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 <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.

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) similar/same/nearly same (means)/very small difference/both at a low level;
means/averages (all) close to 0.8 mg ml^{-1};
differences not (statistically) significant;
similar/same/nearly same range/spread of data; **[2 max]**
All marking points are comparisons between control and IKO mice. Do not award marks for comparisons between male and female mice.

(b) stress causes increase (in mean blood glucose/sugar);
older mice/males/females / aging mice show the increase; **[2]**
*Reject answers that **only** compare control and IKO mice or **only** compare male and female mice.*

(c) in young mice/3 month old mice lack of FoxO1/IKO/fewer beta cells does not affect/has little effect on blood glucose/sugar;
in older females/aging males blood glucose/sugar (much) higher with lack of FoxO1/IKO/fewer beta cells; **[2]**

(d) *Award **[1]** for an answer:*
accept either 35 / 34.8 / 34.78 (*this answer may be expressed as a negative*)
OR 53 / 53.3 / 53.33;
Do not award the mark if more than two decimal places shown or if the answer is incorrectly rounded up or down.

*Award **[1]** for working, accepting* any of the following:
$2.3 - 1.5$
OR $1.5 - 2.3$
OR $\left(\frac{(2.3 - 1.5)}{2.3}\right) \times 100$
OR $\left(\frac{1.5}{2.3}\right) \times 100 = 65 / 65.2 / 65.22\%$
OR other credible alternatives for working; **[2]**

(e) lack of FoxO1 (correlates) with low/decreased insulin and high/increased glucagon levels **[1]**

(f) newly formed β cells **[1]**
Accept if newly formed beta cells in IKO mice but not in control mice only.
Reject all answers apart from the first given and any comparisons between IKO and control mice, rather than between younger and older mice.

(g) *All marking points are deductions based on comparing older females with 3 month females and on the assumption that any changes in % are due to aging.*
newly formed β cells fewer/reduced/smaller % (in control/IKO mice);
cells still producing insulin (slightly) more/increased/higher % in controls;
cells still producing insulin fewer/reduced/smaller % in IKO mice;
cells no longer producing insulin only in older IKO mice; **[2 max]**
Accept answers where IKO mice are referred to as mice without FoxO1 and control mice are referred to as mice with FoxO1.

(h) *supported in older IKO mice/older mice lacking FoxO1 by:*
cells no longer producing insulin present (only) in older IKO mice/mice lacking FoxO1;
(type 2) diabetes/high blood glucose/lower insulin in older IKO mice/mice lacking FoxO1;

not supported by:
lower mass of β cells in older IKO mice/mice lacking FoxO1;
no drop/small rise/small change in cells producing insulin in older control mice; **[2 max]**

Candidates must make it clear in their answer to (h) whether the data is in support of the hypothesis or against. Evidence can be included for and against. Answers should specify whether the data is from older IKO mice or from older control mice. If the age is not specified in the answer, penalise for one of the marking points but not any others.

(i) promotes transcription of/expression of genes;
for differentiation /growth/mitosis/cell division in β cells / for making insulin;

represses transcription of/expression of genes;
for making glucagon; **[2 max]**

2. (a) (i) polygenic / more than one gene **[1]**
Accept polygenetic. Mark only first answer if more than one answer given.

(ii) lactase added to milk / lactase immobilised;
lactose hydrolysed/broken down into glucose and galactose;
for people who are lactose intolerant/lack lactase;
increases sweetness/solubility/smooth texture (in processed foods); **[3 max]**

(b) (i) I is alpha helix and II is beta pleated sheet **[1]**
Reject (α) double helix but accept α/A/a and β/B/b instead of alpha and beta.

(ii) hydrogen bonds;
Reject hydrogen and covalent bonds unqualified and hydrogen bonds between bases.
(hydrogen bonds) between N–H and C=O (on different amino acids);
Reject between amine and carboxyl groups.
(hydrogen bonds) between adjacent turns of the helix/every fourth amino acid; **[2 max]**
Accept above points in an annotated diagram.

(iii)

Globular	*Fibrous*
water soluble (mostly)	not (water) soluble;
rounded shape/tertiary structure	long/narrow shape / no tertiary structure;
enzymes/hormones/catalysis/transport /defence functions	structural/movement functions;

[2 max]
A table is not required but for each feature the difference between globular and fibrous proteins must be made clear.

3. (a) (i) dicotyledonous / dicot **[1]**

(ii) veins on leaves are net-like/reticulate/branching/non-parallel;
flower has five petals; (*reject four or five and five or six*)
lateral/branching/fibrous roots /tap root; **[2 max]**
Accept correct answers in (ii) even if the answer in (i) was incorrect.

(b) (i) line to one of potatoes labelled as (stem) tuber **[1]**
Reject root tuber and bulb tuber but accept potato tuber.

