Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2015

Biology

Higher level

Paper 2

12 pages

Subject Details: Biology HL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[32 marks]** and **TWO** questions in Section B **[2 × 20 marks]**. Maximum total = **[72 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.

Section B

Extended response questions - quality of construction

- Extended response questions for HL P2 carry a mark total of **[20]**. Of these marks, **[18]** are awarded for content and **[2]** for the quality of construction of the answer.

- Two aspects are considered:
  expression of relevant ideas with clarity
  structure of the answers.

- **[1]** quality mark is to be awarded when the candidate satisfies **EACH** of the following criteria. Thus **[2]** quality marks are awarded when a candidate satisfies **BOTH** criteria.

Clarity of expression:

The candidate has made a serious and full attempt to answer all parts of the question and the answers are expressed clearly enough to be understood with little or no re-reading.

Structure of answer:

*The candidate has linked relevant ideas to form a logical sequence **within** at least two parts of the **same question** (eg within part a and within part b, or within part a and within part c etc. but **not between** part a and part b or between part a and part c etc.).*

- It is important to judge this on the overall answer, taking into account the answers to all parts of the question. Although, the part with the largest number of marks is likely to provide the most evidence.

- Candidates that score very highly on the content marks need not necessarily automatically gain ***[2]*** marks for the quality of construction (and *vice versa*).

Section A

1. (a) increasing/positive trend/correlation; **[1]**

(b) a. in the Arctic ocean the surface area of sea ice has declined whereas in Antarctica the surface area has increased;
b. the rate of change is greater for the Arctic than for Antarctica;
c. there are greater fluctuations in the surface area of sea ice in Antarctica than in the Arctic;
For mp a, it is acceptable if there is no comparative term such as "whereas" or "but"; **[2 max]**

(c) a. change / decrease / melting of sea ice is expected with global warming;
b. decrease of sea ice in Arctic is supportive evidence of global warming;
c. increase in sea ice in Antarctic is not supportive evidence of global warming;
d. Antarctic increase / both changes may be associated with climate change (caused by global warming);
e. global warming does not affect all areas in the same way / global warming has complex effects;
f. data is inconsistent/inconclusive / data on its own does not establish cause and effect / not over a very long period of time; **[3 max]**

(d) *One mark for correct description of the trend off the Antarctic Peninsula and one mark for correct description for the Ross Sea; accept correct statements other than those listed in the scheme but do not award a mark for contradictions; marks can be awarded for correct statements about the sea ice season for Antarctica overall; Some students are referring to moving South in the Ross Sea when it is clear that they are moving North. If you can discern their intention, then give the BOD on this;*

Antarctic Peninsula:
a. decrease/stable at the base of the peninsula / decrease in the area of the penguin colonies/West of the tip / increase/+1 above and below the peninsula / variable pattern;

Ross Sea:
b. sea ice is increasing / +1 in the Ross Sea / area below / North of the Ross Sea / lower Ross Sea / Southern part of Ross Sea/closest to the South pole is stable/no change to the length of the sea ice season / variable pattern; **[2 max]**

(e) a. (off AP) sea ice season has declined as has penguin population;
b. colony 2 and 3 sea ice season has <u>not</u> declined <u>and</u> population increased;
c. colony 3 increase in population <u>and</u> growing length of sea ice season;
d. colony 2 has stable / increasing numbers <u>and</u> sea ice season is not changing;
e. colony size and sea ice season length/area are correlated;
f. Population numbers for colony 1 and 3 the same at start of study but both experience a big (opposite change); **[3 max]**
Accept answers that refer to "sea ice" or "sea ice area".

(f) a. global warming leads to climate / environmental change; *eg* temperature change / ice melting
b. stable ice associated with stable population / no climate change;
c. ice changes associated with population changes;
d. changes in penguin population size can indicate climate change / global warming;
e. example of how climate change can alter population; *eg* prey availability / habitat loss;
f. not all species will be affected in the same way (so care needed in applying conclusions more widely)
g. there is information on changes of population over the past 35 000 years; **[3 max]**

2. (a) gel electrophoresis/DNA profiling **[1]**

(b) male 1 because all child's bands / alleles match either mother or male 1 / (approximately) half of bands match male 1 **[1]**
Do not accept reference to genes.

