Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2015

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 underlined are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

Option A — Human nutrition and health

1. (a) farming **[1]**

(b) a. total contribution of transport for energy use is more than for GHG;
b. transport accounts for about 40 % of energy use and about 10 % of GHG emissions;
c. transport on land/truck and car about $\frac{1}{3}$ total energy whereas it is about $\frac{1}{10}$ of GHG emissions;
d. shipping about $\frac{1}{10}$ total energy whereas it is about $\frac{1}{50}$ of GHG emissions;
e. contribution shipping and NZ transport about equal for energy use whereas transport in NZ contributes more to GHG than shipping; **[2 max]**

(c) *Energy:* 10 % ±1
GHG: 2 % ±1 **[1]**
*Both needed for **[1]**.*

(d) a. no data on UK cheese production for comparison;

choose New Zealand cheese because:
b. contribution of food miles to GHG emissions is very small compared with farming;
c. increases choice for consumers;

do not choose New Zealand cheese because:
d. contribution of food miles to energy use is about 40 % of total;
e. transport causes pollution/traffic congestion/GHG emissions;
f. discourages local cheese manufacturers;
g. quality/taste might be affected by time from manufacture to eating; **[3 max]**
*Award **[2 max]** if only one argument.*
Allow marks for choosing UK cheese (instead) for the given reasons.

2. (a) (essential) amino acids;
(essential) fatty acids / oils / lipids / fats;
vitamins;
carbohydrates; **[1 max]**

(b) a. iodine is a mineral that is often scarce in local diets/water supplies;
b. required for normal thyroid function/synthesise thyroxine;
c. prevents goitre/avoid iodine deficiency/avoid absorbing iodine–131/radioactive iodine;
d. prevents brain damage; **[2 max]**

(c) a. protein is needed for growth /muscles / cells / maintenance;
b. excess protein not stored / converted to fat/carbohydrate;
c. kidney stones /liver damage /gout;
d. loss of calcium/risk of osteoporosis /weak bones;
e. (possible) malnutrition if high protein is linked to low carbohydrate;
f. can result in weight loss due to fat/carbohydrate deficiency;
g. fish is high in essential oils;
h. excess of protein may lead to a deficiency of another nutrient; **[3 max]**

3. (a) a. high blood sugar/glucose levels;
b. sugar/glucose in urine;
c. increased thirst/frequent urination;
d. hunger/weight loss/fatigue/blurred vision/slow healing/skin disorders; **[2 max]**

(b) a. reduce blood glucose levels as target/ body/muscle cells less sensitive to insulin / not enough insulin produced;
b. reduce intake of (saturated) fats, to reduce weight;
c. reduce the intake of sugar/simple carbohydrates, causes rapid increase in blood glucose concentration;
d. eat more high fibre foods, satisfy appetite, but cannot be broken down;
e. regular/many small meals, to avoid (rapid) rise in glucose after a big meal;
f. eat complex carbohydrates/carbohydrates with a low glycemic index, digested and absorbed more slowly; **[3 max]**

To award the mark, answers require dietary recommendations with a reason.
Do not accept comments about increased exercise.

Option B — Physiology of exercise

4. (a) 7.1–15.1 **[1]**

(b) a. EPO values in competitive athletes generally higher/numerical values;
b. taekwondo (almost) the same as non-competitive athletes;
c. greatest difference seen in swimming;
d. range of values overlaps; **[2 max]**

(c) *hypothesis supported by:*
a. swimmers (who train for 35 hours per week) have the highest levels;
b. non-competitive athletes (who train for less than five hours per week) have the lowest values;

hypothesis not supported by:
c. taekwondo (who train for 20 hours per week) almost the same as non-competitive athletes;
d. high SD/large variation in all cases so differences not likely to be significant;
e. no data on age range/sex/number of subjects;
f. but swimmers are youngest subjects in the study; **[3 max]**
*Responses for both arguments must be present for **[3]**.*

(d) a. EPO stimulates production of red cells/increased red cell count;
b. greater oxygen carrying capacity for the blood resulting in greater (muscle) performance;
c. increases blood viscosity;
d. resulting in a high risk of stroke/heart attack/sudden death during sleep;
e. gives unfair advantage over athletes who do not use it / results in banning/ exclusion from competition / anaerobic respiration leads to lactic acid build up/fatigue in non-users;
f. EPO produced naturally by body so difficult to test for abuse; **[2 max]**

5. (a) a. VO_2 is a measure of volume of oxygen used by the body;
b. VO_2 max when only carbohydrate is being respired;
c. VO_2 less than VO_2 max indicates fat as well as carbohydrate being respired;
d. a low VO_2 indicates a high proportion of fat being respired; **[2 max]**

(b) a. ventilation rate at rest is reduced;
b. maximum ventilation rate (during exercise) increases;
c. diaphragm and intercostal muscle strength increase;
d. vital capacity may increase/ VO_2 max may increase; **[2 max]**
Do not accept answers relating to cardiac output.

