

MARKSCHEME

May 2005

BIOLOGY

Standard Level

Paper 3

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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.
- ◆ Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
- ◆ 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. Indicate this with “**ECF**”, error carried forward.
- ◆ Units should always be given where appropriate. Omission of units should only be penalized once. Indicate this by “**U-1**” at the first point it occurs. 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) increased fibre intake reduces colon cancer mortality / negative correlation **[1]**
- (b) (i) 17.3 (\pm 0.1) deaths per 100 000 population (*units required*) **[1]**
- (ii) increase of 91.0 (\pm 5.0) g (starch day⁻¹);
 increase from 133 to 222 (\pm 5.0) g (starch day⁻¹);
 other correct numerical example; **[1 max]**
- (c) fibre affects the mortality rate more than starch affects the incidence rate;
 both reduce the incidence of colon cancer;
 (cannot compare) as one displays incidence and the other mortality / mortality and incidence are not the same thing; **[2 max]**
- (d) increase in fibre intake does lower mortality;
 effect may not just be caused by starch / high fibre intake;
 high fibre intake usually associated with high cereal / vegetable / fruit diet;
 data does not show geographical distribution / ethnic influence / gender / age;
 genetic factors not taken into account; **[2 max]**
- A2.** (a) needed for production of rhodopsin;
 is light sensitive pigment in the rod cells of the eye;
 used for black and white vision in dim light;
 prevents night blindness;
 antioxidant;
 healthy skin;
 maintains mucus linings; **[2 max]**
- (b) age - with increasing age up to adulthood more energy is needed as the body grows larger;
 gender - females use less energy than males;
 due to smaller body size and less heat loss because of thicker layers of fat under the skin;
 pregnant females require more energy;
 activity - amount of energy depends on the vigour / type of physical activity;
 condition - extra energy is needed during growth spurts / breast-feeding / illnesses;
 size - larger people need more energy; **[4 max]**
- Accept numerical data instead of explanation in each category*

- A3.** (a) *social: [2 max]*
population growth may make food supply insufficient;
wars / corrupt governments may prevent production / distribution of food;
reference to excessive dieting / overeating / anorexia / bulimia / obesity;
- cultural: [2 max]*
diet is part of the culture of a population;
some cultures have a maize-based diet and may suffer from pellagra (vitamin B₃ deficiency);
some cultures have a polished rice based diet and may suffer from beriberi *[3 max]*
(vitamin B₁ deficiency);
- (b) *zinc:* part / cofactor of some enzymes / part of some proteins that control DNA expression / wound healing / production of insulin / production of sperm;
iodine: (needed by the thyroid gland for) the synthesis of thyroxin / prevents goitre; *[2]*

Option B — Physiology of Exercise

- B1.** (a) maximum weight lifted by student B increases more than for student A;
number of repetitions of student A increases more than student B; [2]
- (b) student A is training for stamina not strength;
by lifting the same weight each time, student A is not progressively overloading his muscles;
greater increase in slow muscle fibres than fast muscle fibres; [2 max]
- (c) increased number of capillaries;
increased number of mitochondria;
increased amount of myoglobin
increased capacity for aerobic (cellular) respiration;
increased proportion of slow fibres; [2 max]
- B2.** (a) neurotransmitter is acetylcholine / cholinergic synapses;
action potential arrives and depolarizes the synaptic knob;
extra cellular calcium ions enter triggering the release of acetylcholine;
acetylcholine diffuses across synaptic cleft;
acetylcholine binds to the muscle receptor and depolarizes the post synaptic membrane;
acetylcholine is removed by acetylcholine esterase; [3 max]
- (b) cross bridge formation between actin and myosin heads;
repeated cycles of cross bridge formation / ratchet mechanisms and ATP hydrolysis moves the actin filaments;
actin filaments pulled toward centre of sarcomere;
light bands become more narrow;
when acetylcholine is no longer present the sarcoplasmic reticulum reabsorbs calcium ions stopping the process; [3 max]
- B3.** (a) *sprinter*: anaerobic respiration;
marathon runner: aerobic respiration; [2]
- (b) lactic acid accumulation in a sprinter;
depletion of the carbohydrate stores in the muscles in marathon runner; [2]
- (c) glycolysis allows skeletal muscle to work when mitochondrial activity is slowed because of low oxygenation;
lactic acid is produced from pyruvate during anaerobic metabolism;
oxygen debt is the oxygen needed to break down the lactic acid in the liver;
continued deep breathing is needed after exercise to replace the oxygen;
lactic acid is converted to pyruvate in the liver; [2 max]

