

MARKSCHEME

May 2004

BIOLOGY

Higher Level

Paper 2

*This markscheme is **confidential** and for the exclusive use of examiners in this examination session.*

*It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of IBCA.*

General Marking Instructions

After marking a sufficient number of scripts to become familiar with the markscheme and candidates' responses to all or the majority of questions, Assistant Examiners (AEs) will be contacted by their Team Leader (TL) by e-mail or telephone. The purpose of this contact is to discuss the standard of marking, the interpretation of the markscheme and any difficulties with particular questions. It may be necessary to review your initial marking after contacting your TL.

DO NOT BEGIN THE FINAL MARKING OF YOUR SCRIPTS IN RED INK UNTIL YOU RECEIVE NOTIFICATION THAT THE MARKSCHEME IS FINALIZED. *You will be informed by e-mail, fax or post of modifications to the markscheme and should receive these about one week after the date of the examination. If you have not received them within 10 days you should contact your Team Leader by telephone. Make an allowance for any difference in time zone before calling. AEs WHO DO NOT COMPLY WITH THESE INSTRUCTIONS MAY NOT BE INVITED TO MARK IN FUTURE SESSIONS.*

You should contact the TL whose name appears on your "Allocation of Schools listing" sheet.

Note:

Please use a personal courier service when sending sample materials to TLs unless postal services can be guaranteed. Record the costs on your examiner claim form.

1. Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.
2. Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.
3. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation in the **left hand margin** to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking.
4. Unexplained symbols or personal codes / notations on their own are unacceptable.
5. Record subtotals (where applicable) in the right-hand margin against the part of the answer to which they refer (next to the mark allocation for Section A). Do **not** circle sub-totals. **Circle the total mark for the question in the right-hand margin opposite the last line of the answer.**
6. For Section B, show a mark for each part question (a), (b), *etc.*
7. Where an answer to a part question is worth no marks, put a zero in the right-hand margin.
8. Section A: Add together the total for each question and write it in the Examiner column on the cover sheet.
Section B: Insert the total for each question in the Examiner column on the cover sheet.
Total: Add up the marks awarded and enter this in the box marked TOTAL in the Examiner column on the cover sheet.
9. After entering the marks on the cover sheet, check your addition to ensure that you have not made an error. Check also that you have transferred the marks correctly to the cover sheet. **We have script checking and a note of all clerical errors may be given in feedback to examiners.**
10. Every page and every question must have an indication that you have marked it. Do this by **writing your initials** on each page where you have made no other mark.
11. If a candidate has attempted more than the required number of questions, mark only the required number in the order in which they are presented in the paper, **unless the candidate has indicated on the cover sheet the questions to be marked.**
12. A candidate can be penalized if he/she clearly contradicts him/herself within an answer. Make a comment to this effect in the left hand margin.

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:

- ◆ Each marking point has a separate line and the end is signified by means of a semicolon (;).
- ◆ An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- ◆ Words in (...) in the markscheme are not necessary to gain the mark.
- ◆ The order of points does not have to be as written (unless stated otherwise).
- ◆ 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.
- ◆ 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.
- ◆ Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
- ◆ 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.
- ◆ 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.
- ◆ 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

- ♦ 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.
- ♦ **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.

