

MARKSCHEME

May 2003

BIOLOGY

Higher Level

Paper 2

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General Marking Instructions

Subject Details: **Biology HL Paper 2 Markscheme**

Mark Allocation

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

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- w Each marking point has a separate line and the end is signified by means of a semicolon (;).
- w An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- w Words in (...) in the markscheme are not necessary to gain the mark.
- w The order of points does not have to be as written (unless stated otherwise).
- w If the candidate’s answer has the same “meaning” or can be clearly interpreted as being the same as that in the mark scheme then award the mark.
- w Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- w Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with “**ECF**”, error carried forward.
- w Units should always be given where appropriate. Omission of units should only be penalized once. Indicate this by “**U-1**” at the first point it occurs. Ignore this, if marks for units are already specified in the markscheme.
- w Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

Section B

Extended response questions - quality of construction

- w 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.
- w Two aspects are considered:
 - expression of relevant ideas with clarity
 - structure of the answers.
- w **ONE** quality mark is to be awarded when the candidate satisfies **EACH** of the following criteria. Thus **TWO** 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 in at least two parts [(a), (b), etc.] of the question.

- w 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.
- w Candidates that score very highly on the content marks need not necessarily automatically gain the two points for the quality of construction (and vice versa).
- w The important point is to be consistent in the awarding of the quality points.

SECTION A

1. (a) whole leaf contains 3.8 % lignin (*accept values* ± 0.5 %) / content close to mesophyll;
veins have greatest amount of lignin;
mesophyll contains the least amount of lignin;
epidermal has slightly more than mesophyll / whole leaf; [2 max]
- (b) mesophyll contains the most protein;
veins contain the least amount of protein;
epidermis content is low but higher than vein/ only 15 mg (± 1 mg);
figures of 48, 15 and 8 (mg) (± 1) used to make comparisons / one approximate ratio
between two figures calculated (*e.g.* epidermal twice as much as leaf vein); [3 max]
- (c) both have low nutritional content;
epidermis contains much water / vein contains little water;
much of veins is indigestible lignin / lignin is not nutritious;
carbohydrate content is (slightly) higher in vein / similar content / moderate in both;
both have low amino acid / protein content; [3 max]
- (d) both species prefer to feed on the mesophyll / feed less on veins;
C. milli feeds more on the mesophyll (than *C. nigra*);
C. nigra feeds slightly more on smaller veins (than *C. milli*) / similar amount / same
amount;
C. nigra feeds more on strengthened veins (than *C. milli*);
both feed least on strengthened veins; [3 max]
- (e) vein tissue has more lignin / much lignin / vice versa for mesophyll;
lignin / veins difficult to ingest / digest / penetrate / vice versa for mesophyll;
smaller veins easier to digest than strengthened veins;
mesophyll best nutritionally / high in protein / amino acids / vice versa for veins;
mesophyll has high water content / vice versa for veins;
C. nigra can digest / use / tolerate lignin more;
C. nigra can feed on lower nutrient diet / *C. milli* needs more protein / amino acid;
C. nigra is excluded from mesophyll because of competition with *C. milli*;
different parts of the leaf supply different nutrients;
suggested anatomical difference to explain differences in preference; [3 max]
- (f) more thrips on control plants than sprayed plants;
greater increase (between 7 June and 20 June) on control plants;
greater difference between control and high dose than control and low dose plants;
little difference between high and low dose plants at end of trial;
Reject: thrip population falls on treated plants. [2 max]
- (g) use genetic modification / genetic engineering / recombined DNA;
obtain / clone the gene for synthesizing jasmonic acid;
transfer the gene into a crop plant;
breed plants that produce more jasmonic acid / produce jasmonic acid before thrips
attack;
select offspring that produce high levels of jasmonic acid / breed again; [2 max]

