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MARKSCHEME

May 2009

BIOLOGY

Higher Level

Paper 2

14 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. Do **not** award more than the maximum marks allowed for part of a question.

2. Each marking point has a separate line and the end is signified 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.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing ***OWTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF (**error carried forward).

10. Only consider units at the end of a calculation. Unless directed otherwise in the markscheme, unit errors should only be penalized once in the paper. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover page.

Section B

Extended response questions - quality of construction

- Extended response questions for SL 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** (e.g. 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*).

- The important point is to be consistent in the awarding of the quality points. For **sample scripts for moderation** the reason why quality marks have been awarded should be stated.

- Indicate the award of quality marks by writing **Q2**, **Q1** or **Q0** in **red** at the end of the answer.

SECTION A

1. (a) $50 - 12 = 38\ (\text{mm}^2)$; *Accept 12 – 50 = –38*
$(38 \div 50) \times 100 = (-)76\,(\%)$; *(ECF)* ***[2]***

(b) *Sesamia* (was most successfully controlled);
in control plants *Sesamia* caused most damage;
all types of Bt/genetically modified maize/A–I show (significant) decrease in damage by *Sesamia*;
mark for correct numerical comparison;
Sesamia caused no damage to type E/ in one instance;
Busseola not controlled/affected by Bt/genetically modified maize/caused largest amount of damage in types A–I/increased damage in some varieties;
Eldana controlled by some types of maize / B/C/D but not others / *Eldana* caused least damage in control and not much difference in many maize types; ***[3 max]***

(c) *males*: $(440 - 325 =)115\,\text{g}$; *(Accept answers in range 105–125 g)*
females: $(268 - 215 =)53\,\text{g}$; *(Accept answers in range 51–57 g)* ***[2]***
Units required, no workings required.

(d) (promotes) highest rate of growth at start of study / tapering off later in the study;
Bt maize appears to cause less growth/mass gain than rat food / vice versa;
more pronounced difference in females;
no difference in growth/mass gain between Bt and non-Bt maize; ***[2 max]***

(e) (Bt) maize may not be as good as the (commercially prepared) rat food;
Bt maize appears to be as good a food source as non-Bt maize;
Bt maize an acceptable/safe food source; ***[1 max]***
Answers require a judgement about Bt maize as a food source rather than a description.

(f) decomposers / recycle nutrients / cause decay / nitrification/nitrogen fixation / denitrification ***[1]***

(g) (for both groups) overall biomasses were higher during flowering than harvest / vice versa
the microbial biomass for the Bt crop was (slightly) lower than for the non-Bt crops at flower time;
the microbial biomass for the Bt crop was (slightly) higher than for the non-Bt crops at harvest time; ***[2 max]***

(h) data does not support the hypothesis as there is little difference between biomass found in the soil (surrounding) roots (of the Bt and non-Bt) at either time;
data does not support the hypothesis as there is a slightly positive effect at harvest;
data supports hypothesis as there is a slightly negative effect at flowering; ***[2 max]***

(i) (i) α helix / alpha helix ***[1]***

(ii) hydrogen bonds;
between the turns of the helix (rather than between R-groups);
bonds between carboxyl and NH groups/C-O---H-N; ***[2 max]***

(iii) non-polar amino acids/R-groups;
(inner part of phospholipid) bilayer is hydrophobic/non-polar; ***[2]***

2. (a) (i) $\frac{T\ \ E}{t\ \ e}$ ***[1]***

(ii) unenclosed seeds, starchy and tunica present, sugary /

$\frac{T\ \ e}{t\ \ e}$ and $\frac{t\ \ E}{t\ \ e}$ *(both needed)* ***[1]***

(iii) crossing over;
between non-sister chromatids (in prophase I);
results in exchange of alleles / change in linkage groups;
so some gametes are T e or t E ; *(linkage notation not expected)*
test cross expect ratio of two phenotypes / correct Punnett Square showing test cross;
but instead get four phenotypes with smaller percentage of recombinants; ***[2 max]***
Above points can be shown in diagrams.

