



# **MARKSCHEME**

**May 2012**

**BIOLOGY**

**Standard Level**

**Paper 3**

*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 IB Assessment Centre.*

## General Marking Instructions

*Assistant Examiners (AEs) will be contacted by their team leader (TL) through Scoris™, by e-mail or telephone – if through Scoris™ or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through Scoris™ or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of Scoris™, please contact [emarking@ibo.org](mailto:emarking@ibo.org).*

If you have any queries on **administration** please contact:

Risha Ali  
Subject Operations  
IB Assessment Centre  
Peterson House  
Malthouse Avenue  
Cardiff Gate  
Cardiff CF23 8GL  
GREAT BRITAIN

Tel: + (44) 29 2054 7777

Fax: + (44) 29 2054 7778

E-mail: [risha.ali@ibo.org](mailto:risha.ali@ibo.org)

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.
2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.
3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**
4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases use Scoris™ annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.
5. Personal codes/notations are unacceptable.
6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, enter a zero in the mark panel on the right-hand side of the screen. Where an answer to a part question is worth no marks because the candidate has not attempted the part question, enter an “NR” in the mark panel on the right-hand side of the screen.
7. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers. Scoris™ will only award the highest mark or marks in line with the rubric.
8. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp “seen” on any page that contains no other annotation.
9. Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have got wrong. However, a mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the “CON” stamp.

## Subject Details: Biology SL Paper 3 Markscheme

### Mark Allocation

Candidates are required to answer questions from **TWO** of the Options [**2 × 18 marks**].  
Maximum total = [**36 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.
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 **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. When marking indicate this by adding **ECF** (error carried forward) on the script.
10. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

**Option A — Human nutrition and health**

- A1.** (a) 42 g (*accept answers in the range of 41 g to 43 g*) [1]
- (b) chewing reduces loss of energy in feces/quotes data { (*accept analysis made quoting correctly;* }  
 { *numerical data* }  
 increasing from 10 to 25 chews gives larger reduction than 25 to 40 chews / *OWTTE*; [2]
- (c) a. more chewing releases more lipids (for absorption);  
 b. chewing breaks cell walls/increases surface area (for digestion); [1 max]
- (d) a. lots of chewing could result in weight gain because less energy/lipids lost;  
 b. nuts are only a part of a person's diet / depends on how many nuts are eaten;  
 c. despite possible weight gain, nut lipids are good for the cardiovascular system / *OWTTE*;  
 d. data restricted to chewing / no data given about sense of fullness after eating nuts;  
 e. eating nuts may satisfy hunger/lead to greater sense of fullness sooner than eating other food;  
 f. small sample size in study; [3 max]
- A2.** (a) a. number of carbons (in the chain/length of chain);  
 b. number of double bonds (in the chain) / may be monounsaturated/polyunsaturated;  
 c. *cis/trans* structure in unsaturated fatty acids / *OWTTE*;  
 d. location of double bonds;  
 e. counting inwards from opposite end of COOH group/omega 3/omega 7; [2 max]
- (b) a. (bulk) may help regulate digestive process/peristalsis/prevent constipation;  
 b. may lower risk of colon/intestinal cancer/appendicitis/diabetes/cardiovascular disease;  
 c. may decrease hunger (helping with control of food intake); [1 max]
- (c) a. quick drop in weight (through loss of body fluids);  
 b. important for children/pregnant/breastfeeding women;  
 c. loss of calcium ions in urine / possible risk of osteoporosis;  
 d. unbalanced diet / lack of essential nutrients;  
 e. *e.g.* essential vitamins/minerals/fibre;  
 f. possible rise in blood pressure;  
 g. release of ketones into bloodstream/ketosis (causing loss of appetite);  
 h. possible risk of kidney/liver disorders/stones/reduced functioning;  
 i. gout; [3 max]

