



# **MARKSCHEME**

**May 2009**

**BIOLOGY**

**Standard Level**

**Paper 3**

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## General Marking Instructions

### 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. 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.
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.

**Option A — Human nutrition and health**

- A1.** (a) monounsaturated fatty acids and carbohydrates (*both required*) [1]
- (b) 80 (%) (*units not required*) [1]  
 Allow answers in the range of 80.00 to 80.20%.
- (c) monounsaturated fatty acids has more VLDL/cholesterol/  
 LDL/triglycerides;  $\left\{ \begin{array}{l} \text{Allow numerical} \\ \text{expressions.} \end{array} \right.$
- monounsaturated fatty acids has (slightly) less HDL;  $\left\{ \begin{array}{l} \text{Allow numerical} \\ \text{expressions.} \end{array} \right.$
- cholesterol increases the most in monounsaturated fatty acids (in  $\text{mg dl}^{-1}$ );  
 VLDL has highest percentage increase in monounsaturated fatty acids; [2 max]
- (d) less cholesterol/VLDL/LDL means lower chance of coronary heart disease/CHD;  
 accumulation of fats in arteries leads to atherosclerosis/clots/coronary heart  
 disease/CHD;  
 hypothesis seems to be supported as triglycerides/cholesterol/VLDL/LDL decrease;  
 hypothesis seems to be supported as the ratio of the LDL:HDL is lower;  
 hypothesis seems not to be supported as HDL remains about the same; [3 max]
- A2.** (a) dairy products / (oily) fish / egg yolk / liver *etc.* [1]
- (b) appetite controlled by hormones;  
 produced in pancreas / small intestine / adipose tissue;  
 pass message to control centre in brain/hypothalamus;  
 sensation of satiety / *OWTTE*;  
 stomach has stretch receptors which send message to brain; [3 max]

- A3.** (a) (i) body becomes resistant/not responsive to insulin;  
pancreas does not produce enough insulin;  
dietary factors / genetic predisposition;  
lack of exercise; *[1 max]*
- (ii) high glucose content in blood/hyperglycemia;  
thirst/frequent urination;  
slow-healing sores;  
tiredness;  
red/swollen gums;  
blurred vision/blindness;  
kidney/back pain;  
nerve damage;  
glucose in urine;  
erectile dysfunction; *[2 max]*
- (b) PKU caused by mutation in gene;  
phenylalanine builds up in bloodstream;  
so must not be contained in diet / diet low in phenylalanine / few proteins eaten;  
diet should include fruit, grain, vegetables and special formula milk;  
diet must be undertaken very early in life;  
otherwise brain damage/mental retardation;  
tremors / seizures / eczema / skin rashes; *[4 max]*

**Option B — Physiology of exercise**

**B1.** (a)  $3 \text{ m mol l}^{-1}$  (allow answers in the range of  $2.8 \text{ m mol l}^{-1}$  to  $3.2 \text{ m mol l}^{-1}$ ) [1]

(b) increases arterial lactate concentration [1]

(c) altitude and hypoxia increase arterial lactate concentration due to more anaerobic respiration;  
 altitude has a greater effect than oxygen concentration;  
 the values of hypoxia are greater than normoxia at 0 m (sea level) but the same at high altitude;  
 altitude/hypoxia causes less oxygen saturation of hemoglobin so less oxygen available in tissues;  
 altitude/hypoxia causes less oxygen for aerobic respiration; [3 max]

(d) passed to liver;  
 turned into pyruvate;  
 used in aerobic respiration;  
 converted to glucose; [2 max]

**B2.** (a) I. Z line;  
 II. actin (filaments); [2]

(b) (i)

slow muscle fibre (tonic)	fast muscle fibre (twitch)
contract slowly	contract rapidly;
resist fatigue	fatigue easily;
high myoglobin	low myoglobin;
aerobic metabolism	anaerobic metabolism;
very good blood supply	moderate blood supply;
high stamina	low stamina;
more mitochondria	less mitochondria;

