



# **MARKSCHEME**

**November 2002**

**BIOLOGY**

**Higher Level**

**Paper 3**

## Subject Details:      **Biology HL Paper 3 Markscheme**

### Mark Allocation

Candidates are required to answer **ALL** questions in each of **TWO** Options (total [20 marks]). Maximum total = [40 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.

**Option D – Evolution**

- D1.** (a) the number of South American native families decreases as;  
the number of North American immigrant families increases; [2]
- (b) competition between families diminished resources / led to extinctions;  
only the best adapted families survived;  
habitats can only support a certain number of types of organisms; [1 max]
- (c) the genera increased by 100 and  $\frac{100}{70} = 142\%$  increase (*accept 142-143 %*) [1]
- (d) family differences are greater / larger unit of classification than genus / genera are within families so they will always be fewer;  
smaller differences between genera allow for occupation of many slightly different niches;  
North American immigrant mammals can diversify more easily in South America than South American native mammals; [2 max]
- (e) fossils;  
present number of land mammals in South America; [1 max]
- D2.** (a)  $\frac{1}{2500}$  means  $q^2 = 0.0004$ ,  $q = 0.02$  and  $p = 0.98$ ;  
 $2pq = 2(0.98)(0.02) = 0.0392 = 3.9\%$  carriers (*accept 4 %*);  
*If method is correct but answer is wrong, award [1].* [2 max]
- (b) gene pool will change / evolution will occur;  
allele frequency will change / genotype frequency will change; [1 max]

- D3.** (a) during metaphase I pairs of homologous chromosomes form tetrads;  
chromosomes are combinations of alleles;  
50:50 chance for which side of equator each homologous chromosome will locate;  
process called independent assortment;  
results in recombination of alleles from homologous chromosomes;  
probability for a particular gamete is  $(1/2)^n$  ( $n$  = number of chromosomes);  
probability further reduced by crossing over during tetrad formation / crossing over produces more variation;  
fertilisation results in recombination of alleles from different gametes / e.g. of a cross showing allele combination;  
probability for a particular individual offspring is the product of the probability for each gamete;  
lower probability for a particular individual (unique combination of alleles) means greater variety of offspring;  
offspring have different combinations from their parents;

[7 max]

- (b) *Other answers may be acceptable.*  
long period of parental care (neoteny);  
development of speech / language;  
more social organisation;  
use of tools / technology;  
greater manual dexterity;  
hunting for meat / migration to colder climates;  
use of fire;

[3 max]

**Option E – Neurobiology and behaviour**

**E1. (a)** autonomic system consists of sympathetic and parasympathetic control;  
sympathetic and parasympathetic control are antagonistic systems;  
sympathetic control promotes fight or flight response / increases energy use;  
sympathetic control accelerates heart rate;  
and increases stroke volume;  
sympathetic control inhibits release of saliva;  
parasympathetic control promotes restoration / rebuilding / conservation of energy;  
parasympathetic control reduces heart rate;  
and reduces stroke volume;  
parasympathetic control promotes release of saliva;  
neurotransmitters are acetylcholine for parasympathetic and noradrenaline for sympathetic;

*[6 max]*

**(b)** experiences may cause structural changes in neurons;  
when neural stimulus releases neurotransmitters;  
which attach to receptors of postsynaptic cell;  
causing uptake of calcium ions by postsynaptic cells;  
calcium ions activate enzymes / role for calcium indicated;  
which change shape of dendrite;  
to allow more connections / more receptors;  
resulting in new “wiring” of brain / allowing easier transmission of impulse across synapse;  
experiences may also cause changes in brain biochemistry;  
when neural stimulus changes RNA in neurons;  
causing synthesis of specific memory proteins;  
storage of “memory proteins” is associated with learned behaviour;  
since protein-inhibiting drugs can destroy memory;