(ii) in phloem; (*reject xylem and phloem)*
sugars/sucrose;
pumped in/active transport/active translocation / energy required;
from source to sink; **[3 max]**

Section B

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

4. (a) a. scrotum – *shown around testes*;
b. testes/testis/testicles – *shown inside scrotum*;
c. epididymis – *shown adjacent to testis and connected to sperm duct*;
d. sperm duct/vas deferens – *double line connecting testis/epididymis to urethra*;
e. seminal vesicle – *sac shown branched off sperm duct (not off the urethra)*;
f. prostate gland – *shown positioned where sperm duct connects with urethra*;
g. urethra – *shown as double line linking bladder to end of penis*;
h. penis – *with urethra passing through it*; **[5 max]**

*Award **[1]** for each structure clearly drawn and labelled that conforms to the italicized guidelines given.*

(b) a. both produce haploid cells / both produce (mature/male/female) gametes;
b. both have mitosis at start/in epithelium / both involve mitosis and meiosis;
c. both have cell growth before meiosis;
d. both involve differentiation (to produce a specialised gamete);

	Comparison	*Oogenesis*	*Spermatogenesis*
e.	what is produced where	eggs/ova produced in the ovaries	sperm (atozoa) produced in the testes;
f.	when the process starts/is initiated	during development of embryo/fetus	during puberty/adolescence;
g.	if there are breaks in meiosis	breaks occur in prophase I/ prophase II/ metaphase II	no breaks;
h.	if cytokinesis during meiosis is equal	cytoplasm split unequally / larger cell and smaller cells	equal division of cytoplasm;
i.	number of gametes per meiosis	one cell/egg (per meiosis) / some become polar bodies	four sperm (per meiosis) / all cells become sperm;
j.	number of gametes produced/released	one (usually) at a time/per month/per menstrual cycle	many/far more/(hundreds of) millions daily/at a time;
k.	timing of release	on about Day 14/in middle of menstrual cycle/at ovulation	continuously (from testis) / by ejaculation/intercourse;
l.	if gametogenesis ever stops	stops (at menopause)	goes on (throughout adult life/until death);

[8 max]

A table is not required but both statements in one row of the table above must either be explicitly stated or clearly implied for each mark awarded.

(c) a. more (offspring) than the environment can support / carrying capacity reached;
b. increased mortality/lower life expectancy/more deaths;
c. <u>competition</u> (for resources) / struggle for survival;
d. food/mates/nest sites/territory/other example of resource shortage / example of greater need;
e. variation between members of population / example of variation;
f. better adapted more likely to survive / converse; (*reject Lamarckian statements such as those who adapt survive)*
g. better adapted reproduce / pass on (favourable) genes/traits / converse;
h. natural selection / (survival of fittest) leads to evolution; **[5 max]**

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

5. (a)
a. (consists of) prophase, metaphase, anaphase and telophase;
b. chromosome number halved/reduced/(diploid) to haploid;
c. homologous chromosomes pair up/form a bivalent/synapsis in prophase;
d. crossing over between non-sister chromatids/chromatids of different homologues;
e. nuclear envelope breaks down (at end of prophase/start of metaphase);
f. tetrads/bivalents/homologous pairs move to/align on equator/cell centre/on metaphase plate in metaphase; (*accept homologous chromosomes without pairs if pairing has already been described)*
g. attachment of spindle fibres/microtubules to centromeres/kinetochores;
h. (homologous) chromosomes separate/pulled to opposite poles in anaphase;
i. nuclear envelopes reform/do not reform (because of meiosis II) in telophase; **[6 max]**

Accept the above points in a series of annotated diagrams. Reject answers with single chromatids forming pairs in metaphase or separating or moving to opposite poles in anaphase.

(b)
a. DNA replication is semi-conservative;
b. each (molecule formed) has one new strand and one from parent molecule;
c. helicase uncoils DNA;
d. helicase separates the two strands by breaking hydrogen bonds between bases; (*reject unzips as an alternative to uncoils but accept as alternative to separates if breakage of hydrogen bonds is included)*
e. RNA primase adds primer / primase adds (short) length of RNA;
f. DNA polymerase III binds to/starts at (RNA) primer;
g. DNA polymerase (III) adds nucleotides/bases in a 5' → 3' direction;
h. bases according to complementary base pairing / A–T and C–G;
i. (leading strand) built up continuously (towards the replication fork);
j. (lagging strand) built up in pieces/short lengths/Okazaki fragments;
k. DNA polymerase I removes RNA/primers and replaces them with DNA;
l. ligase seals gaps between nucleotides/fragments/makes sugar-phosphate bonds;
m. nucleoside triphosphates provide the energy to add nucleotides; **[8 max]**

Accept the above points in annotated diagrams.

