more variation than American flies (steeper curve);
at lower latitudes/below 45º North American flies have larger wings than European species;
South American flies have smaller wing size than European/ N. American flies; ***[2 max]***

(ii) American species show less variation because they have had less time to diverge / evolve;
size of American flies closer to that of flies recently introduced/founder effect/European founder population from low latitudes;
American flies exposed to different selective pressures; ***[1 max]***

(c) isolated populations diverge (genetically) / separation of gene pools;
may become a new species / allopatric speciation;
wing size will follow same trend as in Europe as population spreads to higher latitudes;
because larger size favoured by higher latitudes;
wing size may stay small due to smaller gene pool; ***[2 max]***

D2. (a) the non-living synthesis of simple organic molecules/amino acids from inorganic molecules;
the assembly of these molecules into polymers/polypeptides;
the origin of self-replicating molecules that made inheritance possible;
the packaging of these molecules into membranes with an internal chemistry different from their surroundings; ***[2 max]***

(b) self-replicating and catalytic activities of RNA;
short sequences of RNA have been able to duplicate/copy other RNA molecules accurately;
RNA enzyme/ribozyme (able to synthesize other molecules);
3-dimensional structure of ribosome catalytic sites (for peptide formation) are composed of RNA;
able to store information in sequence of (4) nucleotides (similar to DNA); ***[2 max]***

D3. (a) most carbon is ^{12}C but there is small amount of (radioactive) ^{14}C;
organisms absorb the same ratio of $^{12}C:^{14}C$ as in the environment;
after death, no more atoms accumulate;
^{14}C steadily breaks down so amount decreases/ $^{12}C:^{14}C$ increases with age / half-life (approx 5730 years) expresses rate of decay of ^{14}C;
the less ^{14}C in a sample the older the fossil / ^{14}C useful for dating samples one thousand to one hundred thousand years old; ***[2 max]***

(b) *Ardipithecus* is an older genus (5.2 – 4.4 million years ago) than *Australopithecus* (4 – 2.5 million years ago);
toe structure of *Ardipithecus* shows it was probably bipedal / early *Australopithecus* at least partially bipedal;
tooth structure changed as diet changed from soft fruits/leaves/seeds/nuts to omnivorous diet;
large/primitive canines seen in *Ardipithecus* to smaller canines in *Australopithecus*;
increasing height – *Ardipithecus* is smaller (the size of a chimpanzee);
change in face from projecting to flat face / from tall to small lower jaw / development of high forehead / loss of brow ridges; ***[3 max]***

D4. both explain similar structures in different organisms;

Convergent evolution	*Divergent evolution*
different ancestor	common ancestor;
converge to produce similar solutions/analogous structures	diverge to suit different functions/homologous structures;
e.g. wings in insects and birds	*e.g.* vertebrate limb structure;
species appearance becomes more similar over time	species appearance becomes more different over time;
unrelated species look similar but are genetically different	species look different but are closely related genetically;

[3 max]

Option E — Neurobiology and behaviour

E1. (a) downwind approach distance increases with increasing nest-feeder distances / the closer the feeder to the nest, the shorter the downwind approach distance / direct/positive relationship ***[1]***

(b) feeders at 5 m have smaller downwind approach distances than feeder at 60 m / *vice versa*;
feeder at 5 m has peak frequency at 50 % whereas at 60 m peak/plateau/flat at 20 %;
narrower range of approach distances for 5 m while wider range of approach distances for 60 m;
feeders at 5 m has peak approach distance at 1 m downwind while feeders at 60 m has peak plateau at 4 m – 4.5 m; ***[3 max]***

(c) difficulty handling ants / size of ants;
variation of wind;
other odours;
path of trail not easy to measure accurately; ***[1 max]***
Accept any other reasonable suggestions.

(d) *EITHER:*
innate behaviour/taxis;
because all walking at same angle to constant wind/all turn and follow odour trail when they detect smell;
OR:
learned behaviour;
may have learned because of repetition/training/following other ants; ***[2]***

E2. (a) rapid response that occurs automatically/involuntarily in response to a stimulus ***[1]***

(b) (i) *Two correct labels for **[1]**.*
I: sensory neuron
II: motor neuron
III: <u>dorsal root</u> (of spinal nerve) *NOT dorsal root ganglion*
IV: <u>white matter</u> (of spinal cord) ***[2 max]***

(ii) *Role of part I: **[1 max]***
receptor cell detects stimulus and converts it to a nerve impulse;
impulse travels along sensory neuron to (dorsal root of) spinal cord;

*Role of part II: **[1 max]***
impulse travels along motor neuron to effector organ;
causes muscle to contract removing contact with painful stimulus; ***[2 max]***

E3. (a) (i) mechanoreceptor *[1]*

(ii) hair cells of cochlea *[1]*

(b) inheritance plays role as basic song is the same for all members of a species;
birds raised in isolation still sing but song lacks complexity/sounds different from song heard in the wild / more complex songs develop when there is social interaction;
young birds learn details of songs/dialects from fathers/other birds;
(development of birdsong) is a form of motor learning/ability to learn is genetic/inherited; *[2 max]*

E4. cocaine affects synapses using dopamine as neurotransmitter;
cocaine attaches to dopamine receptors on presynaptic membrane;
blocks dopamine transporters/prevents re-uptake / causes dopamine to persist in the synaptic cleft;
amplifies synaptic transmission / is an excitatory psychoactive drug / causes constant stimulation of postsynaptic neuron;
dopamine builds up in the synapse contributing to euphoria/pleasurable effects; *[2 max]*

