

# Markscheme

**May 2015**

**Biology**

**Higher level**

**Paper 3**

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## Subject Details: Biology HL Paper 3 Markscheme

### Mark Allocation

Candidates are required to answer questions from **TWO** of the Options [**2 × 20 marks**].

Maximum total = [**40 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 D — Evolution**

1. (a) a. (all three) *Canis* populations show a mixture of haplotypes from two (or more) origins;  
b. Minnesota-northwestern wolves have a mixture of haplotypes from grey wolf/*C. lupus* and eastern wolf/*C. lycaon*;  
c. southern Ontario coyote has mixture of haplotypes from western coyote/*C. latrans* and eastern wolf;  
d. northeastern coyote has mixture of haplotypes from western coyote/*C. latrans* and eastern wolf; **[2 max]**
- (b) a. both contain haplotypes C1, C9 and C19;  
b. C19 haplotype in greater proportion in northeastern coyotes / vice versa;  
c. C9 haplotype in greater proportion in southern Ontario coyotes / vice versa;  
d. C1 in smaller proportion in southern Ontario than northeastern coyotes / vice versa;  
e. southern Ontario coyotes / northeastern coyotes have more haplotypes from coyotes than wolves;  
f. fewer haplotypes from other sources in northeastern coyotes / vice versa; **[2 max]**
- (c) no overlapping ranges since no haplotypes/C9, C19 from western coyotes present with haplotype/C22 from grey wolf in any of the hybrids **[1]**
- (d) northeastern coyote has greater proportion of C1/ haplotype from (eastern) wolf (than southern Ontario coyote) **[1]**
- (e) a. all three show evidence that the eastern wolf was their ancestor/all have haplotypes from the eastern wolf;  
b. southern Ontario and northeastern coyotes have different eastern wolf haplotypes from the Minnesota northwestern wolf / southern Ontario and northeastern coyotes have C1 while the Minnesota northwestern wolf has C3 and C13; **[2]**
2. (a) protobionts/protocell **[1]**
- (b) a. mitochondria/chloroplasts were once (independent) prokaryotes;  
b. taken in by (larger) heterotrophic/host cell (through endocytosis);  
c. new living arrangement mutually beneficial / depend on each other to exist as single organism; **[2 max]**
- (c) (i) a. allele/genotype;  
b. phenotype; **[2]**
- (ii) all the alleles/genes of a population (at a particular time) **[1]**

3. a. cladistics uses cladograms/tree diagrams;  
b. show clades/branches (in parallel) that begin at a point/node;  
c. each clade includes a (common) ancestral organism/node and all its descendents;  
d. members of a clade share derived/inherited characteristics;  
e. clades are nested/subsets of larger clades;  
f. cladograms show evolutionary history/origin of organisms / phylogeny;  
g. branch length (of clade) can indicate (relative) amount of genetic change/time;  
h. clades based on (objective) molecular analysis/genetic evidence / differ in amino acid sequences/DNA base changes/mutations;  
i. fewest number of differences/maximum parsimony determines branch separation;  
j. predictability of DNA base changes/mutation rates suggests evolutionary timelines;  
k. problems arise when gene change varies (greatly) from one gene to the next;  
l. cladograms may not match traditional/Linnaean classification;  
m. (mismatch) prompts re-examination of data / reclassification of a group;  
*Some of the above points may be included in a correctly annotated diagram clearly stating above points.*

**[6 max]**

**Option E — Neurobiology and behaviour**

4. (a) increases tolerance to pain (when given in weeks 2 and 3) [1]
- (b) team C [1]
- (c) (i) a. placebo has no effect in team B where morphine was not administered previously;  
 b. team B thought they were getting morphine but their performance was the same as team A;  
 c. placebo has a greater effect if morphine has been administered previously as in team C;  
 d. naloxone negates the (expected) effect of placebo (even if morphine administered previously) in team D;  
 e. error bars overlap so results may not be statistically significant/ no difference; [2 max]
- (ii) naloxone (an endorphin blocking drug) blocks the receptors for endorphins / stops endorphins from acting as pain killers [1]
- (d) a. pain tolerance goes down in all groups / all have same level of pain tolerance;  
 b. morphine-like effect/morphine effect is temporary;  
 c. endorphins/naturally produced pain-killers levels/number of receptors for pain-killers decreases;  
 d. decrease in pain tolerance is evidence for motivation/determination during competition and training / lack of motivation when no competition; [2 max]
5. (a) *Award [1] for every two correct up to [2 max].*  
 I: sensory/afferent neuron;  
 II: interneuron/relay neuron;  
 III: motor/efferent neuron;  
 IV: effector/muscle; [2 max]
- (b) mechanoreceptor [1]
- (c) (i) cerebellum [1]
- (ii) a. (autonomic nerve signals from medulla oblongata) can override pacemaker;  
 b. parasympathetic stimulation decreases heart rate;  
 c. parasympathetic/vagus nerve runs from the medulla oblongata to the heart;  
 d. sympathetic nerves from medulla (travel down spinal cord where) synapse with other nerves before going to heart; [2 max]
- (d) birth in spring when more food/less cold weather/other reason giving offspring more chance for survival [1]

