Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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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 <u>underlined</u> 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 <u>all</u> 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;   **[6 max]**
Some of the above points may be included in a correctly annotated diagram clearly stating above points.

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) <u>and</u> 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)

		Archaea	*Eubacteria*
Peptidoglycan in cell wall	a.	absent	present;
Membrane lipids	b.	branched (fatty acids) / ether links	unbranched/straight chain (fatty acids) / ester links;
Histones associated with DNA	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*)
*Award **[1]** for any two.* **[1]**

(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 <u>Gram-negative</u> 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_2 and ethanol produced in beer <u>and</u> bread production;
   e. CO_2 raises/leavens/expands bread dough;
   f. CO_2 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;   **[6 max]**
   *Award **[5 max]** if only mentions one of the two processes.*

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)

	Quadrat	*Transect*
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   **[1]**
Both needed for [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 $D = \dfrac{N(N-1)}{\sum n(n-1)}$;
   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/macroinvertebrates 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   **[1]**
                 Candidates should not use region with overlap of dotted and solid lines.

          (ii)   0.4 (s) (allow 0.38 to 0.43)   **[1]**

     (c)   (i) CO_2 attaches to protein portion (not Fe) in heme/carbaminohemoglobin
                 formed;   **[1]**

          (ii)   a. CO_2 diffuses into erythrocytes;
                 b. joins water to form carbonic acid/H_2CO_3;
                 c. catalyzed by carbonic anhydrase (inside erythrocytes);
                 d. H_2CO_3 dissociates into H^+ and HCO_3^-;   **[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/oxyntic 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]**