Option F — Microbes and biotechnology

F1. (a) 28 hours after untreated sewage added *(Allow answers in range 27–29 hours)* ***[1]***

(b) (i) sunlight reduces counts of fecal coliform bacteria significantly;
fecal coliform bacteria fall below 1 count per 100 ml on day 2;
no reduction during dark period;
significant drop on day 1 / bacteria count drops from 10^5 per 100 ml to less than 10^2 per 100 ml on day 1; ***[2 max]***

(ii) sunlight causes small reduction of coliphage viruses;
coliphage virus counts never fall below 10^2 counts per 100 ml;
no reduction during dark period; ***[2 max]***

(c) coliphage viruses because they are less affected by the sun/numbers do not decrease much in two days ***[1]***

F2. (a) *Both required for **[1]**.*
A: denitrification
B: putrification/decay/decomposition ***[1]***

(b) (i) arrow pointing from nitrogen in atmosphere to ammonium compounds ***[1]***

(ii) nitrification / converts nitrite to nitrate ***[1]***

(c) adding nitrates causes increase in growth of phytoplankton/algal blooms;
decomposition (of increased biomass/dead plants/animals) uses up more oxygen;
can result in death of other aquatic organisms due to lack of oxygen;
plant/algal biomass increases causing turbidity of water; ***[2 max]***

F3. (a) main ingredients used are soybeans, wheat, salt and water;
(mold) *Aspergillus oryzae*/*A. sojae* special seed starter added (to the roasted wheat and steamed soybeans);
carbohydrates fermented to produce alcohol and lactic acid;
proteins broken down to peptides/amino acids;
colour due to 6–8 month maturation process; ***[2 max]***

(b) *Explanation must correspond to the example given.*
EITHER
use of high salt concentration with example (*e.g.* salted cod);
high concentration draws water out by osmosis;
decreased moisture/dehydration delays/prevents growth of microorganisms;

OR
use of high sugar concentration with example (*e.g.* candied dry fruit/glace cherries/fruit in syrup);
high concentration draws water out by osmosis;
decreased moisture/dehydration delays/prevents growth of microorganisms; ***[2 max]***

F4. used in recombinant DNA technology/genetic engineering;
produces genes for gene transfer;
enzyme catalyzes production of DNA/complementary DNA/cDNA from RNA;
to isolate mRNA/mature RNA/RNA without the introns found in eukaryote genes;
DNA spliced into host DNA (*e.g. E. coli*) will code for a functional protein (*e.g.* human insulin); ***[3 max]***

Option G — Ecology and conservation

G1. (a) arsenic accumulates in leaves;
arsenic concentration (in leaves) increases rapidly in the first 7 weeks;
arsenic (in leaves) increases from 0 to approximately 6000 $mg\,kg^{-1}$ at 7 weeks;
maximum arsenic level (in leaves) is about 7500 $mg\,kg^{-1}$ at end of experiment/valid numerical example;
after week 7 arsenic concentration in plant increases more slowly/begins to plateau;
arsenic concentration in roots remains relatively unchanged throughout the experiment;
(Accept range of 7–10 weeks in all above points) ***[3 max]***

(b) (i) 77 weeks; *(Allow answers in range 70 – 80 weeks)* ***[1]***

(ii) Chinese brake fern could be used to remove arsenic from soil;
after 20 weeks about 25 % of soil arsenic removed by fern;
arsenic concentration increases (rapidly) in fern (tissue) in 20 weeks;
eventually/longer periods may reach toxic levels for plant; ***[2 max]***

(c) plants may become toxic for consumers;
arsenic may accumulate in the food chain / biomagnification; ***[1 max]***

G2. (a) plant distribution closely linked to levels of abiotic factors in the environment;
given organism can survive only within a certain temperature range to which it is adapted;
water is a limiting factor in most terrestrial ecosystems and plants are classified according to ability to tolerate water shortage;
most plants can only tolerate narrow pH range;
light intensity/quality/wavelength and duration/photoperiod are important for photosynthesis;
most plants cannot tolerate large fluctuations in salinity/high salinity;
mineral nutrients affect plant fertility/soil structure/water retention; ***[3 max]***
Accept ONE correct reference to herbivore activity.

(b) transect used when there is a transition in habitats and populations;
description of use of a line or belt transect;
height variation/light intensity/salinity/various abiotic factors can be recorded;
along the transect, along with sampling of plant species present; ***[2 max]***

G3. (a) *Answer needs to be specific giving <u>name</u> of organism, where it was released and how. Examples <u>must</u> be accidental releases.*

e.g. zebra mussel (*Dreissena polymorpha* originally from Russia/Caspian) carried in ships' ballast water and introduced into Great Lakes / rats accidentally introduced to mainland of New Zealand from visiting ships / Africanized honey bees introduced to Brazil ("killer bees") ***[1]***

(b) inter-specific competition/alien species have characteristics that may enable them to out-compete native species;
lack of predators may allow alien species to reproduce more rapidly;
alien species may utilize areas or resources that native species cannot;
predation by invasive species can cause loss of biodiversity;
can lead to species extinction, especially of endangered species;
alien species may introduce new diseases;
use of alien species for biological control can be ineffective or negative; ***[3 max]***

G4. tundra is found in the Northern hemisphere only;
at latitudes of around 60°;
size of tundra is changing due to global warming; ***[2 max]***