3. (a) a. living things are composed of cells;
b. cells are the basic/smallest unit of life;
c. cells come from pre-existing cells; **[2 max]**
Do not accept cells are the "smallest organisms".
Do not accept "cells are the building blocks" of life on its own.

(b) (i) attachment to surfaces / holds bacteria together / conjugation **[1]**
Do not accept "exchange material" on its own.
If more than one function is given, mark the first answer only.

(ii) 15 000 *(accept answers in the range of 14 000 to 16 000)* **[1]**

(c) (i) *helicase*: unwinds /unzips the DNA (into two strands) / breaks H bonds; **[1]**

(ii) *DNA polymerase III*: connects/forms (covalent) bonds between nucleotides in a 5' to 3' direction (*OWTTE*) / polymerizes nucleotides; **[1]**

(iii) *RNA primase*: forms RNA primers /short RNA strands; **[1]**

(iv) *DNA ligase*: joins/seals the nick between the (Okazaki) fragments; **[1]**

4. (a) genes located on the <u>same</u> chromosomes **[1]**

(b) a. Punnett grid correctly drawn / correct gametes;
b. phenotype ratio 9:3:3:1;
c. correct identification of expected phenotypes (9) black cats with curled ears, (3) grey cats with curled ears, (3) black cats with normal ears, (1) gray cat with normal ears; **[3]**

(c) a. natural selection could change the proportion;
b. better sense of hearing with normal ears / other suggestion of selective advantage of one phenotype or the other;
c. greater chance of survival with better adapted phenotype;
d. survival to reproductive age/more reproduction of certain cats (with better adapted phenotype);
e. (ear type is) heritable/offspring inherit alleles (for adaptation) from surviving cats;
f. proportion (with adaptation) increases in population; **[4 max]**

***NB**: The entire argument could be made using curled ears as the better adaptation.*

Section B

Remember, up to TWO "quality of construction" marks per essay.

5. (a)
a. found in eukaryotes;
b. consists of DNA wrapped around proteins/histones;
c. histones are in an octamer/group of eight;
d. are held together by another histone/protein;
e. in linker region;
f. help to supercoil chromosomes / to facilitate DNA packing;
g. (function is to) regulate transcription / gene expression; **[4 max]**

(b)
a. DNA is replicated/copied semi-conservatively/from a template;
b. mutations can be a source of variation / resulting protein has new or different functions;
c. mutations/changes in the DNA may not result in changes in the amino acid for which the triplet codes;
d. genetic code is redundant;
e. genes occur as paired alleles which can be different;
f. crossing-over occurs;
g. recombines linked alleles producing new combinations;
h. random orientation of bivalents / homologous chromosomes (in metaphase I);
i. large genetic variation in (haploid) gametes / 2^n / 2^{23};
j. random recombination of alleles during fertilization (leads to variation);
k. different phenotypes among members of the same population;
l. natural selection may lead to enhanced survival of recombinants; **[8 max]**

(c)
a. germinal cells / spermatogonia undergo mitosis to keep a supply of germinal cells present;
b. some germinal cells / spermatogonia grow larger to become primary spermatocytes;
c. primary spermatocytes go through meiosis I;
d. to form secondary spermatocytes;
e. these secondary spermatocytes go through meiosis II;
f. to produce spermatids;
g. spermatids differentiate/grow a tail and reduce their cytoplasm
h. spermatids associated with nurse cells (Sertoli cells);
i. sperm detach from Sertoli cells and enter lumen of the seminiferous tubule;
j. testosterone stimulates sperm production; **[6 max]**

*(Plus up to **[2]** for quality)*

6. (a) ***NB**: Drawings must be correctly proportioned and clearly drawn showing connections between structures. The drawing may show the heart without contraction or in any stage of contraction. Award **[1]** for any correctly labelled part that has been drawn to the stated standards.*

a. atria/right atrium/left atrium – *shown above the ventricles and must not be bigger than ventricles*;
b. ventricle/left ventricle/right ventricle – *below the atria, must have thicker walls than atria*;
c. vena cava/superior vena cave/inferior vena cava – *connected to right atrium*;
d. pulmonary artery – *shown from right ventricle (to lungs)*;
e. pulmonary vein(s) – shown *(from lungs)* to left atrium;
f. aorta – *shown as large artery from left ventricle out of heart*;
g. AV valves/atrioventricular valves / mitral/bicuspid and tricuspid – *named correctly and shown between both atria and ventricles and labelled at least on one side*;
h. semilunar valves – *shown in aorta/pulmonary artery*; **[6 max]**