(b)

angiospermophytes	**bryophytes**
flowering	non-flowering;
(true) roots	rhizoids/no true roots;
(true) leaves	scales / thallus/no true leaves;
seeds produced	spores produced (in capsule);
waxy cuticle	no cuticle;
vascular (tissue)	non-vascular / no vascular tissue

[2 max]

3. (a) (i) nucleus contains genetic information / is site of DNA replication / site of RNA transcription;
nuclear membrane/envelope (which has pores) allowing exchange of substances between nucleus and cytoplasm; ***[1 max]***

(ii) magnification $= 30\,000\,\mu m \div 5\mu m = 6000\times$ ***[1]***
(Accept answers in range 6000–6200×. Do not deduct for differences in precision in calculation.)

(iii) large number of mitochondria;
to meet energy demand/ATP production (needed for high metabolic activity);

or

large amount of rER;
indicates high rate of protein synthesis; ***[2 max]***

(b) both viruses and bacteria much smaller than this cell;
bacteria (approx.) size of a small organelle/mitochondrion;
viruses (approx.) 100 nm and bacteria (approx.) 1 μm / (most) viruses 30 nm – 100 nm and (most) bacteria 1 μm – 10 μm; ***[2 max]***
Accept ranges which fall within these boundaries.

SECTION B

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

4. (a) *Award **[1]** for each of the following clearly drawn and correctly labelled. Label lines must be unambiguous in terms of what they are indicating.*
double/inner and outer membrane/envelope – shown as two concentric continuous lines close together;
granum/grana – shown as a stack of several disc-shaped subunits;
(intergranal) lamella – shown continuous with thylakoid membrane;
thylakoid – one of the flattened sacs;
stroma;
(70S) ribosomes/(circular) DNA / lipid globules / starch granules / thylakoid space; ***[4 max]***

(b) transpiration is water loss (from plant) by evaporation;
flow of water through xylem from roots to leaves is the transpiration stream;
evaporation from spongy mesophyll cells;
replaced by osmosis from the xylem;
(diffusion of water vapour) through stomata;
water lost replaced from xylem / clear diagram showing movement of water from xylem through cell(s) (walls) to air space;
water pulled out of xylem creates suction/low pressure/tension;
transpiration pull results;
water molecules stick together/are cohesive;
due to hydrogen bonding/polarity of water molecules;
xylem vessels are thin (hollow) tubes;
adhesion between water and xylem due to polarity of water molecules;
creates continuous column/transpiration stream; ***[7 max]***

(c) flowering affected by light;
phytochrome;
exists in two (interconvertible) forms/P_{fr} and P_r;
P_r (red absorbing/660 nm) converted to P_{fr} (far-red/730 nm absorbing) in red or day light;
sunlight contains more red than far red light so P_{fr} predominates during the day;
gradual reversion of P_{fr} to P_r occurs in darkness;
P_{fr} is active form / P_r is inactive form;
in long-day plants, flowering induced by dark periods shorter than a critical length / occurs when day is longer than a critical length;
enough P_{fr} remains in long-day plants at end of short nights to stimulate flowering;
P_{fr} acts as promoter of flowering in long-day plants;
short-day plants induced to flower by dark periods longer than a critical length/days shorter than a critical value;
at end of long nights enough P_{fr} has been converted to P_r to allow flowering to occur;
P_{fr} acts as inhibitor of flowering in short-day plants; ***[7 max]***

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

5. (a) non-disjunction (can cause Down syndrome);
occurs when pair of homologous chromosomes fails to separate during meiosis;
one gamete/daughter cell receives two chromosomes / diagram showing this;
occurs in anaphase I/II of meiosis;
fertilization involving this gamete leads to change in chromosome number/47 chromosomes;
most common form of Down is trisomy 21/extra chromosome 21;
increase risk of Down syndrome with increased age of mother; ***[4 max]***

(b) oogenesis is process by which female gametes/eggs are produced;
begins during fetal development;
oogonia/large number of cells formed by mitosis;
oogonia/cells enlarge/undergo cell growth/become primary oocytes;
begin first meiotic division but stop in Prophase I;
until puberty;
(at puberty) some follicles develop each month in response to FSH;
(primary oocyte) completes first meiotic division;
forms two cells of different/unequal sizes / unequal distribution of cytoplasm;
(creating a) polar body;
polar body eventually degenerates;
larger cell/secondary oocyte proceeds to meiosis II;
stops at prophase II;
meiosis II completed if cell is fertilized;
ovum and second polar body formed; ***[8 max]***

