



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 markscheme 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) countryside (girls) [1]
- (b) city girls have the best overall nutrition / better for all nutrient intake;
biggest difference is in vitamin D;
smallest difference is in energy;
for all nutrients, both groups are below the RDA values; [2 max]
- (c) (i) mean of 355 / 355.3 / 355.33 mg day⁻¹ (*units needed*) [1]
- (ii) 30 (. 1) % [1]
Allow ECF from (c) (i).
- (iii) *Award [1] for any two different valid sources.*
milk / milk products;
sardines;
(dark) green (leafy) vegetables;
tofu;
cereals; [1 max]
Any other valid suggestions.
- (d) rickets is due to lack of calcium / vitamin D/calciferol / (for bone/teeth formation);
vitamin D/calciferol is essential for calcium absorption;
increase awareness of nutritional origin of rickets;
increase the sunlight exposure to increase vitamin D/calciferol / production in body;
(subsidies to) increase intake of food rich in vitamin D/calciferol / (distribute) vitamin D/calciferol / calcium supplements;
increase intake of food rich in calcium *e.g.* milk; [3 max]
- A2.** (a) an amino acid that the body cannot make but requires / must be ingested [1]
- (b) anemia is the lack of red blood cells / hemoglobin;
may be due to an iron deficiency in the diet;
may be due to vitamin deficiency *e.g.* cyanocobalamin (vitamin B12) / folic acid / vitamin C;
anemia may be hereditary;
named example of food rich in iron *e.g.* red meat, liver, spinach; [2 max]

- A3.** (a) provides nutrients necessary for growth;
provides nutrients necessary for maintenance and repair;
provides sufficient energy / balance between energy intake and expenditure;
provides nutrients for metabolic processes / reactions. **[2 max]**
- (b) vegans eat only plant products while vegetarians eat some animal products *e.g.* milk and milk products, eggs, *etc.* as well as plant products **[1]**
- (c) fibre is mainly cellulose / cannot be digested;
fibre helps prevent constipation / increases bulk in intestine / helps egestion / allows peristalsis;
helps increase bulk in stomach / reduces appetite to eat more / reduces obesity;
may reduce risk of diseases / colon cancer / hemorrhoids / appendicitis;
may reduce rate of sugar absorption / may help treatment of diabetes; **[3 max]**

Option B — Physiology of Exercise

- B1.** (a) directly proportional / positive correlation / more exercise leads to higher cardiac output *[1]*
- (b) (i) 82.5 (. 3) % *[1]*
- (ii) 5.25 / 5.3 (*units not needed*) *[1]*
- (c) cardiac output to muscles / overall cardiac output increases more in top athletes/with training;
training/top athlete decreases cardiac output to rest of body;
training increases oxygen consumption in muscle / overall oxygen consumption during heavy exercise;
training does not change oxygen consumption by rest of body during heavy exercise;
training causes changes by increasing stroke volume / lung capacity; *[3 max]*
- B2.** (a) *Both needed for [1].*
axial **and** appendicular *[1]*
- (b) central nervous system/CNS *[1]*
- (c) controlled by (motor areas) of the cerebral cortex;
impulse sent via motor neuron;
impulse crosses synapse / neuromuscular junction / motor end plate;
increase of calcium in muscles;
contraction of muscle fibres;
sliding of actin and myosin;
feedback to the brain / control by antagonistic muscles;
via proprioceptors/stretch receptors / sensory neurons; *[4 max]*

- B3.** (a) (i) inadequate oxygen supply to respiring muscle;
lactate from anaerobic respiration builds up;
O₂ needed to convert lactate (to pyruvate); *[1 max]*
- (ii) liver; *[1]*
- (b) sprains are minor tears to ligaments;
torn ligaments are complete tears;
dislocation of joints where bones move out of alignment;
intervertebral damage where disc is torn and centre bulges out;
erosion of cartilage; *[2 max]*
- (c) warm-up makes muscles/joints more supple / less likely to tear/strain / increases
blood flow to provide oxygen/glucose/reduce lactate / increases ventilation to
provide more oxygen;
cool-down disperses lactate / allows cardiovascular system to adjust; *[2]*

Option C — Cells and Energy

- C1.** (a) (i) 72.5 (. 1.0) % [1]
- (ii) 40 % (decrease) [1]
- (b) both are inversely proportional / as CAA concentration increases both activity and growth decrease;
 growth is more irregular at low concentrations;
 ACTase activity decreases more at higher concentration/after 30 mmol dm⁻³ than growth;
 both show linear decreases between 10 and 30 mmol dm⁻³; [2 max]
Any other valid comparisons.
- (c) end-product is slowing enzyme activity;
 allostery / non-competitive inhibition; [2]
- (d) use CAA to control/inhibit bacterial growth/antibiotic functions;
 use CAA to treat *H. pylori* infection; [1 max]
- C2.** (a) *Award [1] for any two products.*
 ATP;
 NADH;
 pyruvate; [1 max]
- (b) polar amino acids are hydrophilic and non-polar amino acids are hydrophobic;
 position of polar and non-polar amino acids determine protein shape / function / location;
 (in channel proteins) hydrophilic amino acids line the channels and allow transport of ions/polar substances;
 non-polar amino acids are in contact/embedded within the lipid membrane;
 polar amino acids on the surface proteins make them water soluble;
 non-polar in the centre of water-soluble proteins stabilize the structure; [3 max]
Accept any of the above points if clearly explained using a suitably labelled diagram.