2. (a) alleles of gene / pairs of alleles which both affect the phenotype / both expressed (when present together in an individual / in the heterozygote); [1]
Reject: both dominant / both recessive
- (b) 1st generation–3 / father 3;
father 1 can only donate an O allele / B allele cannot come from O parent; [2]
- (c) $I^A I^A$ / AA;
 $I^A I^B$ / AB;
 $I^A I^O$ and $I^B I^O$ / AO and BO / $I^A i$ and $I^B i$; [3]
Award marks for correct answers then deduct [1] for each incorrect genotype, e.g. including genotypes with only one allele. Minimum mark [0]. Do not accept phenotypes instead of genotypes.
3. (a) the site (on the surface of an enzyme) to which substrate(s) bind / the site (on the enzyme) where it catalyzes a chemical reaction; [1]
- (b) bring substrates close together in active site / in correct orientation;
forms enzyme-substrate complex / substrate(s) bind to active site;
lowers the **activation** energy for the reaction;
weakens bonds in the substrate; [2 max]
- (c) enzymes have an optimal pH;
lower activity above and below optimum pH / graph showing this;
too acidic / basic pH can denature enzyme;
change shape of active site / tertiary structure altered;
substrate cannot bind to active site / enzyme-substrate complex cannot form;
hydrogen / ionic bonds in the enzyme / active site are broken / altered; [3 max]
- (d) energy storage / source of energy / respiration substrate;
(heat) insulation;
protection (of internal organs);
water proofing / cuticle;
buoyancy;
(structural) component of cell membranes;
electrical insulation by myelin sheath;
(steroid) hormones;
glycolipids acting as receptors; [2 max]
Three correct [2], one or two correct [1].

Use one tick to mark the first one or two correct answers. Use a second tick to mark the third correct answer. Mark the first three answers only.

SECTION B

4. (a) Award [1] for each of the following structures clearly drawn and labelled correctly. Award marks for labelled eukaryotic structures, then deduct [1] per labelled prokaryotic structure shown e.g. mesosome, cell wall.

nuclear membrane / nucleus (with nuclear membrane shown double with pores);
 ribosomes (free or attached to ER);
 endoplasmic reticulum / ER;
 plasma / cell membrane (*reject if shown as double line*);
 mitochondria (shown with inner and outer membrane);
 Golgi (apparatus);
 lysosomes;

[6 max]

- (b) uses / requires energy / ATP;
 goes against concentration gradient / lower to higher concentration;
 requires a protein in the cell membrane / pump / carrier protein (*reject channel*);
 hydrolysis of ATP / $\text{ATP} \rightarrow \text{ADP} + \text{phosphate}$;
 involves a conformational change in the pump / protein / diagram to show this;

[4 max]

- (c) glucose converted to pyruvate (two molecules);
 by glycolysis;
 pyruvate enters the mitochondria;
 pyruvate converted to acetyl CoA / ethyl CoA;
 by oxidative decarboxylation / NADH and CO_2 formed;
 fatty acids / lipids converted to acetyl CoA;
 acetyl groups enter the Krebs cycle (*accept acetyl CoA*);
 FAD / NAD^+ accepts hydrogen (from respiratory substrates) to form NADH / FADH_2 ;
 FADH_2 / NADH donates electrons / hydrogen to electron transport chain (*reject donates H^+*);
 electrons release energy as they pass along the chain;
 oxygen final electron acceptor;
 production of water;
 builds up proton gradient / protons pumped across inner membrane;
 protons flow into matrix of mitochondria through ATPase;
 ATP produced;
 produces 36 / 38 ATP (per glucose);
 Accept any appropriate terminology for NAD and FAD.

[8 max]

(Plus up to [2] for quality)

5. (a) Award [1] for each of the following structures clearly drawn and labelled correctly.

petals;
sepal;
stigma;
style;
ovary;
stamen / anther and filament;
receptacle / nectary;

[6 max]