- ♦ 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 the two points 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) darkness increases with age / positive correlation [1]
- (b) both increase with age (initially);
length increases faster (initially);
both level off (at end);
mane reaches maximum length before it reaches darkest colour; [2 max]
- (c) great number of data points / overlapping points;
there is much variation in the data (at all ages) / many outliers;
use of arbitrary units; [1 max]
- (d) $20.5(0)^{\circ}\text{C} (\pm 0.1)$ (*units required*) [1]
- (e) a darker mane absorbs more sunlight/heat making the lion warmer;
dark-maned lions are more conspicuous (in dry vegetation) / less camouflaged;
dark-maned lions need less food/energy to stay warm when temperature is higher;
*Reject answers suggesting dark manes **attract** heat.* [1 max]
- (f) at lower temperatures ($< 21.25^{\circ}\text{C}$) males feed more (than females);
at higher temperatures ($> 21.75^{\circ}\text{C}$) females feed more (than males);
the higher the temperature the less food males eat;
females eat slightly more food at higher temperatures / temperature has little effect;
males and females eat the same amount at $21.5(0)^{\circ}\text{C} (\pm 0.1)$;
*Reject answers referring **only** to abdominal size.* [2 max]
- (g) males (more than females);
dark-maned (males more than light-maned males);
light-maned males same as females;
older males (more than younger); [3 max]
dark $4.3(\pm 0.1)$ versus light $2.5(\pm 0.1)$ / male $3.8 (\pm 0.1)$ versus female $2.3 (\pm 0.1)$;
Accept ranges shown by error bars instead of means.
- (h) dark and long-maned; [1]
- (i) males approach light and short-maned lions;
light/short-maned may be weaker/less threatening/converse;
light/short-maned may be smaller/younger/not sexually mature/converse;
light/short-maned lions mistaken for females; [3 max]
- (j) *Advantages: [1 max]*
protects the neck / signals strength / sexual maturity / dominance / attractive to females / appears longer;
Disadvantages: [1 max]
overheating / makes lion more visible to prey / restricts field of vision / harbours parasites; [2 max]
Reject disadvantages of small manes. Mark first advantage and first disadvantage only.

2. (a) small cells have larger ratio (than larger cells) / ratio decreases as size increases;
surface area/membrane must be large enough to absorb nutrients/oxygen/substances needed;
surface area/membrane must be large enough to excrete/pass out waste products;
need for materials is determined by (cell) volume;
cell size is limited (by $\frac{SA}{vol}$ ratio) / cells divide when they reach a certain size;
reference to diffusion across/through membrane/surface area; **[3 max]**

(b) Award **[1 max]** for each organelle. Mark first answer only.

- (i) translation / produces polypeptides / proteins / protein synthesis;
- (ii) support of ribosomes / site of protein synthesis / synthesis of proteins for secretion / folding of polypeptides;
- (iii) produces glycoproteins / processing of proteins / forms lysosomes / formation of vesicles (for exocytosis); **[3 max]**

(c) Award **[1]** for each of the following pairs. Mark first answer only in boxes 1, 2 and 3.

<i>prokaryotic cells</i>		<i>eukaryotic cells</i>	
nucleoid / no nucleus / nuclear membrane	vs.	nucleus / nuclear membrane;	
naked DNA / no histones	vs.	DNA associated with protein / histone;	
no mitochondria	vs.	mitochondria present;	
no Golgi / no ER	vs.	Golgi / ER present;	
circular DNA	vs.	linear DNA;	
no/very few membrane-bound organelles	vs.	membrane-bound organelles;	
ribosomes smaller / 70S	vs.	ribosomes larger / 80S;	
no mitosis / meiosis	vs.	mitosis / meiosis;	
flagella lack internal microtubules	vs.	flagella have microtubules (9+2);	[3 max]

Allow **[1]** only for a similarity.

3. (a) more than one codon/base triplet codes for an amino acid **[1]**
- (b) may lead to an understanding of genetic/inherited diseases/conditions;
may lead to the production of gene probes to detect carriers of genetic diseases;
may lead to the production of pharmaceuticals based on DNA sequences;
study of similarities/differences between human race/population;
find location of genes / produce a complete gene map;
study of human origins / migration / relationships with other species; **[2 max]**
- (c) reverse transcriptase catalyzes the production of DNA from RNA **[1]**
- (d) *Award [1 max] for use in diagnosis and [1 max] for use in treatment.*
diagnosis:
detection of (antibodies to) HIV;
detection of HCG / pregnancy test kits;
detection of cardiac enzyme in suspected heart attacks;
detection of tissue / blood type;
testing for (different strains of) malaria;
ELISA tests;
- treatment:*
targeting cancer cells with attached drugs;
treatment of rabies / Ebola / lymphoma;
destroying T-cells to reduce rejection of transplants; **[2 max]**