- C3.** (a) *Award [1] for each of the following structures clearly drawn and correctly labelled.*
- thylakoid membrane / grana;
 - double outer membrane / envelope;
 - ribosomes;
 - circular DNA;
 - lipid globules / starch granules;
 - stroma;
- [3 max]**
- (b) large surface area of thylakoids for light absorption / photosynthesis;
(small) space in the thylakoids to accumulate protons;
fluid stroma for enzymes of the Calvin cycle / light independent reaction;
- [2 max]**
- (c) ATPase location in the thylakoid membrane (lets protons across the membrane);
protons go down concentration gradient;
protons move from the thylakoid to the stroma;
energy is used to synthesise ATP;
- [2 max]**
- Accept any of the above points if clearly explained using a suitably labelled diagram.*

Option D — Evolution

- D1.** (a) (i) Santa Fe 370-380 mm; (*units needed*)
 Genovesa 250-260 mm; (*units needed*) **[1 max]**
Both needed for [1].
- (ii) food availability / predation / competition / territory size / different selection pressures **[1]**
Any other valid suggestions.
- (b) males are generally bigger than females on both islands / females tend to be smaller;
 maximum size of males is greater than females on each island;
 range of male sizes greater than range of female sizes on each island;
 range of males and females sizes overlap; **[2 max]**
- (c) males have to defend territory for mates;
 bigger males more successful mating;
 bigger males pass on their genes / size trait;
 longer length in females seems advantageous; **[2 max]**
Any other valid explanations.
- D2.** (a) order Primate, family Hominidae **[1]**
- (b) genetic evolution is dependent on/controlled by genes;
 cultural evolution is learned/taught / language dependent;
 genetic evolution is limited by the genetic composition/genotypes of the populations;
e.g. of human genetic evolution (such as increase in cranial capacity);
 cultural evolution allows much more rapid evolution;
e.g. of human cultural evolution (such as tool making); **[4 max]**
- D3.** (a) $^{14}\text{C}/\text{C}^{14}$ /carbon-14 and $^{40}\text{K}/\text{K}^{40}$ /potassium-40 **[1]**
- (b) bodies/(soft) body parts often not preserved;
 require special conditions for preservation;
 very few fossils are found / gaps in fossil record;
 difficult to get a full picture from few parts/organisms;
 lack of data leads to speculation about human evolution;
 adult/juvenile fossils difficult to ascertain; **[3 max]**
- (c) organisms with common ancestry found in areas geographically separated have
 different adaptations / divergent evolution;
e.g. Darwin’s finches in the Galapagos Islands / New World monkeys in America
 and Old World monkeys in Africa / marsupials in Australia;
 similar adaptations of unrelated organisms in similar habitats / convergent evolution;
e.g. streamlined shape of dolphins and fish; **[3 max]**
Any other valid examples.

Option E — Neurobiology and Behaviour

- E1.** (a) (i) 25 (. 1) Hz (*units needed*) [1]
- (ii) 17.0 (. 1) seconds (*units needed*) [1]
- (b) low activity at start and in middle;
activity increases when sniffing female;
neural activity drops (gradually) after sniffing is finished;
neural activity is not constant/fluctuates;
the highest peak occurs whilst sniffing the pheromone-producing region; [3 max]
- (c) place a fake/imitation female in the cage and measure neural activity during sniffing by male;
remove glands producing pheromones in female before test;
test with only the scent of the pheromone (and no mouse); [1 max]
Any other valid suggestion.
- E2.** (a) (i) controls autonomic reflexes *e.g.* regulates blood pressure / heart rate / breathing rate / coughing [1]
- (ii) controls balance / coordination of muscle movement; [1]
- (b) *Accept any correct spinal reflex with the following identified.*
receptor detects stimulus;
sensory neuron relays impulse to CNS/spinal cord;
associative / spinal / relay / intermediate neurons relays impulse to motor neuron;
motor neuron relays impulse to effector;
effector responds *e.g.* in the knee jerk;
stimulus/tap detected by stretch receptors;
sensory neuron (stimulated) to send impulse to CNS/spinal cord;
relays impulse to motor neuron;
motor neuron stimulates / relays message to (upper) thigh muscle;
(upper) thigh muscle contracts / knee jerks up; [3 max]
Credit annotated diagrams.
- (c) shine light in eye to see if pupil constricts;
pupil reflex is cranial reflex / ANS reflex / controlled by the brainstem;
(if pupil reflex is lost) patient is most likely brain dead;
some drugs (barbiturates) / nerve damage may interfere with pupil reflex; [2]

