

# Markscheme

**May 2015**

**Biology**

**Standard level**

**Paper 3**

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## 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) urea [1]
- (b) 0.20 (kg) (less weight in HP) [1]
- (c) LDL cholesterol increases and HDL cholesterol decreases as (proportion of) protein increases/carbohydrate decreases / *OWTTE* [1]
- (d) a. lack of essential amino acids to form protein;  
b. not enough protein for growth;  
c. not enough amino acids/protein to form muscle/tissues;  
d. low protein may affect production of enzymes; [2 max]
- (e) *(the data does not support the recommendation)*:  
a. as HP has the highest level of plasma urea which could be toxic;  
b. HP has a high level of LDL/bad cholesterol and a low level of HDL/good cholesterol which could lead to coronary heart disease; } *(accept high ratio of LDL: HDL)*  
c. HP produces a high level of glucose (compared to AP) which could lead to diabetes;  
d. HP produces a low birth weight (compared to AP) which may affect development / *OWTTE*;
- (the data does support the recommendation)*:  
e. the mother has a similar weight gain to AP thus avoiding health problems; [3 max]
2. (a) (i) liver / dairy products / fish / egg  yolks  / other source [1]  
(ii) sunlight [1]
- (b)
- |    | <i>human milk</i> | <i>artificial milk</i>          |
|----|-------------------|---------------------------------|
| a. | lactose           | glucose / may not be lactose;   |
| b. | human proteins    | animal proteins / soy proteins; |
| c. | antibodies        | no human antibodies;            |
| d. | no supplements    | supplements;                    |
- [2 max]
- Answer does not need to be in a table format.*
3. (a) a. glucose in urine;  
b. high blood glucose;  
c. frequent urination / dehydration/excess thirst;  
d. constant hunger;  
e. weight loss;  
f. tiredness; [2 max]
- (b) a. (point) mutation of gene;  
b. defective enzyme/phenylalanine hydroxylase (PAH);  
c. phenylalanine/Phe not broken down to tyrosine/Tyr;  
d. phenylalanine/Phe accumulates;  
e. (if not treated) symptoms mental retardation/seizures;  
f. diet free of phenylalanine/Phe to avoid symptoms; [4 max]

**Option B — Physiology of exercise**

4. (a)  $(-)$ 9 mmol kg<sup>-1</sup> (of dry matter) (*units required*) [1]
- (b) a. (both) type II fibres decline more than type I / type I declines the least;  
 b. type IIx decline the most;  
 c. type II decrease more between 0 and 10 seconds than later whereas type I only decrease after 10 seconds; [3]
- (c) a. type I is a slow muscle fibre capable of sustained activity (stamina)/high rates of aerobic respiration;  
 b. type I muscle fibre have a very good blood supply / plenty of myoglobin/mitochondria allowing for aerobic respiration to take place;  
 c. type II used initially in strenuous exercise (in preference to type I); [1 max]
- (d) a. mitochondria/myoglobin required to make ATP;  
 b. type IIx need more ATP in a short period of time, so probably anaerobic respiration (therefore probably white fibre);  
 c. type IIx as shows a fast power decline, producing fatigue; [2 max]
5. (a) a. formation of cross-bridges/myosin binds to the thin filament/actin;  
 b. Z-bands pulled towards each other;  
 c. sliding of actin and myosin filaments/shortening the sarcomere/I-band;  
 d. use of ATP to break cross-bridges / myosin releases actin when binding to ATP;  
 e. myosin heads re-set;  
 f. contraction ceases when myosin head detaches from the thin filament; [3 max]
- (b) (i) *synovial fluid*: avoids friction/lubricates / absorbs shock (at the elbow joint) [1]  
 (ii) *biceps*: flexes arm/raises lower arm [1]
6. (a) a. *tidal volume*: volume of air taken in with each inhalation/out with each exhalation;  
 b. *ventilation rate*: number of inhalations/exhalations/breaths per minute; [2]
- (b) a. exercise increases aerobic respiration;  
 b. CO<sub>2</sub> concentration in blood increases;  
 c. drop in pH of blood detected / blood more acidic;  
 d. breathing centres send impulses to diaphragm and intercostal muscles;  
 e. increase rate of contraction;  
 f. increase in ventilation rate increases oxygen uptake/decreases CO<sub>2</sub>; [4 max]

**Option C — Cells and energy**

7. (a) 50 (pmol O<sub>2</sub> min<sup>-1</sup>) (*allow answers in the range of 49 to 51*) [1]
- (b) a. both increase with time after fertilization;  
 b. mitochondrial OCR increases (a lot) more than non-mitochondrial;  
 c. after 48 hours there is approximately three times more mitochondrial than non-mitochondrial OCR;  
 d. at 3 hours non mitochondrial OCR is higher than mitochondrial; [2 max]
- (c) a. mitosis requires a large amount of energy;  
 b. more cells implies higher metabolic rate/DNA synthesis/other cell processes;  
 c. more mitochondria present with time;  
 d. mitochondria work more efficiently/faster; [2 max]
- (d) protect DNA/protein/lipids/embryo (until mitochondrial respiration removes oxygen efficiently) [1]
8. (a) a. (primary structure) is sequence of amino acids;  
 b. (quaternary structure) is the linking of two or more polypeptides to form one protein; [2]
- (b) a. temperature;  
 b. pH;  
 c. light;  
 d. CO<sub>2</sub>; [3 max]
9. (a) a. enzyme has active site;  
 b. enzyme-substrate complex formed;  
 c. substrate induces active site to change;  
 d. bonds in substrate are weakened;  
 e. activation energy is reduced; [3 max]