[2 max]

*Award [1] per correct row.*

(ii) warm up involves gentle exercise before exercise;  
 warm muscles/joints are less likely to be strained/more supple;  
 increases blood flow/oxygen to muscles;  
 but there is limited scientific proof;  
 some people do not suffer ill effects from not warming up; [3 max]

**B3.** (a) maximum volume of air exhaled after deep inhalation **[1]**

(b) *benefits:*

EPO induces production of red blood cells;  
more red blood cells so more oxygen in muscles;  
gives advantage over athletes that do not use it / increased performance;

*risks:*

but too many red blood cells can produce damage in capillaries/heart failure/  
chronic mountain sickness/increased blood clotting/increased risk of stroke;  
limited information on long-term effects;  
exclusion/banning from competitions;

**[3 max]**

*Award [2 max] if only benefits or risks are addressed.*

**Option C — Cells and energy**

- C1.** (a)  $380\mu\text{mol min}^{-1}\text{g}^{-1}$ ; (*allow answers in the range of 375 to 385  $\mu\text{mol min}^{-1}\text{g}^{-1}$* )  
1900% increase; **[1 max]**
- (b) only glucose no change in time, while only maltose increases with time **[1]**
- (c) glucose inhibition is greater than maltose activation;  
glucose is a product of the breakdown of maltose;  
so this is end-product inhibition/negative feedback;  
glucose joins enzyme at allosteric site;  
changing shape of active site, so no reaction;  
glucose represses expression of  $\alpha$ -glucosidase / gene repressed; **[3 max]**
- (d) two phosphate groups added to glucose / phosphorylation;  
glucose / hexose biphosphate converted to two 3C compounds / triphosphate/TP;  
oxidation of triphosphate/TP to pyruvate;  
net gain of 2 ATP and 2 NADH + H<sup>+</sup>; **[2 max]**
- C2.** (a) (i) primary structure is (number and) sequence of amino acids;  
joined by peptide bonds;  
secondary structure is folding pattern;  
held by H-bonds;  
 $\alpha$ -helix /  $\beta$ -sheet; **[3 max]**
- (ii) example of fibrous (*e.g.* collagen/myosin/keratin) and of globular (*e.g.* hemoglobin /myoglobin/catalase);  
fibrous are long, narrow shape while globular are rounded;  
fibrous are usually structural and globular are usually functional/metabolic;  
fibrous are insoluble in water while globular are (usually) soluble; **[2 max]**  
*Award [1 max] if no example provided.*
- (b) oxidation is addition of oxygen while reduction is removal;  
oxidation is removal of H<sup>+</sup>, reduction is addition;  
oxidation is loss of electrons, reduction is gain; **[1 max]**
- C3.** (a) *light-independent reactions*: stroma;  
*light-dependent reactions*: thylakoid / grana; **[2]**
- (b) absorb photons of light / photoactivation;  
raised to a higher energetic level;  
pass from molecule to molecule;  
drop back to own level emitting energy; **[3 max]**



**Option D — Evolution**

- D1.** (a) 2 (%) (*units not required*) [1]  
*Allow answers in the range of 2.0 to 2.1.*
- (b) 17.5% (*allow answers in the range of 17.3% to 17.7%*) [1]
- (c) both show range variation;  
average genetic divergence of mtDNA much less than average nDNA; *Allow numerical comparison.*  
greater range of genetic variation in nDNA than mtDNA / 18% in nDNA and 6.5% in mtDNA;  
three of mtDNA have less than 1% genetic divergence while none of nDNA have less than 5%;  
the highest divergence of mtDNA is similar to the lowest of nDNA;  
mtDNA3 and nDNA8 have no (known) species with the same sequence divergence; [3 max]
- (d) endosymbiotic theory [1]
- D2.** (a) RNA can replicate;  
can act as a catalyst;  
can code for information; [2 max]
- (b) simulated conditions of pre-biotic earth (in closed container);  
water vapour;  
mixture of ammonia, methane, hydrogen / reducing atmosphere;  
sparks/electric (discharge to simulate lightning);  
condenser / cooling of mixture;  
obtained amino acids; [3 max]