V*alves need to open in correct direction.*

(b) a. (both) atria collect blood (from veins);
b. sinoatrial/SA node sends impulses to muscle/fibres initiating contraction;
c. blood is pushed to ventricles by contraction of atria/atrial systole;
d. AV (atrioventricular) valves are open (as atria contract);
e. semilunar valves are closed so that ventricles fill with blood;
f. ventricles contract / ventricular systole;
g. AV (atrioventricular) valves close (preventing backflow);
h. (blood is pushed through the) semilunar valves/pulmonary artery and aorta;
i. when ventricles relax /diastole, semilunar valves close preventing backflow of blood; **[5 max]**

Do not accept the description of blood flow without a clear action.
Do not accept general statements such as systole = heart contraction and diastole = heart relaxation.
***[4 max]** if answer suggests that left and right sides are contracting at different times or simultaneous contraction not indicated.*

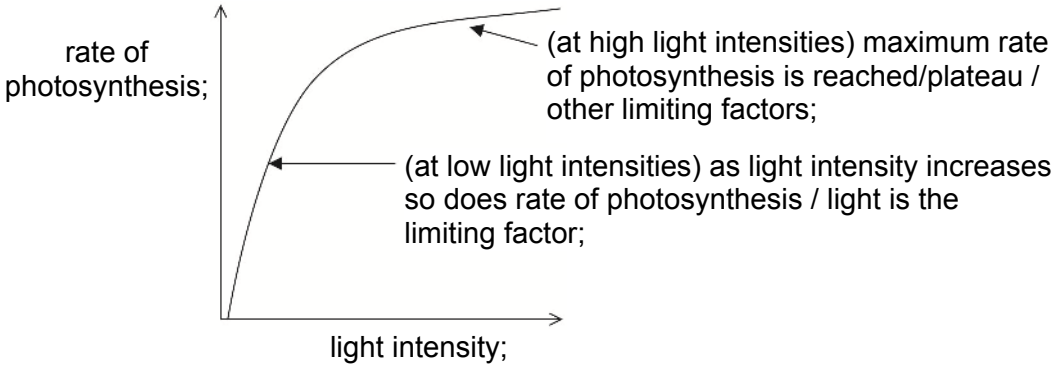
(c) a. higher nitrogen/urea as blood enters nephron/Bowman's capsule than when it leaves the nephron (in the renal vein);
b. most small soluble molecules/glucose/nutrients/ions are removed from blood in Bowman's capsule;
c. through ultrafiltration;
d. proteins / blood cells / large molecules remain in the blood;
e. as filtrate moves through the nephron (tubule), water is returned to the blood (by osmosis);
f. glucose/nutrients is returned to blood by active transport (and diffusion) / selective reabsorption;
g. in the proximal convoluted tubule;
h. urea / uric acid remain in the filtrate / removed from blood;
i. sodium is pumped into the medulla in the loop of Henlé;
j. water reabsorption is enhanced by a high sodium gradient (in the medulla);
k. permeability of the collecting duct membrane is regulated by hormones / ADH;
l. water concentration in urine is variable to maintain homeostasis in the blood;
m. more oxygen/less carbon dioxide in blood entering (kidney) than in blood leaving (kidney); **[7 max]**

*(Plus up to **[2]** for quality)*

7. (a) a. photophosphorylation is the production of ATP;
b. (some of the) light absorbed by chlorophyll / photosystem II;
c. photolysis/splitting of water separation of hydrogen ion from its electron;
d. the electron transport system moves the electrons through a series of carriers;
e. (electron transport system occurs) in the thylakoid membrane;
f. electron transport linked to movement of protons into thylakoid space;
g. a proton gradient builds up (in the thylakoid space);
h. small thylakoid space enhances the gradient;
i. hydrogen ions move by diffusion through the ATP synthase;
j. ADP + inorganic phosphate (P_i) forms ATP;
k. (the kinetic energy from) movement of hydrogen ions (through ATP synthase) generates ATP;
l. ATP synthase is a protein complex in the thylakoid membrane;
m. formation of proton gradient / ATP synthesis linked to electron transport is chemiosmosis; **[8 max]**

Award marks for a clearly drawn correctly annotated diagram.