(b)

	<b><i>competitive inhibition</i></b>	<b><i>non-competitive inhibition</i></b>
a.	the inhibitor is similar to substrate	inhibitor (usually) different to substrate;
b.	inhibitor binds to active site	inhibitor joins away from active site/allosteric site;
c.	inhibitor prevents binding of substrate	inhibitor changes shape of active site not allowing substrate to join;
d.	increasing the substrate concentration diminishes effect of inhibitor	change in substrate concentration does not diminish inhibition;
e.	both slow down the rate of reaction;	

[4 max]

*Answer does not need to be in a table format.*

**Option D — Evolution**

10. (a) as brain mass increases life span increases / positive/direct relationship/correlation [1]

(b) other placental mammals [1]

	<i>primates</i>	<i>marsupials</i>
a.	larger range of brain mass	(smaller);
b.	(generally) greater brain mass	(generally less);
c.	larger range of life span	(smaller);
d.	(generally) with greater life span	(generally with lesser life span);
e.	both with positive relationship between brain mass and life span;	
f.	both overlap (with the primates higher);	

[3 max]

*Do not accept answers stating only numerical values without comparative wording.*

(d) a. larger brain size allows for /higher intelligence/better cognition/more complex brain functions;  
 b. more efficient food finding / escape from predators;  
 c. longer life span favours parental care/survival for more reproduction;  
 d. (these advantages) favour natural selection which leads to evolution; [2 max]

11. (a) time taken for radioactivity to fall to half its original level [1]

(b) a. *Homo* presents a less projecting face/smaller jaw than *Australopithecus*;  
 b. *Homo* presents better adaptations to bipedalism/more erect posture;  
 c. *Homo* has larger brain size;  
 d. *Homo* has smaller molar size;  
 e. *Homo* has smaller brow ridge size; [2 max]

(c) a. *balanced polymorphism*: sickle-cell trait / cystic fibrosis / other example;  
 b. *transient polymorphism*: industrial melanism in moths / red-wing and black spot to black-wing ladybugs/ladybirds / other example; [2]

12. (a) a. prebiotic Earth had a reducing atmosphere (no oxygen);  
 b. (some) prokaryotes were photosynthetic;  
 c. photosynthesis produces oxygen; [2 max]

(b) a. microorganisms/prokaryotes taken into cell by endocytosis;  
 b. kept inside cell and perform respiration/photosynthesis;  
 c. developing into mitochondria/chloroplasts;  
 d. mitochondria/chloroplasts have double membranes (as expected in cells taken in by endocytosis);  
 e. mitochondria/chloroplasts have (circular naked) DNA (as prokaryotes);  
 f. mitochondria/chloroplasts have 70S ribosomes (as prokaryotes);  
 g. mitochondria/chloroplasts grow and divide like (prokaryotic) cells; [4 max]

**Option E — Neurobiology and behaviour**

13. (a) *bees fed with ethanol:*  
5.9 (%); (allow answers in the range of 5.8 (%) to 6.0 (%))
- bees fed without ethanol:*  
1.3 (%); (allow answers in the range of 1.2 (%) to 1.4 (%))
- } (both needed) [1]
- (b) a. without alcohol (antennation starts at a high level and) decreases with time;  
b. with alcohol, the value (starts low and) very slowly increases;  
c. the values of both group become very similar with time; [2 max]
- (c) a. (time spent) walking is greater in bees without alcohol (than alcohol);  
b. (time spent) grooming is greater with alcohol (than without alcohol);  
c. the end point difference is greater in walking;  
d. (time spent) walking increases whereas grooming decreases for both groups of bees; [2]
- (d) a. (hypothesis supported as) alcohol decreases antennation at the start of the experiment;  
b. (hypothesis supported as) alcohol increases begging at the start;  
c. begging time is more variable/has less significant differences with alcohol so less clear than in antennation;  
d. (hypothesis is supported as) the effect of alcohol on social behaviours becomes less distinguishable over time (with the effect of sucrose); [3 max]
14. (a) a. *smell*: chemoreceptor; (do not accept olfactory)  
b. *temperature*: thermoreceptors; [2]
- (b) I: *name*: intermediate/relay neuron  
*function*: send impulse/message from sensory to motor neuron;
- II: *name*: motor neuron  
*function*: send impulse/message from spinal cord to effector/muscle;
- } (name and function needed for the mark) [2]



15. (a)

