

MARKSCHEME

November 2003

BIOLOGY

Standard Level

Paper 3

General Marking Instructions

Subject Details: **Biology SL Paper 3 Markscheme**

Mark Allocation

Candidates are required to answer **ALL** questions in each of **TWO** Options (total **[18 marks]**).
Maximum total = **[36 marks]**.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- ◆ Each marking point has a separate line and the end is signified by means of a semicolon (;).
- ◆ An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- ◆ Words in (...) in the markscheme are not necessary to gain the mark.
- ◆ The order of points does not have to be as written (unless stated otherwise).
- ◆ If the candidate’s answer has the same “meaning” or can be clearly interpreted as being the same as that in the mark scheme then award the mark.
- ◆ Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- ◆ Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded.
- ◆ Units should always be given where appropriate. Omission of units should only be penalized once. Ignore this, if marks for units are already specified in the markscheme.
- ◆ Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

Option A – Diet and Human Nutrition

- A1.** (a) (i) 52.97 % / 53 %; (*units are not required*) [1]
- (ii) 45.48 % / 45 % / 46 %; [1]
- (b) component of the pigment in the rod cells (in the retina);
contributes to elasticity of skin;
pigment used in night vision / low light; [1 max]
Note that “eye” pigment alone is an insufficient response.
- (c) Savoy beets lose less β -carotene than fenugreek;
both Savoy beets and fenugreek lose more β -carotene when single packed than
when double packed; [2]
Answers may be numerical.
- (d) double packing reduces β -carotene loss for fenugreek at both temperatures;
double packing reduces β -carotene loss for Savoy beets only under cold conditions;
double packing requires more material / costs more; [2 max]
- (e) double packing insulates better;
double packing reduces oxidation;
double packing keeps leaves drier;
double packing blocks out more (UV) light; [1 max]
- A2.** (a) carbohydrates;
proteins;
lipids; [2 max]
*Award [1] for each correct answer, up to [2 max]. Subtract [1] from the total
for each incorrect answer.*
- (b) energy requirements will increase with mass/size;
more mass requires more energy for movement;
but bigger bodies have lower surface area to volume ratios;
so bigger bodies (proportionately) consume less energy to keep warm / bigger
bodies have lower metabolism / bigger bodies lose less heat by radiation;
increased growth rates require more energy / infancy and adolescence require more
energy for growth;
energy requirements also change due to other factors *e.g.* climate / activity /
pregnancy / lactation / illness; [4 max]

- A3.** (a) a substance required by the body to provide energy, maintain health or to provide material for growth and repair;
one of the components in a balanced diet; **[1 max]**
- (b) rickets is the result of poor bone growth / poor calcification of bones;
vitamin D / calciferol deficiency in diets can lead to rickets;
calcium deficiency in diets can lead to rickets;
vitamin D can be obtained from (fish) liver;
vitamin D can also be synthesised by the action of UV light on pro-vitamins in the skin;
pro-vitamins of vitamin D can be obtained from green vegetables;
rickets may also be caused by a hereditary disease;
rickets can be caused by poor calcium absorption; **[3 max]**

Option B – Physiology of Exercise

B1. (a) muscle glycogen levels are reduced; **[1]**

(b) the overall levels of muscle glycogen are not restored between each run;
the muscle glycogen levels gradually decrease over the three days of running;
the greatest reduction in muscle glycogen occurs after the first day’s run;
the level of muscle glycogen increases / returns to (almost) normal; **[2 max]**

(c) carbohydrates provide energy to contracting muscles;
glucose / carbohydrate is respired by the mitochondria in the muscles;
respiration produces ATP;
ATP provides the energy for muscle contraction; **[2 max]**

(d) the athletes’ diets restore some of the glycogen after a run;
the diets are insufficient to restore the glycogen to its original level / even after five days rest some athletes’ glycogen levels do not return to the original level;
more carbohydrate is needed in the diet of training athletes / increase dietary carbohydrate intake / carbohydrate loading / pasta loading;
less extensive exercise should be performed / longer rest intervals are needed between exercise / preparation for a race should include a break in training schedule; **[3 max]**