SECTION B

4. (a) active site of enzyme binds to specific substrate;
shape of the active site and substrate fit/complement each other;
lock and key model;
chemical properties of substrate and enzyme attract / opposite charges;
enzyme/active site is not rigid and substrate can induce slight changes in shape;
allows substrates of similar structure to bind with same enzyme;
induced fit;
causes weakening of bonds in substrate to lower activation energy; **[5 max]**

- (b) allosteric enzyme has binding site(s) away from/other than the active site;
(shape of an) allosteric enzyme alternates between active and inactive (form);
non-competitive inhibitor binds to allosteric site/away from active site;
non-competitive inhibitor changes shape of active site;
non-competitive inhibitors do not compete with substrate for the active site;
end-product can inhibit enzyme needed for early/first step in metabolic pathway;
negative feedback since increased level of product decreases rate of its own production;
metabolic pathway regulated according to the requirement for its end-product;
idea that inhibition is reversible; **[8 max]**
Award [1] for named enzyme and [1] for its non-competitive/end-product inhibitor.

- (c) *Award [1] for each of the following pairs up to [3 max].*

<i>fibrous</i>		<i>globular</i>
repetitive amino-acid sequences	vs.	irregular amino acid sequences;
long and narrow / long strands	vs.	rounded / spherical/ball shaped;
support / structural functions	vs.	metabolic / other functions;
(mostly) insoluble in water	vs.	(mostly) soluble in water;

Award [1 max] for example of fibrous proteins.

collagen;
myosin;
(α)-keratin;
fibroin / elastin / silk protein in insects and spiders;

Reject fibrinogen.

Award [1 max] for example of globular proteins.

catalyses / other named enzyme;
hemoglobin / myoglobin;
insulin / other peptide hormone;
immunoglobulin / other globular protein;

[5 max]

*Reject examples of fibrous and globular proteins apart from the **first** named examples.*

(Plus up to [2] for quality)

5. (a) Award [1] for any two of the following up to [2 max].

helicase;
DNA polymerase / DNA polymerase III;
RNA primase;
DNA polymerase I;
(DNA) ligase;

[2 max]

Award [1] for one function for each of the named enzymes.

helicase:

splits / breaks hydrogen bonds / uncoils DNA / unwinds DNA;

(DNA) polymerase III:

adds nucleotides (in 5' to 3' direction) / proof reads DNA;

(RNA) primase:

synthesizes a short RNA primer (which is later removed) on DNA;

(DNA) polymerase I:

replaces RNA primer with DNA;

(DNA) ligase:

joins Okazaki fragments / fragments on lagging strand / makes sugar-phosphate bonds between fragments;

[4 max]

- (b) differentiation is development in different/specific ways;
cells carry out specialized functions / become specialized;
example of a differentiated cell in a multicellular organism;
cells have all genes / could develop in any way;
some genes are switched on / expressed but not others;
position / hormones / cell to cell signals / chemicals determine how a cell develops;
a group of differentiated cells is a tissue;

[4 max]

- (c) homologous chromosomes form tetrads / bivalents/pairs / undergo synapsis;
crossing over;
during prophase I;
exchange of DNA/genes/alleles between (non-sister) chromatids / chromosomes;
description / diagram of chiasma;
new combinations of maternal and paternal genes / alleles / DNA;
bivalents/homologous chromosomes orient/align themselves on equator randomly;
during metaphase I;
orientation of one homologous pair of chromosomes is independent of others;
homologous chromosomes separate/move to opposite poles;
independent assortment(of unlinked genes);
leads to $2^n / 2^{23}$ possible gametes (without crossing over);
additional variation when chromatids separate in second division;