6. (a) a. biceps flexes/bends the arm;
b. triceps extends/straightens the arm; **[2]**

(b) a. creatine phosphate can supply ATP initially/for up to 10 seconds;
b. after (10 seconds) mainly from anaerobic respiration/glycolysis;
c. cannot prolong intense exercise (beyond two minutes); **[2 max]**

(c) a. ATP binds to myosin heads;
b. ATP used to break cross bridges;
c. energy released when ATP forms ADP and phosphate;
d. myosin head reset;
e. actin slides over myosin; **[2 max]**

Option C — Cells and energy

7. (a)
a. constant/low increase in February and early March;
b. increasing to a peak in late March;
c. decrease throughout April; **[2 max]**

(b)
a. increased CO_2 leads to greater (rate of) photosynthesis;
b. greatest effect on March 30th;
c. smallest effect on April 28th;
d. effect is not constant / difference varies; **[2 max]**

(c)
a. temperature/light intensity may be limiting factors;
b. temperature on sample days may have affected (rate of) photosynthesis/higher temperatures may increase (rate of) photosynthesis / vice versa;
c. light intensity may have affected (rate of) photosynthesis in earlier days/higher light intensity for longer may increase (rate of) photosynthesis / vice versa;
d. water/rainfall must be same for both groups;
e. control and test plants must be grown under the same conditions/other named abiotic variable; **[3 max]**

8. (a) *Award **[1]** for **two** correct labels. Structures must be drawn correctly for mark to be awarded.*
outer membrane – *drawn as a continuous line*;
inner membrane – *showing folding to create cristae*;
cristae – *shown as distinct infoldings of inner membrane;*
matrix;
intermembrane space – *shown as continuous space between outer and inner membranes;*
(70S) ribosomes – *shown as small dots in proportion with organelle, not too large;*
(naked) loop of DNA; **[2 max]**

(b)
a. matrix is site of reactions of Krebs cycle;
b. thin intermembrane space to build up high proton concentration/$[H^+]$;
c. ATP synthase/respiratory complex on inner membrane to produce ATP as protons pass back to matrix;
d. folded inner membrane / cristae to increase surface area (for electron transport chain);
e. ribosomes to make enzymes/proteins (required for Krebs cycle); **[3 max]**

9. (a) a. substrate(s)/ATP and glucose bind at the active site;
b. hexokinase shape/active site changes;
c. so that substrate(s)/ATP and glucose now fit the active site;
d. ATP and glucose react and products released;
e. hexokinase shape restored;
f. induced fit model allows for broad specificity/range of substrates; **[3 max]**
*Award **[2 max]** if no reference to any of the specific enzyme, substrates or products in the question.*

(b) a. metabolic pathway is a series of enzyme catalysed reactions;
b. allosteric enzyme catalyses one step/first step in the mechanism/chain of reactions;
c. enzyme is inhibited by the end product;
d. end product binds at a site other than the active site/allosteric site;
e. reaction mechanism is interrupted / product formation stops;
f. more inhibition of enzyme as end product concentration rises / less inhibition as end product reduces;
g. example of negative feedback; **[3 max]**

Option D — Evolution

10. (a) *3 months:* Hb^SHb^S
15 months: Hb^AHb^S (*accept* Hb^SHb^A) **[1]**
*Both needed for **[1]**.*

(b) a. overall decrease over time;
b. repeating pattern of periods of constant survival followed by drops;
c. constant up to about 3–4 months;
d. rapid decrease between 3/4 and 7/9 months;
e. remains fairly constant after 9 months / further drop at 24 months; **[2 max]**
Accept numerical values in place of some statements.

(c) a. both decrease with time;
b. survival is similar / equal up to about 3 months;
c. (from about 3 months onwards) heterozygote/Hb^AHb^S exceeds homozygote/Hb^AHb^A;
d. Hb^AHb^A continues to decrease while Hb^AHb^S levels off;
e. after about 15 months difference between survival rates remains about the same; **[2 max]**

(d) a. Hb^SHb^S/homozygous for sickle cell may confer a protective effect up to about 3–4 months;
b. similar survival for Hb^AHb^S and Hb^AHb^A/heterozygous and homozygous normal up to about 6 months suggests no clear protective effect;
c. after about 6 months the greater survival for Hb^AHb^S indicates some protective effect; (*Do not allow this marking point without a reference to the months.*)
d. only 1022 Kenyan children so cannot draw firm conclusions/could be other genetic/environmental factors;
e. example of balanced polymorphism; **[2 max]**