- A3.** (a) a. (healthy) mother's milk is more nutritious than infant formula;  
b. easier to digest/nutrients more easily absorbed from mother's milk;  
c. mother's milk has more lactose than cows' milk (important for energy in infant);  
d. mother's milk has more cholesterol than cows' milk (important for building new cell membranes in infant);  
e. infant receives immunities/antibodies/hormones from mother;  
f. infant can avoid developing allergy to cows' milk/soy protein;  
g. naturally sterile, so safer in areas where sterilizing water is not possible;  
h. infant-mother bonding is improved;

[2 max]

- (b) *To award [3 max], response must include both pro and con arguments.*

*pro arguments:*

- a. jobs depend on meat/eggs/milk/honey production;  
b. animal products may be used for other purposes with example (*e.g.* leather for shoes);  
c. supplies nutrients/named nutrient found only in meat (*e.g.* vitamin B12);

*con arguments:*

- d. immorality of killing animals/religious belief;  
e. cruelty to animals during their life;  
f. pollution caused by livestock farming;  
g. smaller number of people that can be supported by given area of farmland/  
energy loss due to extra trophic level;

[3 max]

**Option B — Physiology of exercise**

- B1.** (a) contractive force drops [1]
- (b) 90 mins (*units required*) [1]
- (c) 76% (*units required*) (*accept answer in the range of 73% to 79%*) [1]
- (d) to compare effect of adding lactic acid to samples with no lactic acid [1]
- (e) a. lactic acid does not fatigue muscle during exercise;  
 b. lactic acid helps muscle recover ability to contract;  
 c. lactic acid increases contractive force (of muscles);  
 d. increased  $K^+$  accumulation in muscles causes muscle fatigue;  
 e. lactic acid counteracts effect of  $K^+$  in muscle; [3 max]
- B2.** (a) *Award [1] for any two of the following correctly identified.*  
 a. I. myosin head/filament;  
 b. II. actin filament;  
 c. III. dark band/A band;  
 d. IV. Z line; [2 max]
- (b) a. move more air into/out of the lungs per minute;  
 b. increase concentration gradients between air in alveoli and blood;  
 c. increase rate of absorption of oxygen/removal of carbon dioxide;  
 d. muscles need more oxygen (for cell respiration) during exercise; [2 max]
- (c) a. cardiac output is volume of blood pumped out by the heart per minute;  
 b. increased blood  $CO_2$  concentration/lowers blood pH;  
 c. (triggers neuron to) brain to accelerate heart rate;  
 d. contracting muscles squeeze veins increasing blood flow to heart;  
 e. greater volume of blood returning to heart increases stroke volume of heart; [2 max]
- B3.** (a) a. helps muscle cells to produce ATP;  
 b. useful during exercise involving intense bursts of energy (sprinting/lifting/wrestling);  
 c. studies on creatine phosphate value to athletes are inconclusive;  
 d. ingestion of creatine phosphate causes problems that impair performance;  
 e. *e.g.* high blood pressure/dizziness/muscle cramps/nausea/diarrhoea/water retention;  
 f. only effective in athletes with naturally low concentrations (most people already have enough, since muscles can maintain a small amount);  
 g. endurance, involving aerobic respiration, is not increased; [4 max]
- (b) a sprain is an injury to a ligament (that connects bones) whereas a torn muscle is an injury to muscle fibres [1]