- D3.** (a) all the genes in an (interbreeding) population **[1]**
- (b) both involve the formation of new species;  
by the isolation of its genetic pool (in both cases);  
both provide conditions for natural selection;  
sympatric in same geographical area, allopatric in different;  
sympatric could be reproductive/behavioural isolation while allopatric physical  
isolation;  
example of each; (*e.g.* allopatric speciation of Galapagos finches and sympatric  
speciation due to polyploidy) **[4 max]**  
*Award mark only where comparison is clear.*
- (c) growth in brain requires more protein;  
increased brain correlates with change of diet from plants/leaves to fruit/meat  
(higher quality diet);  
eating meat provides more protein;  
larger brain implies more evolution as learning capacities increase; **[2 max]**

**Option E — Neurobiology and behaviour**

- E1.** (a) 15 s (*allow answers in the range of 14 s to 16 s*) [1]
- (b) lemon [1]
- (c) the greater the colour contrast, the shorter the search times / negative correlation [1]
- (d) hypothesis (seems to be) supported as in larger flowers (15 mm and 25 mm) colour contrast seems to be the strategy used to detect flowers;  
 hypothesis (seems to be) supported as in smaller flowers (8 mm) colour contrast does not affect search times / always long search times;  
 colour contrast is difficult to see in very small flowers from a distance;  
 so another strategy must be used (*e.g.* scent / green receptor signal);  
 lemon colour is an exception as always has low search time;  
 bumblebees receive stimulus in lemon coloured flowers not perceived in other colours / lemon coloured real flowers might have more sucrose;  
 density of flowers not known; [3 max]
- (e) innate behaviour (shown by most bumblebees) helps them find flowers (instinctively) with more food sources/camouflage better so survive better;  
learned behaviour (taught by other bumblebees) helps them find flowers with more food sources/camouflage better/more adaptable to changing conditions so survive better; [1 max]  
*Accept references to taxis and foraging behaviour.*
- E2.** (a) *Award [1] for any two of the correct parts labelled.*  
 I. bones of (middle) ear / ossicles / malleus, incus and stapes;  
 II. auditory nerve / cochlear nerve;  
 III. cochlea;  
 IV. eardrum / tympanic membrane / tympanum; [2]
- (b) animals learn to avoid dangerous situations / predators;  
 animals learn how to hunt/obtain food;  
 animals learn to adapt to changing environments;  
*e.g.* birds learn to avoid cats; (*allow any other valid example*) [2 max]
- (c) called classic conditioning;  
 Pavlov sounded bell before food (conditional stimulus);  
 dog secreted saliva (conditioned response);  
 dog associated two (external) stimuli (bell and food); [2 max]
- E3.** (a) *stimulus*: change in environment;  
*reflex*: rapid, unconscious/involuntary response; [2]
- (b) chemical substance that acts primarily upon the central nervous system;  
 increase postsynaptic transmission;  
 can cause chemical dependency / lead to substance abuse / addictions;  
 stimulants produce psychomotor arousal/more alertness;  
 by acting like neurotransmitters / interfering with breakdown of neurotransmitter;  
 can affect the transmission of optic signal in the thalamus/optical cortex;  
 example given; [3 max]