	<b>cocaine</b>	<b>THC</b>
a.	excitatory (psychoactive) drug	inhibitory (psychoactive) drug;
b.	affects dopamine transmitters	affects cannabinoid receptors
c.	prevents the return of dopamine to the presynaptic membrane	blocks release of excitatory neurotransmitter;
d.	depressive mood disorders	loss of memory / slurred speech / loss of balance / impairs reaction time/muscle coordination;
e.	pleasurable feeling	increases intensity of sensual perception / feeling of emotional well-being / allows clear thinking of complex ideas;
f.	addictive;	

**[4 max]**

*Answers do not need to be in a table format.*

- (b) a. *excitatory drug*: nicotine / amphetamines/ other drug;  
 b. *inhibitory drug*: benzodiazepines / alcohol / other drug;

**[2]**

**Option F — Microbes and biotechnology**

16. (a) 50 (%) (*allow answers in the range of 48 (%) to 52 (%)*) [1]
- (b) 16 (%) (*allow answers in the range of 12 (%) to 20 (%)*) [1]
- (c) a. there are less QS<sup>-</sup> strains that produce cholera than those that do not produce cholera;  
 b. approximately 50 % in cholera producing and approximately 70 % in non-cholera producing;  
 c. greatest percentage in QS<sup>-</sup> in both so most are not quorum sensing; [2 max]
- (d) (*the hypothesis is supported as*)  
 a. more sensing in bacteria that cause cholera than in those that do not;  
 b. forming aggregates to facilitate the propagation of the pathogen / bacteria working together can produce pathogenicity;  
 c. bacteria with QS<sup>+</sup> and cholera producing strains are positively selected; [1 max]
- (e) a. thin layer of peptidoglycan sandwiched between outer and inner membrane layer;  
 b. outer layer containing lipopolysaccharide and (protein);  
 c. high lipid and low peptidoglycan content; [2 max]  
*Accept correct answers on a clearly labelled diagram.*
17. (a) a. viral vector modified to include healthy gene;  
 b. virus is taken up by cells;  
 c. inserts normal gene into chromosome;  
 d. white blood cells / bone marrow / other cells replaced into patient; [2 max]
- (b) a. *Aspergillus* sp: production of miso / soy sauce / food preservatives; } (*allow other verifiable use*)  
 b. *Saccharomyces*: production of beer/wine/bread/other alcoholic drink; [2]
18. (a) a. *Rhizobium*: nitrogen fixation;  
 b. *Nitrobacter*: oxidizes/changes nitrites to nitrates;  
 c. *Azotobacter*: nitrification / bind atmospheric nitrogen / nitrogen fixation; [3]
- (b) a. anaerobic digestion of biodegradable material;  
 b. fermentation (of carbohydrates) by bacteria;  
 c. methanogens produce methane;  
 d. methane/biogas used as energy;  
 e. waste products used as fertilizer;  
 f. CO<sub>2</sub> produced (as a by-product); [4 max]

**Option G — Ecology and conservation**

19. (a) (i) 42 (N) (*allow answers in the range of 41 (N) to 43 (N)*) [1]  
 (ii) 2.6 (cm<sup>2</sup>) (*allow answers in the range of 2.5 (cm<sup>2</sup>) to 2.7 (cm<sup>2</sup>)*) [1]
- (b) positive correlation / as area of foot increases so does force required [1]
- (c) a. back of crevice less subjected to action of waves;  
 b. (hypothesis supported as) small area of foot requires less force;  
 c. amount of predators/food could be affecting the distribution;  
 d. larger limpets may not fit in the back of the crevice;  
 e. less competition with larger limpets at the back of the crevice; [3 max]
- (d) transect line / quadrat with transect line [1]  
*Do not accept quadrat alone.*
20. (a) (i) a. 380 / 64;  
*Award [1] for the correct calculation of the numerator or the denominator*  
 b. 5.94; (*accept 5.9*)  
*Award [1] for correct answer.* [2]
- (ii) a. there is greater species diversity/richness than a year ago /  
 diversity/richness has increased;  
 b. the community is showing signs of stability / succession has progressed; [2 max]
- If the answer in (a)(i) is smaller than 4.3 allow ECF and use the following  
 markscheme.*
- c. there is less species diversity/richness than last year / diversity/richness  
 has decreased;  
 d. the community is less stable / succession has regressed; [2 max]
- (b) tundra [1]

21. (a) a. named example of invasive species;  
b. named example of biological control;

[2]

*possible examples:*

<b><i>invasive species</i></b>	<b><i>control</i></b>
rats	Indian mongoose
aphid	Ladybird (beetle)
rabbits	Myxoma virus

- (b) a. substances/pesticides/heavy metals accumulate up the food chain / at each trophic level;  
b. substances cannot be metabolized/excreted;  
c. these substances become concentrated in (fatty) tissues/internal organs;  
d. magnified in organisms in upper part of chain as they eat more/larger organisms;  
e. increase in concentration may become toxic in higher trophic levels;  
f. example of a consequence of biomagnification e.g (*DDT causes thinning of egg shells (in birds)*);

[4 max]