B2. (a) I. humerus
II. synovial fluid / membrane / capsule **[2]**

(b) muscles are co-ordinated by reflexes from the CNS / spinal cord;
the biceps and triceps muscles are antagonistic;
contraction of a muscle is stimulated by motor nerves;
stretch receptors / proprioceptors in muscles and tendons sense muscle stretching;
when stretch receptors in muscles are stimulated they produce a reflex stimulating muscle contraction / stretch reflex;
reciprocal innervation of muscles / when one muscle is excited the antagonistic muscle receives no excitation / is inhibited; **[3 max]**

(c) *Award [1] for type of injury and [1] for an appropriate description.*

Injury	Description
tennis elbow	inflamed tendon;
dislocation	bone/humerus pulled from socket of ulna;
torn ligament	sprain;
ruptured tendon	sprain;
fracture / break	due to excessive torsion / compression / flexing

[2 max]

- B3.** greater muscle activity produces more CO_2 / increase in respiration produces more CO_2 ;
increased blood CO_2 levels lowers blood pH / makes the blood more acidic;
low blood pH is detected by chemoreceptors in the arteries / carotid arch;
the breathing centre / respiratory centre of the brain is stimulated;
diaphragm and intercostal muscles contract more strongly / more frequently;
ventilation rate increases;
volume of air per breath increases / depth of breathing increases;

[3 max]

Option C – Cells and Energy

- C1.** (a) substrate for respiration / energy source / for ATP production;
material for growth of cell walls;
precursor for other molecules (*e.g.* amino acids); **[1 max]**
- (b) glucose must be transported from the extracellular fluid / culture medium to the cytoplasm / transported to the cell;
the transporter molecules must be located on the cell (surface) membrane; **[2]**
- (c) in the presence of light but no glucose, both modified and unmodified algae grow in the same way;
in the presence of light and glucose, the unmodified algae show no change but the modified algae grow faster and for a longer period of time;
in the absence of light but with glucose, the unmodified algae do not grow at all but the modified algae grow as well as when there is light and glucose; **[2 max]**
- (d) algal cells are pigmented green / have chlorophyll;
pigments absorb light for photosynthesis;
the more the algae grow, the more light is absorbed (so shading algae below them);
unmodified algae floating deeper in the water receive less light / are shaded and starve;
modified algae (given glucose) can carry on metabolising even if they are shaded / do not need light; **[3 max]**
- C2.** (a) *Any two from the following.*
fibrous: e.g. fibrin, collagen (*do not accept “tendon”*);
globular: e.g. hemoglobin, fibrinogen, amylase (*do not accept “enzyme”*); **[2]**
- (b) a new reaction pathway is created;
activation energy is reduced;
the equilibrium for the reaction is achieved more quickly / the reaction is faster; **[2 max]**
- (c) ATP inhibits phosphofructokinase at (allosteric) site away from the active site;
inhibition alters the enzymes conformation / structure;
the active site does not accept the substrate molecule;
when respiration increases ATP levels phosphofructokinase is inhibited;
respiration slows down;
phosphofructokinase is the first enzyme in the respiration pathway so there is no build up of metabolic intermediates;
as ATP is used up by the cell the inhibition of phosphofructokinase is reduced;
respiration speeds up again;
this is an example of negative feedback; **[4 max]**
- C3.** ATP, reduced NADPH / NADPH₂ / NADPH + H⁺ and O₂; **[2]**
Need both NADPH and H⁺ to achieve [1].