**Option C — Cells and energy**

- C1.** (a) as temperature rises, (Rubisco) activity rises / direct correlation/proportional [1]
- (b)  $\frac{2.65 - 0.63 \times 100\%}{2.65} = 76\%$  (accept answer in the range of 73% to 79%) [1]
- (c) Rubisco [1]
- (d) a. as an enzyme activase is a protein;  
 b. 42 °C is the optimal temperature (for activase);  
 c. activity is decreased because the protein denatures;  
 d. denaturation changes enzyme/active site shape reducing catalytic activity; [2 max]
- (e) a. initial increase in photosynthesis rate up to 42 °C ;  
 b. decrease in photosynthesis rate after 42 °C ;  
 c. reduced activity of activase lowers the activation of Rubisco;  
 d. less Rubisco activity means less fixation of carbon (dioxide); [2 max]
- C2.** (a) the linking together of two or more polypeptides to form a protein [1]
- (b) a. polar and non-polar amino acids help determine protein structure;  
 b. polar amino acids on the outside of proteins make them soluble in water;  
 c. polar amino acids in channels in membranes allow passage of polar substances/  
 reference to surface proteins or membranes;  
 d. polarity *or* non-polarity of surface amino acids on proteins determines their  
 interaction with other molecules (substrates, hormones, signalling molecules); [2 max]
- (c) a. inhibitor molecule attaches to enzyme at site away from active site/attaches to  
 allosteric site;  
 b. binding of inhibitor molecule alters shape of active site/causes conformational  
 change;  
 c. shape change in active site disables enzyme from accepting substrate/reduces  
 enzyme activity/destroys enzyme functionality;  
 d. increasing substrate concentration has no effect on the inhibitor;  
 e. irreversible; [2 max]

**C3.** (a) Award [1] for any two of the following correctly identified.

- a. I. matrix;
- b. II. inner membrane;
- c. III. cristae / intermembrane space;
- d. IV. outer membrane;

[2 max]

- (b)
- a. electrons are passed along electron transport system (on inner membrane of mitochondria);
  - b. energy is released as electrons move from one carrier to next;
  - c. carrier is oxidized as it loses an electron to the next carrier, which becomes reduced;
  - d. energy released during electron transport causes proton pumping;
  - e.  $H^+$  pumped against concentration gradient from matrix to intermembrane space;
  - f.  $H^+$  moves down concentration gradient back through inner membrane/ATP synthase;
  - g. passage of  $H^+$  through ATP synthase causes phosphorylation of ADP/production of ATP;

[4 max]

**Option D — Evolution**

- D1.** (a) Limenitidinae [1]
- (b) Limenitidinae [1]
- (c) large wing size / camouflage/cryptic coloration / warning coloration / mimicry / powerful wing muscles / high flight speed / erratic flight pattern / *OWTTE* [1]
- (d) (i) a. natural selection favours survival of better-adapted individuals;  
 b. better-adapted butterflies have greater ability to escape predation;  
 c. and survive to reproduce;  
 d. allowing them to pass their characteristics/alleles/genes to offspring;  
 e. over generations, the number of butterflies with best-escaping ability increases in the population / frequency of alleles/genes for better escaping ability increases in the population/gene pool; [3 max]
- (ii) a. palatable butterflies with high escaping ability can survive to pass on genes / palatable butterflies with low escaping ability are eaten and their genes are lost;  
 b. unpalatable/distasteful butterflies, regardless of escaping ability, are not eaten/are avoided by predators;  
 c. such butterflies survive to pass on their genes to the next generation; [2 max]
- D2.** (a) introduced organic compounds/water of extraterrestrial origin [1]
- (b) a. deep-sea hydrothermal vents;  
 b. release plumes of water rich in nutrients/minerals;  
 c. supply energy sources/heat/inorganic chemicals for molecule assembly; [2 max]
- (c) relative frequencies of alleles in a population change over successive generations [1]
- (d) convergent evolution is when unrelated organisms develop similar characteristics; divergent evolution is adaptive radiation/when related organisms become adapted in different ways; [2]
- D3.** (a) the time it takes for a radioactive isotope to lose one half of its original radioactivity / *OWTTE* [1]
- (b) a. many gaps in the fossil record contribute to uncertainty;  
 b. existing fossils are tiny representation of previous life on Earth;  
 c. most fossils are incomplete so entire structure must be postulated;  
 d. some fossils are not genuine so they can obscure the truth;  
 e. fossils can represent different stages of life, not always adulthood;  
 f. difficulty in determining the age of fossil;  
 g. a limited fossil record is analogous to a small data set which can lead to broad speculation with a variety of hypotheses; [3 max]