6. a. synapses are junctions/gaps between neurons (presynaptic and postsynaptic);  
b. cocaine affects nerve cells in pleasure/reward pathways of brain;  
c. pathways use dopamine as neurotransmitter;  
d. presynaptic neuron normally releases and removes dopamine from synapse;  
e. cocaine binds to presynaptic neurons;  
f. binding prevents removal/reuptake of dopamine from synapse;  
g. postsynaptic neuron keeps firing/remains stimulated;  
h. (brain) then reduces number of postsynaptic receptors;  
i. causes addiction since drug needed to maintain normal pleasure/reward sensations;  
j. greater sensitivity to anxiety/depression;

**[6 max]**

**Option F — Microbes and biotechnology**

7. (a) 34 (years old) and Amerindian [1]  
*Allow answers in the range 33–35.*
- (b) (i) a. rapid increase in diversity early in life/before age four;  
 b. (from age four into adulthood) bacterial diversity tends to level off/stay within same (broad) range of diversity/great variation; [1 max]
- (ii) a. Amerindians reach highest plateau / Malawians and US reach a lower plateau than the Amerindians;  
 b. US reach lowest plateau / US reach a lower plateau than the Malawians and Amerindians; [2]
- (c) a. US population use disinfectants/antiseptics / pasteurise/sterilise/irradiate food more than populations in Malawi or Amazon;  
 b. different diets support different populations of bacteria;  
 c. different soil/water/local animal bacteria;  
 d. different use of antibiotics;  
 e. contact with farm/wild animals by rural populations; [2 max]
- (d) a. diets could be tailored to a particular gut ecosystem to maximize digestion/ personal health/weight control;  
 b. antibiotics could be prescribed with minimal effect on gut bacteria/reduce diarrhoea;  
 c. fecal transplants; (*accept other reasonable answers*) [1 max]

8. (a) (i)
- |                                     |    | <i>Archaea</i>                       | <i>Eubacteria</i>                                      |
|-------------------------------------|----|--------------------------------------|--|
| <i>Peptidoglycan in cell wall</i>   | a. | absent                               | present;   |
| <i>Membrane lipids</i>              | b. | branched (fatty acids) / ether links | unbranched/straight chain (fatty acids) / ester links; |
| <i>Histones associated with DNA</i> | c. | present (some species)               | absent;  |
- [3]
- Award [1] for each correct row.*
- (ii) producers/nitrogen fixers/decomposers/parasites/pathogens/nitrifiers/denitrifiers (*accept other correct roles*) [1]  
*Award [1] for any two.*
- (iii) *Award [1] for each of the following clearly shown and labelled.*  
 a. chain of cells;  
 b. photosynthetic cells / photosynthetic membrane;  
 c. nitrogen-fixing cell/heterocyst – *larger than other cells in chain*;  
 d. DNA / ribosomes – *no nuclei in cells*; [2 max]
- (b) (outer membrane of) cell wall of Gram-negative bacteria [1]

9. a. *Saccaromyces* yeast used;  
b. yeast ferments sugars/glucose anaerobically;  
c. amylase released by germinated grain/barley/cereals breaks down starch (in seeds) to sugar;  
d. CO<sub>2</sub> and ethanol produced in beer and bread production;  
e. CO<sub>2</sub> raises/leavens/expands bread dough;  
f. CO<sub>2</sub> remains (partially) dissolved in beer/gives beer its bubbles/carbonation;  
g. during baking ethanol evaporates from bread;  
h. baking kills the yeast/stops fermentation;  
i. ethanol produced in beer (eventually) kills yeast cells/stops fermentation by yeast;  
j. by-products / different yeast varieties give different beers/flavours;
- Award [5 max] if only mentions one of the two processes.*

**[6 max]**

**Option G — Ecology and conservation**

10. (a) 0–10 meters [1]
- (b) a. *Bythotrephes* found at all depths down to 20–30 m/none below 30 m;  
 b. greatest number/density (of organisms) at 10–20 m;  
 c. least number/density (of organisms) at 0–10 m; [2 max]
- (c) a. avoids/driven away by light (to colder water);  
 b. in absence of light attracted to warmer water;  
 c. can tolerate a wide range of temperature (*accept numbers in range of 4/5–20/25°C*); [2 max]
- (d) a. zooplankton found in (warmer) surface water where small plants/  
 algae/phytoplankton are found due to light;  
 b. as predator, *Bythotrephes* moves up to the surface to feed on zooplankton at night;  
 c. as prey, *Bythotrephes* moves to lower/darker depths during the day to avoid being (easily) seen by predators/fish; [2 max]