(c) *To award full marks, discussion must contain both pro and con considerations.*

pros/positive considerations: ***[3 max]***
chance for infertile couples to have children;
decision to have children is clearly a conscious one due to difficulty of becoming pregnant;
genetic screening of embryos could decrease suffering from genetic diseases;
spare embryos can safely be stored for future pregnancies/used for stem cell research;

cons/negative considerations: ***[3 max]***
IVF is expensive and might not be equally accessible;
success rate is low therefore it is stressful for the couple;
it is not natural/cultural/religious objections;
could lead to eugenics/gender choice;
could lead to (unwanted) multiple pregnancies with associated risks;
production and storage of unused embryos / associated legal issues / extra embryos may be used for (stem cell) research;
inherited forms of infertility might be passed on to children; ***[6 max]***
Accept any other reasonable answers.

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

6. (a) DNA is double-stranded while RNA is single-stranded;
DNA contains deoxyribose while RNA contains ribose;
the base thymine found in DNA is replaced by uracil in RNA;
one form of DNA (double helix) but several forms of RNA (tRNA, mRNA and rRNA); ***[3 max]***

(b) occurs during (S phase of) interphase/in preparation for mitosis/cell division;
DNA replication is semi-conservative;
unwinding of double helix / separation of strands by helicase (at replication origin);
hydrogen bonds between two strands are broken;
each strand of parent DNA used as template for synthesis;
synthesis continuous on leading strand but not continuous on lagging strand;
leading to formation of Okazaki fragments (on lagging strand);
synthesis occurs in $5' \rightarrow 3'$ direction;
RNA primer synthesized on parent DNA using RNA primase;
DNA polymerase III adds the nucleotides (to the $3'$ end)
added according to complementary base pairing;
adenine pairs with thymine and cytosine pairs with guanine; *(Both pairings required. Do not accept letters alone.)*
DNA polymerase I removes the RNA primers and replaces them with DNA;
DNA ligase joins Okazaki fragments;
as deoxynucleoside triphosphate joins with growing DNA chain, two phosphates broken off releasing energy to form bond; ***[8 max]***
Accept any of the points above shown on an annotated diagram.

(c) they increase rate of (chemical) reaction;
remains unused/unchanged at the end of the reaction;
lower activation energy;
activation energy is energy needed to overcome energy barrier that prevents reaction;
annotated graph showing reaction with and without enzyme;
substrate joins with enzyme at active site;
to form enzyme-substrate complex;
active site/enzyme (usually) specific for a particular substrate;
enzyme binding with substrate brings reactants closer together to facilitate chemical reactions (such as electron transfer);
induced fit model / change in enzyme conformation (when enzyme-substrate/ES complex forms);
making the substrate more reactive; ***[7 max]***

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

7. (a) antibiotic resistance can be inherited;
alleles for resistance can be passed from one cell to another by exchange of plasmids/conjugation;
some varieties are more resistant than others;
bacteria reproduce very rapidly and have high mutation rate;
evolution can occur rapidly;
increased exposure to antibiotics is the environmental change that selects for resistant varieties;
for example, in hospitals / animal feed / inappropriate prescriptions / not finishing prescriptions;
bacteria without resistance die / resistant bacteria survive and pass on genes to next generation;
results in change in genetic makeup of population; ***[5 max]***

(b) immunity is the ability of an organism to resist infection;
due to presence of (specific) antibodies;
immunity can be active or passive;
passive due to receiving antibodies from external sources/across placenta/from breast milk/injection;
active results from facing an infection directly/through vaccination;
pathogen/foreign cell invades body;
leads to clonal selection/formation of B memory cells;
B-cells produce <u>specific</u> antibodies;
if same pathogen enters body again memory cells activated/stimulated to divide;
antibodies produced faster <u>and</u> in greater amounts; ***[6 max]***

(c) *Benefits:* ***[4 max]***
immunity results
can limit pandemics/epidemics/spread of (infectious) diseases;
diseases can be eradicated/smallpox eliminated;
reduces mortality/deaths due to disease;
can protect vulnerable groups/young/old/with other conditions;
decrease crippling effects of diseases (such as polio);
decreased health care costs;

Dangers: ***[4 max]***
may produce (mild) symptoms of the disease;
human error in preparation/storage/administration of vaccine;
individual may react badly to vaccine / defective immune system / hypersensitive/allergic reaction;
immunity may not be life-long/booster required;
possible toxic effects of mercury-based preservatives/thimerosal; ***[7 max]***

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