Option C — Cells and Energy

- C1.** (a) between 1.5 and 3.5 hours (or number between these figures) after feeding mealworm RQ values are higher than for millet;
 no difference in RQ values between 3.5 hours and 6 hours;
 between 0.5 and 1.5 hours (or number between these figures) millet RQ values much higher than for mealworm;
 between 2 and 3 hours mealworm RQ values are slightly higher than for millet; **[2 max]**
- (b) millet is not composed entirely of carbohydrates;
 millet contains more carbohydrates;
 mealworms contain more lipids / proteins; **[2 max]**
- (c) (i) using carbohydrate (from millet as a respiratory substrate) **[1]**
 (ii) reverting to other substrates / carbohydrates (from millet) used up **[1]**
- C2.** (a) beta sheet / alpha helix **[1]**
- (b) fibrous proteins have a long and narrow shape, globular protein have rounded shape;
 fibrous mostly insoluble in water, globular protein soluble in water
 fibrous in secondary structure, globular in tertiary structure
 fibrous: collagen / myosin / silk / keratin / other fibrous protein;
 Globular: immunoglobulin / hemoglobin / catalase / named enzyme /
 other globular protein; **[3 max]**
- (c) polar amino acids are hydrophilic / “water loving”;
 polar amino acids form hydrophilic proteins / channels;
 allow hydrophilic / polar / charged particle substances through the membrane;
 controls shape / function / location of the protein in the membrane;
 polar amino acids on the surface proteins make them water soluble;
Accept any of the above points if clearly explained using a suitable diagram **[2 max]**

- C3.** (a) stroma **[1]**
- (b) electron transport causes protons to be pumped inside the thylakoid;
ATPase located in the thylakoid membrane (lets protons across the membrane);
protons go down the concentration gradient;
protons move from the thylakoid to the stroma;
energy is used to synthesise ATP; **[3 max]**
- (c) photosynthetic rate is dependent on light intensity and wavelength;
leaves lower in the tree will have a lower photosynthetic rate / or vice versa;
leaves lower in the tree will receive filtered light / light of reduced number of
wavelengths / contains less violet/blue and/or red light / or vice versa;
leaves lower in the tree will receive more light consisting of yellow and green light/
or vice versa; **[2 max]**

Option D — Evolution

- D1.** (a) low food availability limits tentacle diameter **[1]**
- (b) (i) highest clearance rate in high food availability;
up to five days of age no difference in clearance rate (between low and high food availability larvae); **[2]**
- (ii) more food/nutrients leads to faster developments **[1]**
- (c) larger tentacle diameter leads to higher food uptake;
as tentacle diameter increases this leads to higher clearance rate;
increased food uptake leads to faster development;
faster development to adult stage leads to earlier reproductive stage;
reference to competition / natural selection; **[2 max]**
- D2.** (a) Wallace’s Line;
division of two land masses by a sea;
occurred about 100 million years ago;
separation led to divergent evolution / ancestral animals were able to evolve along diverging lines;
marsupials on the Australian side of (Wallace’s Line), placental on the other / Asian side; **[3 max]**
- (b) by casts / impressions;
by organisms falling into soft mud;
which hardens into rock;
by impregnation / petrification;
minerals enter;
so it hardens / becomes rock;
preserved by no oxygen;
so no decay;
e.g. peat / ice / amber / tar; **[3 max]**
- (c) DNA is degraded / broken down;
no complete genome ever found;
DNA is contaminated; **[1 max]**

- D3.** (a) genetic is slow, culture is fast;
genetic is inherited vertically / from generation to generation, cultural can be inherited vertically and horizontally / between peers;
genetic component of a trait comes before cultural;
cultural is passed on from one generation to the next by oral or written traditions / teaching and learning;

[3 max]

- (b) grasping limbs / opposable thumb;
mobile arms / shoulder joints flexible;
stereoscopic vision / eyes on front;
skull modified for upright posture;

[2 max]

Option E — Neurobiology and Behaviour

- E1.** (a) (i) between $110 - 120^\circ$ (*units required*) [1]
- (ii) between $270^\circ - 360^\circ$ / upper left hand quadrant [1]
- (b) (i) 20 ms (*units required*) [1]
- (ii) between $2 (\pm 1) - 56 (\pm 1)$ ms (*units required*) [1]
- (iii) e.g. different sensitivity of antennae;
genetic variation in the species;
variation in the intensity of the tap on the antenna;
variation in the position of the tap on the antenna; [1 max]
- (c) left antenna because approximately 110° turn only / the left antenna because it moves to the right; [1 max]
- (d) avoids danger by moving in the opposite direction to stimulus;
still sees source of danger / stimulus;
moves away at an angle of $110 / 120^\circ$;
behaviour results in better survival rate; [2 max]
- E2.** (a) Award [1] for any two of the following structures clearly drawn and correctly labelled.
cerebral hemispheres;
hypothalamus;
cerebellum;
medulla oblongata;
pituitary gland; [2 max]
- (b) cerebral hemispheres – complex thought / memory / learning / problem solving;
hypothalamus – controls secretion of hormones by the pituitary gland / hunger / thirst;
cerebellum – co-ordinates muscle movement / controls balance;
medulla oblongata – controls autonomic reflexes e.g. breathing rate / heart rate / regulates blood pressure / coughing;
pituitary gland – secretes hormones that control many processes in the body; [2 max]

E3. (a) *Award [1] for each correct definition and example.*

mechanoreceptors:

(respond to) mechanical energy in the form of movement / sound / pressure / gravity – *e.g.* hair cells in the inner ear / stretch receptors in tendons;

chemoreceptors:

(respond to) chemical substances – *e.g.* nerve cells in nostrils / taste buds in tongue;

thermoreceptors:

(respond to) temperature – *e.g.* warm and cold nerve endings in the skin;

[3 max]

- (b) provides objective data rather than opinion / greater accuracy;
allows graphical representation of data;
allows for statistical analysis / average values (so anomalies less significant);
enables comparative study;
can be used to support/refute an hypothesis / draw reliable conclusion;
can generate new questions for research;
permits the analysis of absolute data (*e.g.* presence or absence of certain substance);
establishes frequency of behaviour;

[4 max]

Option F — Applied Plant and Animal Science

- F1.** (a) (i) 8 ppm (units required) **[1]**
- (ii) 44 (± 2) **[1]**
- (b) with increasing concentration of extract growth stimulation turns into growth inhibition / *vice versa*;
concentrations of 0.16 and 8 ppm have a growth stimulating effect of 13%, 18% respectively, ± 1 on figures;
at 40 and 200 ppm extract shows 18 % and 48 % growth inhibition respectively, ± 1 on figures;
five fold increase of extract (40 to 200 ppm) does not lead to a five fold increase in growth inhibition; **[2 max]**
fifty fold increase in extract (0.16 to 8 ppm) does not have a noticeable/significant effect on the growth stimulation;
- (c) light might break down the extract;
light might activate the extract;
darkness may lengthen the activity period;
find out when it works best;
light may stimulate reaction between extract and seedling;
light may inhibit reaction between extract and seedlings; **[2 max]**

- F2.** (a) *Answers must refer to both biological and chemical control in order to receive full marks.*

biological: [2 max]

predator/parasite/pathogen may damage ecosystems by attacking other organisms apart from the pest;
do not often work outside restricted area e.g. greenhouse;
can only be introduced when there is a pest / some damage will be done before it can be introduced;
can become a pest itself;

chemical: [2 max]

may cause health problems;
resistance;
non-target species;
accumulation year on year;
water / air pollution;
accumulation in food(s);
long-term effects;
non bio-degradable;

[4 max]

- (b) antibiotics increase growth rates by controlling infection;
can boost production of milk and meat so more food available;
less illness / suffering in animals;
allow high density / intensive farming;
increase in antibiotic resistant strains of bacteria;
antibiotics may harm human health and the environment;

[3 max]

- F3.** (a) *Answers must refer to both regulators and fertilizers to obtain full marks.*

plant growth regulators: [1 max]

chemical substances that act as messengers;
control growth and development in plants;
some are hormones / auxins;

fertilizers: [1 max]

minerals;
For healthy growth / accept named example e.g. nitrogen for growth

[2 max]

- (b) shoots of plants grow towards light / positively phototropic;
roots grow away from light / regularly phototropic;
shoot tips produce auxin;
acts as a growth promoter / promotes secretion of hydrogen ions into cell walls;
loosens connections between cellulose fibres;
allows cell expansion;
is distributed in the tip from the lighter to the darker side;
plant bends towards the light;

[3 max]

Option G — Ecology and Conservation

- G1.** (a) primary consumer **[1]**
- (b) June to August 1994 (± 1 month);
May to June 1993 (± 1 month); **[1 max]**
- (c) there is a rise in the population starting every (Antarctic) summer;
every year numbers remain low from March until November / from fall until the beginning of summer;
no data available for spring 1994;
increase in numbers coincides with increase in light;
decrease in numbers during fall / autumn; **[2 max]**
- (d) (i) lowest sea water temperature is associated with highest numbers of larvae;
larvae numbers increase when temperature drops below -1.5°C ;
no larvae at temperatures above -1.5°C ;
bigger increase in numbers during July / September 1993 than in July / September 1994 although temperatures the same; **[2 max]**
- (ii) global warming causes rise in sea water temperature;
lower numbers of larvae;
because larvae only present at sea water temperature below -1°C ; **[2]**
- G2.** *Award three correct [2] and for one or two correct [1].*
temperature / climate;
water;
breeding sites;
food supply;
territory;
human interference **[2 max]**
- (b) two closely related species / interspecific competition;
experiments by Ganse with two species of *Paramecium* / other example;
competition for limiting resources eliminates inferior competitor / only one of the species survives in the niche;
competition restricts niche;
two species cannot coexist if niches are identical; **[3 max]**

- G3.** (a) leads to decline of fish stocks;
destroys food chains;
secondary / tertiary / consumers shift to other prey to survive;
species may shift to another habitat / start showing preference for other habitats,
upsetting those habitats as well; *[2 max]*
- (b) indicator species can be used to assess particular conditions, *e.g.* some species prefer
low oxygen content / *vice versa*;
example of an indicator specie *e.g.* lichen for air pollution
indicator species need a particular environment to survive / lack of a particular
species indicates a change in the quality of the ecosystem;
changes in quality can lead to the disappearance / occurrence of species;
changes can be monitored over a longer period;
changes can lead to adequate measures to protect the environment; *[3 max]*
-