(b) xerophytes are adapted to reduced availability of water / deserts;
hydrophytes are adapted to living in / on water (*reject high rainfall*);
named example of each;

xerophytes have small leaves / no leaves / spines and hydrophytes have large (floating) leaves / finely divided (submerged) leaves (*accept suitable drawing*);
xerophytes have reduced stomata and hydrophytes have no stomata on submerged leaves / stomata on upper surface only of floating leaves;
xerophytes have a thick waxy cuticle and hydrophytes have little or no cuticle;
xerophytes have extensive / deep root systems and hydrophytes have reduced / absent roots;

xerophytes have hairs (to reflect sunlight), hydrophytes do not;
hydrophytes have tissues with airspaces, xerophytes do not;
xerophytes can be CAM / C₄, hydrophytes can not;
xerophytes have water storage tissues, hydrophytes do not;

[8 max]

(c) transported in xylem (vessels);
passive / no energy used by plants;
evaporation / transpiration causes low pressure / suction / pull;
transpiration stream / continuous column of water from roots to leaves;
water molecules are cohesive (so transmit the pull) / hydrogen bonding;
root pressure can move water up the plant;
apoplastic pathway is through cell walls;

[4 max]

(Plus up to [2] for quality)

6. (a) active immunity – production of antibodies by the organism itself;
passive immunity – acquisition of antibodies from another organism / from elsewhere;
natural immunity – immunity due to infection / acquisition from mother;
artificial immunity – due to inoculation with vaccine / antibodies / vaccination; [4]
- (b) vaccine injected into body / ingested;
containing killed / weakened pathogen / fragments of pathogen / toxins;
macrophages ingest antigen / antigen presenting cells ingest antigen;
T-helper cells bind to macrophages;
T-helper cells stimulated / activated;

antigen binds to B-cells;
activated T-helper cells then bind to B-cells;
activation of B-cells;
which divide / undergo mitosis to form clones of (plasma) cells;

B-cells / plasma cells produce antibodies;
memory cells produced;
second / booster shot sometimes given;
stimulates memory cells;
more antibodies and faster response / graph to show this;
antibodies are specific to antigen; [8 max]
- (c) motor neurones carry impulses / messages to muscle;
nerves / neurones stimulate muscles to contract;
neurones control the timing of muscle contraction;
muscles provide the force for / cause movement;
muscles are attached to bone by tendons;
bones act as levers;
joints between bones control the range of movement;
antagonistic muscles cause opposite movements; [6 max]

(Plus up to [2] for quality)

7. (a) sperm enters oviduct (fallopian tube) / sperm swims towards egg / (secondary) oocyte / ovum;
sperm attracted to egg / sperm attach to receptors in zona pellucida / chemotaxis;
acrosome reaction / release of (hydrolytic) enzymes from acrosome;
penetration of zona pellucida / jelly coat;
membranes of egg and sperm fuse / sperm (head) penetrates egg membrane;
cortical reaction / granules released to the outside of egg;
zona pellucida hardens / fertilization membrane forms to prevent polyspermy;
nucleus of secondary oocyte completes meiosis II;
fusion of nuclei / (diploid) zygote forms; [6 max]
- (b) (segregation of alleles involves) meiosis;
crossing over / chiasma formation in prophase I / meiosis (*do not allow if wrong phase of meiosis given*);
random orientation / assortment of homologues at metaphase I;
fertilization by chance / one of many male gametes;
number of different gametes is 2^n (ignoring crossing over);
genes / alleles combined from two parents; [4 max]
- (c) energy enters from (sun)light;
chloroplasts / plants / producers / autotrophs capture (sun)light;
energy flows through the trophic levels / stages in food chain;
energy transfer is (approximately) 10 % from one level to the next;
heat energy is lost through (cell) respiration;
energy loss due to material not consumed / assimilated / egested / excreted;
labelled diagram of energy pyramid;
energy passes to decomposers / detritivores / saprotrophs in dead organic matter;

nutrient cycles within ecosystem / nutrients are recycled;
example of nutrient cycle with three or more links;
nutrients absorbed by producers / plants / roots;
nutrients move through (food chain) by digestion of other organisms;
nutrients recycled from decomposition of dead organisms;
nutrients from weathering of rocks enter ecosystem;
nutrients lost by leaching / sedimentation (*e.g.* shells sinking to sea bed); [8 max]

(Plus up to [2] for quality)