**Option E — Neurobiology and behaviour**

- E1.** (a) first spawn/spawning [1]
- (b) a. frequency at full moon/E about the same;  
b. both arrival (event) and amplexus (event) have low/similar frequencies in B and C;  
c. highest frequency for arrival (event) in D whereas highest frequency for amplexus (event) in F;  
d. always some arrivals but amplexus (event) only in B to F / no amplexus (event) in G/H/A; [2 max]
- (c) a. mass arrival (events) at phases D and E is followed by large amplexus (events) at phases E and F;  
b. full moon/lunar cycle seems to influence timing of both events (in sequence) / *OWTTE*; [1 max]
- (d) a. it is innate as it is a response to the lunar cycle;  
b. it is innate as it occurs in more than one location;  
c. there is no evidence of experience that leads to learned behaviour; [1 max]
- (e) a. example of environmental condition;  
b. reason for the example; [2]
- e.g.:*  
a. rainfall;  
b. necessary to maintain pond levels to enable the toads to spawn;  
a. temperature / season / daylength;  
b. affects metabolism / survival of offspring;
- E2.** (a) a change in the environment (internal/external) that is detected by a receptor and elicits a response [1]
- (b) receptor > sensory neuron > relay/inter neuron > motor neuron > effector [2 max]  
*Award [1] for any four components of a spinal reflex and [1] for correct sequence.*
- (c) *Award [1] for any two of the following correctly identified.*  
a. I. pinna;  
b. II. bones of the middle ear/ossicles/malleus, incus and stapes;  
c. III. auditory nerve;  
d. IV. cochlea; [2 max]
- (d) a. bone/ossicle/stapes contacts oval window of cochlea;  
b. ossicle vibrations are transmitted to cochlear fluid via the oval window;  
c. cochlear fluid vibrations cause movement of (basilar) membrane (in precise areas);  
d. movement depends on membrane width and thickness in specific area;  
e. movement causes shearing motion of hair bundles projecting from hair cells attached to membrane;  
f. stimulated hair cells generate action potential that arrive in the brain via auditory nerve; [3 max]

- E3.**
- a. bird born with innate knowledge of (basic) song;
  - b. song birds have sensitive period during which they can learn a song;
  - c. must listen to tutor song;
  - d. birds are selective in what song they learn / not any song can be learned;
  - e. song must match some innate knowledge of song that bird is born with/inherited;
  - f. practice singing (subsong) precedes full song;
  - g. song, once learned, is rarely modified;

*[3 max]*

**Option F — Microbes and biotechnology**

**F1.** (a)  $17 \text{ g dm}^{-3}$  (accept answers in the range of  $16.5 \text{ g dm}^{-3}$  and  $17.5 \text{ g dm}^{-3}$ ) [1]

- (b) a. concentration of xylose continues to increase while arabinose stays (approximately) constant;  
 b. concentration of xylose is always greater (than arabinose);  
 c. xylose concentration (appears to) stabilize at 50 hours while arabinose decreases slightly; [2 max]

*Do not accept answers stating numerical values alone.*

- (c) glucose decreases/is used up due to fermentation/anaerobic respiration (by yeast);  
 xylose increases due to (continued) hydrolysis/production;  
 xylose not fermented by yeast / apparently yeast enzymes do not ferment 5-carbon sugars; [3]

*Do not accept xylose increasing due to breakdown of glucose.*

- (d) widely available / relatively inexpensive / waste product of food production / non-competitive with food applications / sustainable / renewable [1]

- F2.** (a) a. studies of (base sequences of) rRNA provided evidence for three domain classification;  
 b. differences in cell walls / Archaea and Eukaryotes have no peptidoglycan in cell wall, Eubacteria do have peptidoglycan in cell wall;  
 c. differences in membrane bonding compared to Eubacteria and Eukaryotes / Archaea have ether bonds in lipid membranes whereas others do not;  
 d. presence or absence of histone proteins / histone proteins present in all Eukaryotes, present in some Archaea, none in Eubacteria; [2 max]

(b) Award [1] for any two organisms correctly listed.