(b)



a. vertical axis labelled as “rate of photosynthesis” and horizontal axis labelled as “light intensity”;
b. drawn showing that at low light intensities, increased intensity leads to increased rate of photosynthesis (sharply);
c. drawn with plateau formed at high light intensities;
d. plateau annotated as maximum rate of photosynthesis;
e. curve intersecting horizontal axis at a value above zero;
f. arrows added to axes or student annotates axis with “rate of photosynthesis increases” and “light intensity increases” **[4 max]**

(c) a. named example of verified genetically modified crop; *eg*, Bt corn / golden rice; *Example must be verifiable.*
b. specific gene added / new protein synthesized by the crop plant / specific modification; *eg* gene from *Bacillus thuringiensis* / cry protein;
c. biological effect of the modification; *eg*, makes the plant toxic to (herbivorous) insects / insect pests / corn borers;

[2 max] *for benefits and* ***[2 max]*** *for harmful effects / costs;*

d. a benefit of specific genetic modification; *eg*, increased crop yields / less land needed;
e. a second benefit of this specific modification; *eg*, reduced need for use of chemical pesticides;
f. a harmful effect of specific genetic modification; ingestion of toxin by non-target species;
g. another specific harmful effect; *eg*, concerns about contamination of neighbouring non-GMO crops affecting trade; **[6 max]**

To award ***[6]*** *responses need to address the name, description and the effect of the modification. Effects have to be linked to the specific example discussed. Marks have to be all linked to one example. Assistant examiners are required to research examples.*

(Plus up to ***[2]*** *for quality)*

8. (a)
a. minerals bound to soil particles;
b. examples of three nutrients from: phosphate, nitrate, magnesium, iron, calcium, potassium, sodium, magnesium;
c. minerals dissolve in water;
d. mass flow causes movement of minerals with movement of water through soil;
e. minerals diffuse down a concentration gradient towards roots (as the mineral concentration next to the roots is continuously decreasing);
f. minerals enter the plant through roots;
g. by active transport / use of ATP;
h. branching of roots increases surface area for absorption of minerals;
i. root hairs increase surface area (for the absorption of minerals);
j. hypha of (mutualistic) fungi may enhance movement of selected ions into roots / increase surface area;
k. root hairs have many mitochondria to provide energy/ATP for active transport;
l. export of H^+ creates electrochemical gradient / displaces ions bound to soil/clay;
m. that causes positive mineral ions to diffuse into (root) cells;
n. negative mineral ions cross membrane linked to H^+ ions moving down (H^+) gradient; **[8 max]**

(b)
a. water to rehydrate the seed / activate metabolic processes;
b. oxygen for aerobic respiration as seed germinates;
c. suitable temperature for <u>enzyme</u> activity;
d. each type of seed has specific temperature requirements / temperature requirements ensure that seeds germinate at the correct time of year; **[3 max]**

Do not accept a simple list of factors without details.

(c)
a. growth phase/G-1: synthesis of proteins/cytoplasm/organelles;
b. synthesis phase/S-phase: replication of DNA;
c. second growth phase/G-2: continued growth of cytoplasm/molecular synthesis/ duplication of organelles;
d. prophase: chromosomes super-coil to prepare for mitosis / nuclear envelope disappears / spindle fibres form;
e. metaphase: chromosomes line up at equatorial/metaphase plate / spindle fibres attach to centromeres/chromosomes;
f. anaphase: chromatids move along microtubules/spindle fibres move chromatids toward opposite poles;
g. telophase: nuclear membranes form around each cluster of chromosomes;
h. cytokinesis: new plasma <u>membrane forms</u> between the nuclei / cell plate forms;
i. a new cell wall forms;
j. (mitosis) results in two cells with identical nuclei; **[7 max]**

Names of phases are required to earn the mark.
Award marks for a clearly drawn correctly annotated diagram.

*(Plus up to **[2]** for quality)*