[8 max]

(Plus up to [2] for quality)

6. (a) *Answers must refer to both fish and birds for full marks, if not award [2 max].*
locomotion is movement from one place to another;
muscles provide force for movement;
fish contract muscles to move their tails / side to side movement;
side to side tail movement pushes fish forwards;
fins are used for steering;
flying birds contract / use muscles to flap wings / move wings up and down;
downward wing movements generate lift;
air flow over fixed wings creates lift; **[5 max]**
- (b) *Award [1] for every two of the following structures clearly drawn and labelled correctly.*
humerus;
radius;
ulna;
cartilage (on ends of bones);
ligaments (connecting humerus with radius/ulna);
capsule (sealing joint);
synovial fluid;
biceps (attached to radius);
triceps (attached to ulna);
tendons (connecting muscle to bone correctly); **[4 max]**
- (c) muscles/fibres/myofibrils contain (repeating) units called sarcomeres;
muscle/sarcomeres contain actin filaments and myosin filaments;
actin fibres are thin and myosin fibres are thick;
arriving action potential causes release of Ca^{2+} ;
from sarcoplasmic/endoplasmic reticulum;
 Ca^{2+} binds to troponin;
causing troponin and tropomyosin to move (on actin);
exposing binding sites on actin / for myosin;
ATP binds to myosin heads releasing them / breaking cross bridges;
ATP hydrolysed / split into $\text{ADP} + \text{P}_i$;
ATP/energy causes myosin heads to change shape / swivel / become cocked;
myosin heads bind / form cross-bridges to (exposed) actin binding sites;
myosin heads swivel / move actin (releasing $\text{ADP} + \text{P}_i$);
myosin filaments move actin filaments towards centre of sarcomere;
sliding of filaments / actin and myosin shortens the sarcomere; **[9 max]**

(Plus up to [2] for quality)

7. (a) light-independent reaction fixes CO_2 ;
to make glycerate 3-phosphate;
glycerate 3-phosphate / GP / phosphoglyceric acid becomes reduced;
to triose phosphate / phosphoglyceraldehyde / glyceraldehyde 3-phosphate;
using NADPH;
using ATP;
ATP needed to regenerate RuBP;
ATP is made in light-dependent reactions;
light causes photoactivation / excitation of electrons;
flow of electrons causes pumping of protons into thylakoid;
ATP formation when protons pass back across thylakoid membrane;
electrons are passed to NADP/NADP^+ ;
NADPH produced in the light dependent reactions;

[8 max]

- (b) *light*:
rate of photosynthesis increases as light intensity increases;
photosynthetic rate reaches plateau at high light levels;

CO_2 :

- photosynthetic rate rises as CO_2 concentration rises;
up to a maximum when rate levels off;

temperature:

- rate of photosynthesis increases with increase in temperature;
up to optimal level / maximum;
high temperatures reduce the rate of photosynthesis;

*Some of the above points may be achieved by means of **annotated** diagrams or graphs.*

[6 max]

(c) *Award up to [2 max] for the difference between the plants.*

xerophytes:

adapted to arid / dry climates / deserts;

hydrophytes:

adapted to grow submerged in water / floating on water;

Reject “grows in wet areas” or “needs lots of water”.

Award [1] for any one of the following structural adaptations in xerophytes.

small thick leaves / spines / water storage in leaves;

thick waxy cuticle;

thick stems / water storage in stems;

stomata concentrated on lower epidermis;

stomata in pits / surrounded by hairs;

deep roots / wide-spreading shallow roots;

Award [1] for any one of the following structural adaptations in hydrophytes.

air spaces in leaves/stems;

wax cuticle on upper epidermis but not on lower epidermis;

stomata on upper epidermis but not on lower epidermis;

“breathing” roots / reduced roots;

pliable parts with little strengthening tissue;

finely divided submerged leaves;

[4 max]

(Plus up to [2] for quality)