11. (a)

	<i>Quadrat</i>	<i>Transect</i>
a.	square frame	tape/string;
b.	used to estimate population size/density/cover/compare population sizes of two or more species	used to investigate distribution of plant or animal species/correlate distribution with abiotic variable;
c.	individuals within quadrat boundaries are recorded	samples taken at even intervals and individuals touching line are recorded;
d.	used in uniform habitat	used in habitat with gradient;

[2 max]

*Accept any horizontal set of ideas, up to two sets.*

- (b) (i) *Species diversity*: rises  
*Production*: rises  
*Both needed for [1].* [1]
- (ii) an organism can occupy/feed at more than one trophic level [1]
- (c) (i) mutation/skin cancer/cataracts/reduced plant growth/ damages chlorophyll/  
 vitamin D production in skin/other correct effect [1]  
**N.B.** note that question does not ask for harmful effect.
- (ii) a. uncrowded environment;  
 b. unstable environment;  
 c. population living below carrying capacity of environment; [2 max]

**12. Simpson index [4 max]**

- a. Simpson index is a measure of species richness/species number and heterogeneity;
- b. involves random sampling and identification of organisms;
- c. use of  $\frac{D = N(N-1)}{\sum n(n-1)}$ ;
- d. high value means high ecological health;
- e. allows analysis/comparison of the biodiversity in two different communities/at different times;
- f. provides information for land management/conservation decisions/monitoring environmental change;

***Biotic index [4 max]***

- g. the biotic index is (a scale from 0 to 10) used to assess overall quality of a water site (such as a stream/river);
- h. involves identifying indicator species/organisms with known environmental conditions/macrobenthos that breath dissolved oxygen;
- i. (identified) species/organisms are assigned to (one of three or four) groups with a rating for tolerance to pollution;
- j. number of organism in each group is multiplied by the tolerance rating of the group;
- k. many (pollution) tolerant species indicates poor water quality / many intolerant species shows excellent water quality;

**[6 max]**

**Option H — Further human physiology**

13. (a) a. 0.3 cm (*allow 0.2 to 0.4*);  
 b. no difference (because of large error bars); **[1 max]**
- (b) growing spurt not yet started/prepuberty **[1]**
- (c) a. causes a reduction in height;  
 b. biggest drop in first year (of treatment);  
 c. levelling off after two years;  
 d. no apparent drop after year two because of overlapping error bars; **[2 max]**
- (d) a. height difference (seen during treatment period) persists into adulthood;  
 b. budesonide group on average about 1.3 cm/13 mm shorter than placebo group / height difference is (likely) unnoticeable/insignificant compared to placebo group;  
 c. benefit from budesonide treatment (probably) outweighs (slight) loss of height; **[2 max]**
- (e) no information on male versus female/diet/ethnic background/health status/medical treatment or history before study/effects on growth at other ages **[1]**
14. (a) (i) active transport/facilitated diffusion/endocytosis **[1]**
- (ii) transports blood from (capillaries of) small intestine to (capillaries/sinusoids of) liver **[1]**
- (b) (i) label should connect to solid line on graph  
*Candidates should not use region with overlap of dotted and solid lines.* **[1]**
- (ii) 0.4 (s) (*allow 0.38 to 0.43*) **[1]**
- (c) (i) CO<sub>2</sub> attaches to protein portion (not Fe) in heme/carbaminohemoglobin formed; **[1]**
- (ii) a. CO<sub>2</sub> diffuses into erythrocytes;  
 b. joins water to form carbonic acid/H<sub>2</sub>CO<sub>3</sub>;  
 c. catalyzed by carbonic anhydrase (inside erythrocytes);  
 d. H<sub>2</sub>CO<sub>3</sub> dissociates into H<sup>+</sup> and HCO<sub>3</sub><sup>-</sup>; **[2 max]**

**15. Function [4 max]**

- a. (chief/peptic/zymogenic cells of) gastric glands release pepsinogen (into stomach cavity);
- b. pepsinogen is an enzyme precursor/inactive enzyme;
- c. (parietal/oxynitic cells of) gastric glands release HCl (into stomach cavity);
- d. HCl activates pepsinogen to enzyme status/pepsin (when they mix in stomach cavity);
- e. pepsin digests proteins/potentially digests stomach tissue;
- f. (mucus cells of) gastric glands release mucus (into stomach cavity) to protect walls from digestion by pepsin;

**Control [4 max]**

- g. Involves both nerves and hormones;
- h. sight/smell of food stimulates brain to send nerve impulses to gastric glands;
- i. when food enters stomach stretch receptors/touch receptors/chemoreceptors stimulated;
- j. (hormone) gastrin released by endocrine glands in stomach wall;
- k. gastrin controls gastric gland secretion of gastric juice/HCl;

**[6 max]**

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