Option D – Evolution

- D1.** (a) some families have become extinct; [1]
- (b) Lipotidae; [1]
- (c) (mitochondrial) DNA;
amino acid sequences / proteins; [1 max]
- (d) river dolphins did not evolve from the same ancestor;
river dolphins evolved in similar environments;
river dolphins were exposed to the same selection pressures;
river dolphins adapted in the same ways;
river dolphins show convergent evolution; [3 max]
- (e) radioisotopes in the rocks where the fossils are found / in fossils;
(absolute) dates are obtained by radioisotopic dating of rocks where fossil toothed whales are found;
comparisons of molecular sequences / DNA / proteins;
(absolute) dates can be estimated from differences due to mutations in living toothed whales / molecular sequences;
position of fossils in the rocks;
(relative) dates may be obtained by comparing the positions of the fossil toothed whales relative to one another; [2 max]
- D2.** (a) non opposable big toe / broad pelvis / more vertical posture / skull on top of vertebrae;
short legs indicating bipedality;
curved finger bones / phalanges;
indicating it was still arboreal;
conical thorax;
indicating vegetarian diet;
dentition more like a chimp / larger canines / parallel molars; [3 max]
- (b) [2 max] for origins:
bipedalism evolved in hominids about 5 Mya;
fossil footprints found (at Laetoli) 3.6 Mya;
anatomy of hominids suggests bipedality at 4.4 Mya;
but the fossil record is limited before this date;
bipedality possibly associated with a change in habitat / climate / woodland to savannah;
[2 max] for consequences:
bipedality provides greater field of view for foraging / detecting predators;
bipedality is an economical form of locomotion;
bipedality frees hands for manipulation / carrying things / gesture; [4 max]
- D3.** Any *three* from:
no free O₂ / reducing atmosphere;
liquid water;
free methane / ammonia / CO₂ in the atmosphere;
strong UV light levels reaching surface;
frequent electrical storms; [3 max]

Option E – Neurobiology and Behaviour

- E1.** (a) direct relationship / positive correlation / as the distance increases so does the duration of the waggle; [1]
- (b) the angle made by the waggle in the dance corresponds to the angle of the sun with the hive;
so bees also indicate the direction of the food source in their dance;
food quality;
food quantity; [1 max]
- (c) 11 m ; (*mark lost if this is the first time the units are omitted*) [1]
- (d) 80 m (\pm 4) m ; (*mark lost if this is the first time the units are omitted*) [1]
- (e) the bees flying in the tunnel cannot see landmarks;
the bees need to see their surroundings so that they can judge how far they have flown;
chequered pattern confuses them / provides false clues;
seeing the sky is not enough to judge distances; [2 max]
- (f) repeat the experiment with tunnels of different lengths;
repeat the experiment in different directions from the hive;
paint cues on the tunnel walls;
use a transparent tunnel; [1 max]
Any other logical suggestions may be possible.
Do not accept "repeat the experiment more times".
- E2.** (a) innate behaviour develops independently of the environmental context / cannot be altered;
learned behaviour reflects conditions experienced by individuals during their development / can be modified; [2]
- (b) named example;
Many organisms are acceptable: species of bird (e.g. swallow) (do not accept "bird"), fish (e.g. salmon), marine mammals (e.g. humpback whale), insects, (e.g. monarch butterfly), and even named sea shore invertebrates migrating with the tide.
mass directional movement;
from one location to another;
large numbers of a species;
triggered by environmental cues (e.g. changes in day length);
guided by environmental cues (e.g. orientation by sun, stars or Earth's magnetic field); [4 max]

- E3.** (a) I. cerebral hemisphere;
II. cerebellum; **[2]**
- (b) the pupil reflex is a cranial reflex;
opening the eyelid lets light into the eye and stimulates the retina;
a reflex will cause the pupil to constrict if the brain is intact;
failure of the pupil to constrict indicates brain damage;
this could be an indication of brain death; **[2 max]**
- (c) *Any two of the following.*
mechanoreceptors / chemoreceptors / thermoreceptors / photoreceptors; **[1]**