11. (a) a. ancestral eukaryote cell engulfs free living prokaryote;
b. free living prokaryote not digested;
c. symbiotic relationship develops between ancestral eukaryote cell and engulfed prokaryote;
d. ancestral eukaryote cell and engulfed prokaryote reproduce as a unit;
e. the engulfed prokaryote provides energy by aerobic respiration for the eukaryote;
f. prokaryote gains protection/nutrition;
g. organelles have double membranes;
h. organelles have DNA/ribosomes;
i. theory cannot be falsified/tested; **[3 max]**

(b) membrane (isolates from surroundings) / able to use molecules from the environment as an energy source / capable of reproduction/self-replication / internal chemistry different from that of the surroundings / contain polymers **[1]**

(c) a. early atmosphere was oxygen free;
b. some prokaryotes could carry out chemosynthesis/photosynthesis;
c. oxygen produced as waste product of photosynthesis;
d. few aerobic organisms;
e. oxygen began to accumulate in the atmosphere; **[2 max]**

12. (a) a. ancestral species occupies new environment / survives natural disaster;
b. different members of the species are exposed to different selection pressures;
c. gives rise to new species that share common structures adapted to new environment / occupy all niches;
d. example of divergent evolution/homology;
e. accept valid example *eg* Galapagos finches, vertebrate pentadactyl limb; **[2 max]**

(b) a. increased brain size over time during human evolution;
b. eating meat increases protein/fat/energy;
c. allows growth of a large brain;
d. large brain may have led to more successful hunting behaviour and larger quantity of protein in the diet;
e. more energy rich food available in more complex societies/as a result of cultural evolution/better agriculture; **[3 max]**

Option E — Neurobiology and behaviour

13. (a) *Paper:* (trial) 1
Plastic: (trial) 5 **[1]**
*Both required for **[1]**.*

(b) a. discovery time in paper flowers always shorter than plastic flowers;
b. larger variation in data for plastic flowers;
c. decreasing discovery time (over the eight trials) for the paper flowers only;
d. no trend in discovery time for plastic flowers;
e. from trial four discovery time for paper flowers remains fairly constant/slight variation whereas for plastic flowers discovery time increases; **[2 max]**

(c) a. mechanoreceptors are touch receptors;
b. discovery time decreases over the eight trials for paper flowers;
c. showing evidence of learning;
d. plastic flowers discovery times show no evidence of learning;
e. paper flowers have a rough surface so mechanoreceptors are more effective / plastic flowers smooth so do not stimulate mechanoreceptors; **[2 max]**

(d) a. improved chances of finding food;
b. advantage in dark/conditions when coloured/scented flowers not available;
c. not completely dependent on light/chemoreceptors to find food;
d. more likely to reproduce and pass gene (for mechanoreceptors) to offspring; advantage over other members of the species through learning; **[2 max]**

14. (a) a. smell or sight of food provides the (unconditioned) stimulus at the start of the experiment;
b. salivation at the sight or smell of the food is the (unconditioned) response;
c. bell/other stimulus repeatedly applied just before food;
d. bell/other stimulus provides a (conditioned) stimulus;
e. (conditioned) response is salivation at the bell/other stimulus only;
f. experiment was an example of classical conditioning; **[3 max]**
*Award **[2 max]** if the terms stimulus and response are not used.*

(b) a. sensory neuron carries signal from sense organ/receptors/nose/eye to CNS;
b. motor neuron carries signal from CNS to effector/muscle/salivary gland;
c. relay neuron carries signal from sensory neuron to motor neuron; **[2 max]**

15. (a) nicotine;
cocaine;
amphetamines;
ecstasy; **[1 max]**
*Award **[1]** for any **two**. Consider the first two only, if there are more.*

(b) a. increases arousal/alertness;
b. feelings of excitement/euphoria;
c. aggressive behaviour;
d. loss of judgement/self-control;
e. social withdrawal/depression/dysfunction;
f. loss of appetite; **[2 max]**

(c) a. peer pressure / cultural traditions;
b. inherited / genetic predisposition;
c. social problems / trauma;
d. passed from mother to newborn/when breast feeding;
e. many stimulate synapses with dopamine as a transmitter / blocks re-uptake of dopamine;
f. pleasurable effects of dopamine/euphoria/regular use may lead to addiction;
g. increasingly large/more regular doses needed for effect; **[3 max]**

Option F — Microbes and biotechnology

16. (a) *Manure type:* pig
Mixing ratio: 3:1 (ratio) **[1]**
*Both needed for **[1]**.*

(b) a. changing the ratio from 1:1 to 2:1 increases biogas yield for all three types of manure;
b. 1:1 ratio is least productive for all three types of manure;
c. changing the ratio from 1:1 to 2:1 has the biggest effect in poultry manure/least effect in cattle manure;
d. changing the ratio from 2:1 to 3:1 increases biogas yield for poultry and pig manure but not cattle manure;
e. the only decrease in yield with an increase in ratio occurs in cattle manure when changing the ratio from 2:1 to 3:1;
f. the biggest effect of changing the ratio is seen in pig manure / the smallest effect of changing the ratio is seen in cattle manure; **[3 max]**

(c) difference in diets/digestive systems/excretory products/intestinal bacteria (between birds and mammals)/water content of manure **[1]**
Accept other suitable suggestions.