- E3.** (a) behaviour that occurs in all members of a species despite variation in the environment / inherited behaviour / stereotyped behaviour / not learnt / instinctive; **[1]**
- (b) *Award [2] for three correct answers and [1] for two or one correct.*
A: rod;
B: cone;
C: bipolar neuron; **[2 max]**
- (c) provides objective data rather than opinion / greater accuracy;
allows graphical representation of data / average values (so anomalies less significant);
allows for statistical analysis;
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; **[2 max]**

Option F — Applied Plant and Animal Science

- F1.** (a) (weak) negative / inverse / as temperature increases crop yield decreases [1]
- (b) 6.5 (. 0.2) bushels acre⁻¹ yr⁻¹ (*units needed*) [1]
- (c) corn has wider range of yield than soybean production;
 both are clustered slightly below 0° difference/average;
 neither had yields < -0.07°C ;
 neither had yields > 0.06°C ;
 for both crops (slightly) warmer temperatures decreases production / (slightly) colder increases production;
 corn yield higher than soybean yield; [2 max]
- (d) higher temperature increases rate of photosynthesis – increases yield;
 higher temperature increases evaporation/transpiration – decreases yield;
 higher temperature increases respiration – decreases yield;
 lower temperature decreases evaporation of water from the soil – increase yield; [3 max]
Accept the converse of the above statements.
- F2.** (a) (i) net increase in plant biomass per unit area of leaf per unit time [1]
- (ii) measure mass of equivalent amounts of plants at start and end of growth period;
 harvest plants from a given area, removing and measuring area of all leaves; [1 max]
- (b) control of temperatures / warmer conditions;
 control of CO₂ concentrations / CO₂ levels increased;
 increase light levels / use of artificial lights;
 control water/irrigation / high humidity;
 control predators / disease;
 control of nutrients/fertilizer addition;
 regulate soil composition / hydroponics;
 protect against extreme weather conditions (*e.g.* hail / gales) [4 max]
- F3.** (a) increased healthy growth development (due to heterozygosity) in offspring of crosses between unrelated parents / outbreeding [1]
- (b) best laying hens are chosen to breed;
 artificial insemination from best roosters (cockerels) / male birds; [1 max]
- (c) intensive animal rearing is when a lot of animals are reared in a small space;
 yields higher per area of land / per worker;
 cheaper production of food for world;
 easier to monitor health of animals;
 overcrowding risks spread of diseases decreasing yield;
 overcrowding causes stress, decreasing yield;
 environmental contamination due to waste production decreasing yield; [3 max]

Option G — Ecology and Conservation

- G1.** (a) (i) 55 (. 1) kg (*units needed*) [1]
- (ii) 1988 / end of 1987 [1]
- (b) greater fluctuations in the northern area;
no data before 1979 for the northern area, so comparison is difficult;
negative correlation between year and body mass / downward trend over time in southern area not evident in northern area;
large decrease in southern area in late 1990s not seen in northern area; [2 max]
- (c) as both animals vary similarly, it supports the hypothesis (in northern area);
hypothesis not supported in southern area in some years;
many other factors may influence the fluctuations;
e.g. weather, competition, predation *etc.*;
no data on bilberries, so cannot say; [2 max]
- G2.** (a) *Award [1] for any two factors.*
temperature/climate;
water;
food supply;
territory/space;
predation;
breeding sites; [1 max]
- (b) two closely related species/interspecific competition;
experiments by Gause 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 identical; [3 max]
- (c) an area with no vegetation / barren area / volcanic rock is colonized by a variety of species;
these species are gradually replaced by others;
interaction between living organisms and abiotic environment / increase in soil organic matter / improves soil structure;
eventually a stable community develops / climax community; [2 max]

- G3.** (a) measure of the richness of species / the health of ecosystems;
high diversity indicates good health / stable site / ancient site; **[1 max]**
Do not accept just “measure of diversity” or the formula only.
- (b) raise funds to protect threatened species / areas / establish nature reserves;
political lobbying;
education;
monitors endangered species; **[2 max]**
- (c) limit amount/quotas of fish to be caught / prevent over-exploitation;
no/reduced fishing during reproductive seasons;
monitoring of environmental/abiotic factors;
monitoring stocks and reproductive rates;
control of pollution of seas/lakes/rivers;
control of net type/mesh size;
smaller fleet sizes / exclusion zones;
education – change in eating non-threatened species;
need for / difficulties in establishing agreements between countries; **[3 max]**
-