(c)
a. complete human DNA/chromosomes sequenced;
b. identification of all human genes / find position/map (all) human genes;
c. find/discover protein structures/functions;
d. find evidence for evolutionary relationships/human origins/ancestors;
e. find mutations/base substitutions/single nucleotide polymorphisms;
f. find genes causing/increasing chance of/develop test for/screen for diseases;
g. develop new drugs (based on base sequences) / new gene therapies;
h. tailor medication to individual genetic variation / pharmacogenomics;
i. promote international co-operation/global endeavours; **[4 max]**

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

6. (a) *Award **[1]** for each structure clearly drawn and labelled.*
a. cell body – *star shaped body at end of neuron with nucleus inside*;
b. dendrites – *as multiple long/narrow protrusions from the cell body*;
c. axon – *at least three times as long as the cell body not including the dendrites*;
d. myelin sheath/Schwann cells – *surrounding the axon*;
e. nodes of Ranvier – *periodic gaps in myelin sheath*;
f. motor end plates – *shown as buttons at the end of multiple branches of axon*; **[4 max]**
Reject the points for axon and myelin sheath if the labelling line does not clearly point to the structure. Accept a bracket label indicating the length of the axon.

(b) a. sliding filament model / filaments/actin and myosin slide past each other;
b. action potential/depolarisation/nerve impulse arrives at end of motor neurone;
c. neurotransmitter/acetylcholine released causing action potential (in muscle fibre);
d. sarcoplasmic reticulum releases calcium ions;
e. calcium ions cause binding sites on actin/for myosin to be exposed;
f. myosin heads bind to sites on actin/form cross-bridges;
g. myosin (head) moves actin filament using energy from ATP;
h. actin moved towards the centre of sarcomere/M line/M band;
i. sarcomeres shortened;
j. (binding of) ATP causes release of myosin head from actin;
k. conversion of ATP to ADP and Pi causes myosin heads to change angle;
l. cycle (of events) repeated (during muscle contraction); **[8 max]**
Accept the above points in annotated diagrams.

(c) *during inhalation*:
a. external intercostal muscles contract moving rib cage up and out;
b. diaphragm contracts becoming lower/flatter;
c. increase in volume and decrease in pressure (of thorax);
d. air flows into lungs as atmospheric pressure is higher;

during exhalation:
e. internal intercostal muscles contract so ribs move in and down;
f. diaphragm relaxes and returns to domed shape;
g. decrease in volume and (therefore) increase in pressure (of thorax);
h. air moves out until pressure in lungs falls/is equal to atmospheric pressure;
i. abdominal muscles can be used to make a stronger/forced exhalation; **[6 max]**

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

7. (a) *Award **[1]** for each structure clearly drawn and correctly labelled.*
a. phospholipid bilayer – *with head and tails*;
b. hydrophilic/phosphate/polar heads and hydrophobic/hydrocarbon/fatty acid/non-polar tails labelled;
c. integral/intrinsic protein – *embedded in the phospholipid bilayer*;
d. protein channel – *integral protein showing clear channel/pore*;
e. peripheral/extrinsic protein – *not protruding into the hydrophobic region*;
f. glycoprotein with carbohydrate attached – *carbohydrate should be outside the bilayer*;
g. cholesterol – *positioned across one half of bilayer and not protruding*;
h. thickness indicated (10 nm); *(allow answers in the range of 7 nm to 13 nm)* **[5 max]**

(b) a. (chlorophyll/pigments/antenna complex) in photosystem II absorb light;
b. light/photoactivation produces an excited/high energy/free electron;
c. electrons pass from carrier to carrier/along electron transport chain/e.t.c.;
d. protons pumped across thylakoid membrane/into thylakoid space;
e. ATP produced (by the light dependent reactions);
f. ATP production by chemiosmosis/by ATP synthase/ATP synthetase;
g. electrons from photosystem II passed to photosystem I;
h. light/photoactivation excites electrons in photosystem I (to higher energy level);
i. production of $NADPH$/reduction of $NADP^{(+)}$ (using electrons from photosystem I); (*reject NAD in place of NADP. Accept reduced NADP instead of NADPH*)
j. electrons from photolysis (needed) for photosystem II;
k. oxygen from photolysis is a waste product/by-product/passes out/excreted;
l. in cyclic photophosphorylation electrons from photosystem I return to it; **[8 max]**

(c) a. (increase in) light (intensity) increases rate (of photosynthesis);
b. until a plateau is reached at higher light intensities/when another factor is limiting;
c. light needed for light dependent reactions/example of light dependent reaction;

d. (increase in) temperature/heat increases the rate (of photosynthesis);
e to an optimum temperature above which the rate drops;
f. temperature/heat affects rate of Calvin cycle/enzyme activity/rubisco activity;

g. (increase in) carbon dioxide (concentration) increases rate (of photosynthesis);
h. until a plateau is reached at higher CO_2 levels/when another factor is limiting;
i. CO_2 needed for light independent reactions/Calvin cycle/carboxylation of RuBP/production of glycerate phosphate; **[5 max]**

If the candidate outlines more than two factors, only mark the first two.
Accept the first two points relating to each factor if clearly shown on a graph with both axes appropriately labelled.
Accept level instead of concentration, intensity or rate.
Do not accept enzyme denaturation as a reason for reductions in photosynthesis at higher temperatures.

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