<i>Organism</i>	<i>Flagellum</i>	<i>Cilia</i>	<i>Cell wall</i>	<i>Chloroplasts</i>	<i>Pseudopodia</i>
<i>Amoeba</i>					✓
<i>Saccharomyces</i> ;			✓		
<i>Chlorella</i> ;			✓	✓	
<i>Paramecium</i> ;		✓			
<i>Euglena</i> ;	✓			✓	

[2 max]

- (c) (i) nitrogen fixation / changes (free) nitrogen to ammonia [1]

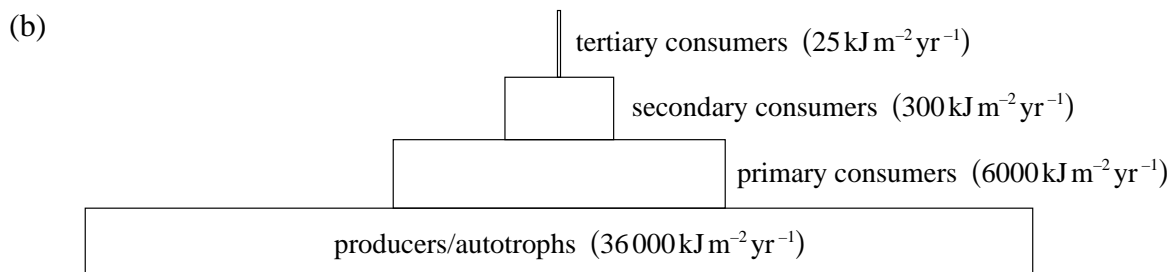
- (ii) alcoholic fermentation of sugars / convert glucose to alcohol and CO<sub>2</sub> [1]

- F3.** (a) a. catalyses production of DNA (copy DNA/cDNA) from mRNA;  
b. copy DNA/cDNA is single stranded;  
c. contains only exons / excludes introns; *[2 max]*
- (b) a. organic matter/manure/waste/agricultural material/seaweed used;  
b. bacteria in digester transform biomass/raw material;  
c. anaerobic conditions / constant temperature / neutral pH in the digester;  
d. bacteria convert organic material to organic acids/alcohol;  
e. other bacteria convert organic acids/alcohols into acetate;  
f. methanogenic bacteria convert acetate to methane; *[3 max]*

**Option G — Ecology and conservation**

- G1.** (a) (i) *P. ferrugineus* [1]  
(ii) *A. chiapensis* [1]  
(b) 64% (no working required) (accept answers in the range of 63% to 65%) [1]  
(c) (i) more (extrafloral nectar for) food / thorns for protection/habitat [1]  
(ii) more protection from herbivores/parasitic ants [1]  
(d) a. mutualistic and parasitic species compete/are in competition / more mutualistic means fewer parasitic/inverse relationship;  
b. mutualistic species more successful/have a greater presence than parasitic species on the *Acacia* species with more thorns and extrafloral nectar;  
c. parasitic species most common on the *Acacia* species with fewer thorns and extrafloral nectar (particularly on *A. chiapensis*); [2 max]  
Do not accept answers stating numerical values alone.

- G2.** (a) a. predation;  
b. competition;  
c. disease;  
d. food supply; [2 max]



- bars of decreasing size going upwards at least a third of the bar below;  
the trophic level on each bar labelled correctly; [2]  
(c) a biome is a type of ecosystem / *OWTTE*;  
the biosphere is all the world's biomes/ecosystems; [2]



- G3.** (a) a. remains/debris/litter from growth/death of plants can increase soil depth;  
b. remains/debris/litter from growth/death of plants can increase soil mineral content;  
c. remains/debris/litter from growth/death of plants can alter soil pH;  
d. remains/debris/litter from growth/death of plants can improve soil water retention and reduce drainage;  
e. growth of (larger) plants can reduce erosion through binding action of roots; **[3 max]**
- (b) example of invasive species and an example of its biological control **[1]**  
*e.g.:*  
prickly pear cactus is controlled by moth (*Cactoblastis cactorum*)  
*Accept other suitable example.*
- (c) a process when chemical substances become more concentrated at each trophic level **[1]**
-