(d) a. suitable manure : water ratio / pig manure is more efficient;
b. anaerobic conditions;
c. suitable temperature/pH for growth of bacteria; **[2 max]**

17. (a) *Paramecium* **[1]**

(b) a. *Paramecium* directs food to mouth by water current set up by cillia;
b. *Amoeba* uses phagocytosis;
c. *Euglena* species may be autotrophic/use photosynthesis or heterotrophic;
d. *Paramecium* and *Amoeba* digest food inside food vacuoles; **[2 max]**

(c) a. amylase produced by germinated grain/barley/cereals breaks down starch (in seeds) to sugar;
b. yeast ferments sugars/glucose anaerobically;
c. CO_2 and ethanol produced;
d. CO_2 remains (partially) dissolved in beer/gives beer its bubbles/carbonation;
e. ethanol produced in beer (eventually) kills yeast cells/stops fermentation by yeast;
f. by-products/different yeast varieties give different beers/flavours; **[3 max]**

18. (a) makes cDNA/DNA on an RNA template / copies RNA into DNA **[1]**

(b) a. used to make DNA from (mature) mRNA;
b. DNA formed without introns/host bacteria have no means to remove introns;
c. single stranded DNA made by reverse transcriptase;
d. DNA polymerase synthesises a complementary DNA (double strand);
e. double stranded DNA spliced into host DNA/gene transfer;
f. obtained from retroviruses (such as HIV);
g. used for gene therapy / diagnosing microbial diseases/named example; **[3 max]**

(c) a. stimulate autoimmune response/tissue rejection / infection resulting from vector;
b. cancer/oncogenes / overexpression of gene; **[1 max]**
Do not accept death as a response.

Option G — Ecology and conservation

19. (a) *S.muticum site: Corophiidae sp.*
control site: S. squamata **[1]**
*Both needed for **[1]**.*

(b) a. fewer different types of organism / smaller diversity at *S. muticum* site;
b. mean abundance at *S. muticum* site is higher for those organisms present;
c. *Rissoidea sp.* and *P. maculata* found at control site but not at *S. muticum* site;
d. *C. pagurus* only found at *S. muticum* site; **[3 max]**
Comparisons are required but the control site does not need to be mentioned in each response.

(c) a. *S. muticum* provide habitat/shelter/protection from predators for some species;
b. *S. muticum* change the environment to suit some species/example of a change;
c. some organisms more successful because less (inter-specific) competition;
d. more food may be available (for herbivores);
e. some herbivores may rely on native algae that have been displaced;
f. (other) conditions at the control site may not be identical to the test site; **[3 max]**

20. (a) a. random positioning of the transect;
b. transect is a line stretched over an area of study;
c. samples taken/species present recorded at regular intervals along the transect;
d. used to investigate effect of an abiotic variable/named example; **[2 max]**

(b) a. rocks begin to break down;
b. minerals begin to accumulate;
c. soil begins to develop;
d. water retention increases;
e. erosion of soil is reduced (by rhizoids and roots); **[2 max]**

(c) *The question asks for an outline but most candidates have given a list of factors without a reason. Therefore award **[1]** for every two factors listed or **[1]** for each qualified factor.*

water (distribution) for turgor/biochemical reactions/photosynthesis;
mineral / inorganic content / salinity of soil/water;
temperature (max, min, range, seasonal changes) / altitude;
light (intensity, duration, wavelength) for photosynthesis;
pH (range, average, changes) of soil/water;
wind (direction, strength); **[2 max]**

21. (a) a. named example of chemical (for example: mercury, DDT, PCBs, TBT, PAHs, heavy metals, selenium);
b. long lived / do not biodegrade / stored in body tissues / fat soluble;
c. present in small concentration in the environment;
d. chemical becomes more concentrated in the bodies of organisms at each successive trophic level;
e. reach toxic levels in top consumer/organisms near the end of the food chain / example of top consumer affected; **[3 max]**

*Award **[2 max]** if no named example of chemical.*

(b) a. includes all aspects of way of life of a species/role of the species in the ecosystem;
b. includes relationships within the community;
c. feeding relationships;
d. interaction with environment/spatial habitat; **[2 max]**