Option F – Applied Plant and Animal Science

- F1.** (a) there is little difference between the treatments up to 16 mg / there are slightly less eggs laid in the 8 mg and 16 mg treatments with pheromone / both treatments produce about 90 eggs per plant up to 16 mg pheromone;
there are a lot less eggs laid when 32 mg of pheromone are used than without the pheromone; **[2 max]**
- (b) the alarm pheromone could be used to warn other aphids to hide from predators;
to frighten off predators / competitors; **[1 max]**
Any other suitable suggestion
Do not accept “to repel another pest species” (given in the stem of the question).
- (c) 32 million aphids; **[1]**
- (d) cabbage root fly do reduce their egg laying in the presence of the aphid pheromone;
however, large amounts are require to have an effect;
so many aphids would be needed on the plants they would cause serious damage to the plants;
the use of peach-potato aphid to control the cabbage root fly would not be very effective; **[3 max]**
- F2.** (a) plant growth regulators are hormones, fertilizers are mineral nutrients;
plant growth regulators control growth / development, fertilizers are essential nutrients for healthy plant growth;
plant growth regulators are released by tissues of the plants (in small quantities), fertilizers are absorbed from the soil (or by leaves); **[2 max]**
- (b) individual plant cells / small clusters of tissue cells may be used;
cultured on agar using aseptic techniques;
growth encouraged by mixture of nutrients and plant growth regulators;
undifferentiated callus forms which can be cut up again;
a different mixture of plant growth regulators used to produce differentiated tissues;
grown up to be adult plant which is a clone of the parent plant;
an infinite number of identical plants can be produced this way; **[3 max]**
- (c) pruning removes the apical regions of the shoots;
therefore removing a source of auxin;
apical dominance is lost;
lateral shoots elongate / grow longer;
plant becomes bushy; **[2 max]**

- F3.** (a) breeding between two distantly related / genetically unrelated members of a species;
breeding which promotes heterozygosity; **[1 max]**
- (b) *maintaining biodiversity of wild plants:*
domesticated plants have been created from only a few species;
environments change / new diseases appear / new areas may be cultivated;
wild species may be more effective producers;
wild species may be more tolerant to disease / climatic stress / other named factor;
transgenic organisms may be created using genes from wild organisms;
hybrids may be created by crossing with wild organisms;
- maintaining ancient farm breeds:*
domesticated species of animals show restricted genetic variation;
environments change / new diseases appear / new areas may be cultivated;
ancient breeds may be more effective;
ancient breeds may be more tolerant;
transgenic organisms may be created using genes from ancient organisms;
hybrids may be created by crossing with ancient farm breeds; **[3 max]**

Option G – Ecology and Conservation

- G1.** (a) (i) 1450 m (± 20) m; (*mark lost if this is the first time the units are omitted*) [1]
(ii) 980 m (± 20) m; (*mark lost if this is the first time the units are omitted*) [1]
- (b) shark 2 turns / changes direction more often than shark 1 / vice versa [1 max]
- (c) shark 1 swims in water where the zooplankton levels are low;
shark 2 swims in water where the zooplankton levels are higher;
shark 2 turns more often because it is feeding in plankton / food rich water / shows highest degree of turns where zooplankton levels are highest;
shark 1 turns less often because it is still searching for food / there is not much to eat; [3 max]
- (d) water temperature;
other sharks / competitors;
mates;
water currents;
pollution;
any other possible reasons; [2 max]
- G2.** (a) provide dead organic matter when they die / produce waste;
aerate the soil when they burrow through it;
roots of plants prevent soil erosion;
decompose dead organic matter to form humus;
enrich with minerals (*e.g.* nitrifying bacteria); [2 max]
- (b) tropical rainforest conservation is an example of *in situ* conservation / cheaper than *ex situ* conservation;
tropical rainforest species provide valuable timber;
tropical rainforest species are sources of new pharmacological molecules / new medicines;
tropical rainforest are a source of revenue through ecotourism;
tropical rainforest provide employment for local people;
tropical rainforests managed to maintain high diversity and to provide sustainable yield of materials; [3 max]
- G3.** (a) (i) D decreases; [1]
(ii) stable ecosystem / absence of changes;
ecosystem not under stress;
ancient / well established ecosystem; [1 max]
- (b) biotic indices use a range of species;
of varying degrees of tolerance;
to measure an abiotic factor;
example of factor (*e.g.* organic water pollution, air pollution);
example of index (*e.g.* fresh water benthic invertebrates, lichens);
biotic indices can reveal long-term effects of environmental stress; [3 max]
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