**Option F — Microbes and biotechnology**

- F1.** (a) (i) (non-denitrifying bacterium) 3 [1]
- (ii) *A. cycloclastes*/Ac [1]
- (b) (i) 0.57 arbitrary units (*accept answers in the range 0.54 to 0.60*) [1]
- (ii) 68 (%) (*units are not required*) [1]  
*Accept answers in the range of 68.0 to 68.5.*
- (c) *R. sphaeroides* strain c causes more inhibition (in all three non denitrifying bacteria) than *A. cycloclastes*/Ac; both have less effect on (non denitrifying bacterium) 1 than the other two; each has approximately the same inhibitory effect on (non-denitrifying bacterium) 2 and (non-denitrifying bacterium) 3 (but *R. sphaeroides* strain c much greater than *A. cycloclastes*/Ac); [2 max]
- (d) *A. cycloclastes*/Ac [1]
- F2.** (a) naked capsid versus(or) enveloped capsid; DNA versus(or) RNA; single stranded versus(or) double stranded DNA/RNA; many different 3D forms/structures; some have sheaths/tails; [3 max]
- (b) named example (*e.g.* human insulin); used for cloning DNA; copies DNA from mature mRNA; cDNA has no introns; host bacteria have no means to remove introns; used for diagnosing microbial diseases (rapidly); *Award [2 max] if no examples provided.* [3 max]
- F3.** (a) named example; characteristic shown; [2]  
*e.g. V. fischeri;*  
 has bioluminescence only in high density;
- (b) saccharomyces (yeast) added to fermentation tank; saccharomyces (yeast) carry out anaerobic fermentation; glucose to alcohol / glycolytic/alcoholic fermentation; glucose to carbon dioxide; [3 max]

**Option G — Ecology and conservation**

**G1.** (a) 40 mg (carbon) m<sup>-3</sup> (allow answers in the range of 39 to 41 mg (carbon) m<sup>-3</sup>) [1]

(b) correct calculations;  
correct answer = 367% ; [2]

(c) warmer temperatures (in summer/spring) cause enzyme activation / converse;  
more reproduction of organisms (so more food) / converse;  
(more sun) more photosynthesis so more biomass (of autotrophs) (so more food for organisms);  
in summer there are other organisms that feed on them;  
ocean water movement could carry nutrients;  
seasonal changes in the abundance of food causes difference; [3 max]

(d) collecting organisms (using nets) and determining dry mass (by destructive analysis) [1]  
Award other reasonable suggestions.

**G2.** (a) *gross production:*  
amount of organic matter/biomass produced by plants / plant respiration and net production;  
*net production:*  
amount of gross production of an ecosystem remaining after subtracting the amount used in respiration/gross production – respiration; [2]

(b)

<i>Biome</i>	<i>Temperature</i>	<i>Moisture</i>	<i>Characteristic of vegetation</i>
<i>Desert</i>	high temperature/ thermal amplitude in day and cold at night	dry / average rainfall less than 25 cm year <sup>-1</sup>	xerophytes / succulent / sparse low lying bushes adapted to water conservation;
<i>Tropical rainforest</i>	hot	damp / wet / average rainfall 225 cm year <sup>-1</sup>	epiphytes / trees and wide leaf plants in undergrowth / huge diversity / tall mature trees of many species;
<i>Tundra</i>	cold / -6°C to -12°C	dry / average rainfall 25 cm year <sup>-1</sup>	small and close to ground / red leaves / grasslands with a few small trees;

[3 max]

Award [1] per biome or per column.

- G3.** (a) (i) named example and location where it was released **[1]**  
*e.g.* beaver/castor liberated in Tierra del Fuego  
*Answers need a named example and a location.*
- (ii) reason for release; **[2]**  
impact on environment;  
*e.g.* for hunting/fur;  
but built dams which altered river courses;
- (b) named example; **[3 max]**  
definition of biomagnification;  
cause;  
consequence;  
*e.g.*  
*name:* DDT / pesticide to control mosquitoes of malaria;  
*definition of biomagnification:* chemicals accumulate along the food chain;  
*cause:* as fat soluble, it accumulates in fatty tissue;  
*consequence:* becoming more concentrated at each trophic level / increasingly more toxic / ultimately leading to death of organism up in food chain;
-