*[4 max]*

- E2.** (a) 20 % for each population **[1]**
- (b) population A has more (more than 2×) minnows hiding than population B;  
population A has more (almost 2×) minnows schooling than population B;  
population B has more (almost 10×) minnows feeding than population A; **[1 max]**
- (c) population A;  
because it shows more defensive behaviour than population B as the pike approaches;  
examples of defensive behaviour such as hiding, schooling and less foraging; **[2 max]**
- (d) distance to feeding patch / minnows **[1]**
- (e) *Other answers may be acceptable.*  
the risk of any one minnow of being eaten is minimized;  
a school may be quicker in evading a pike than an individual;  
a school is more likely to see the pike than an individual; **[1 max]**
- E3.** (a) an inflation / cranial reflex / prevents over-inflation;  
when stretch receptors in walls of bronchioles / alveoli;  
are stimulated because of over stretching of lung tissue at end of inflation;  
sensory impulses of reflex travel via vagus nerve to inspiratory centre / medulla  
reducing the duration of inspiration; **[2 max]**
- (b) altruistic behaviour is when one individual puts itself at risk for the survival of the rest of the immediate family or species;  
*e.g.* in some species, worker ants die in defence of their nest / individual ground squirrels may sacrifice their lives in order to warn the group of approaching predator / young adult jackels help raise parents' litter;  
selfish gene concept; **[2 max]**

**Option F – Applied plant and animal science**

- F1.** (a) 90 %  $\pm$  2 % [1]
- (b) year to year variation in climate / disease / crop failure / demand / world prices [1]
- (c) both increase;  
*per capita* increase from 1966 to about 1975 is more rapid;  
from 1975 to 1985 the *per capita* amount levels off whereas grain production continues to increase; [2 max]
- (d) the *per capita* amount has levelled off / is in decline;  
since the grain production continues to rise, there must be more people and relatively less grain; [2]
- F2.** (a) wheat species with favourable traits were identified;  
species were cross-pollinated;  
resulting hybrids with desirable traits were selected;  
one desirable trait is disease (rust) resistance which allows more wheat plants to survive for harvesting;  
another desirable trait is a semi-dwarf form which can take more fertilizer without falling over to permit easy harvesting;  
because wheat is naturally self-pollinating;  
hybrid varieties can be released to farmers so they can multiply their own seeds for future planting;  
use of genetic engineering techniques;  
*e.g.* of a trait that has been engineered into the wheat crop; [7 max]
- (b) most cereal crops are narrow-leaved and weeds are broad-leaved;  
hormone weed killers destroy broad-leaved plants because;  
hormone weed killers resemble natural auxins in plants;  
yet plant's own enzymes cannot destroy it;  
killers mimic auxins at super-optimal levels to disrupt metabolism and growth / makes broad leaf plant deformed because of excessive leaf growth; [3 max]

- F3.** (a) avoidance of (unnatural) chemical pesticides;  
avoidance of (unnatural) inorganic / chemical fertilizers;  
avoidance of (unnatural) herbicides;  
natural selective breeding instead of genetic engineering;  
crop rotation to keep soil nutrients naturally balanced; **[3 max]**
- (b) *Two techniques needed for the mark.*  
use of micropropagation and cloning;  
use of growth media;  
use of aseptic techniques;  
use of plant hormones such as auxins, kinetin and gibberellins;  
biotechnology / tissue culture / genetic engineering / greenhouses / controlled  
growing environments; **[1 max]**



**Option G – Ecology and conservation**

- G1.** (a) new medicines / materials could be found from organisms growing in the wild;  
ecotourism could provide income;  
crop plants and farm animals could be improved with alleles from wild populations;  
loss of one species could impact on other species because of interdependence;  
disruption of ecosystems could lead to soil erosion / flooding / weather pattern changes;  
disruption of water cycle / nutrient cycles;  
intrinsic value / existence value beyond usefulness to humans;  
cultural importance of species to indigenous groups;  
ensures access of future generations to the wealth of today; **[7 max]**
- (b) damages organic molecules in living organisms;  
damages genetic material / causes mutations;  
increases mortality of phytoplankton / algae in oceans;  
reduces yield among terrestrial crop plants;  
destroys nitrogen-fixing bacteria in soil;  
increases incidence of skin cancer among humans;  
depresses immune system in humans;  
causes cataracts in humans; **[3 max]**
- G2.** (a) 79 %  $\pm$  2 % **[1]**
- (b) Gulf of Mexico / Atlantic **[1]**
- (c) total number of Caribbean endemic species is greater than in the Pacific / 425 and 450;  
no Caribbean endemic species occur in great numbers / >32 compared to the Pacific / which has about 45;  
the number of Caribbean endemic species occurring in small numbers / 1-2 is more than twice that in the Pacific / about 280 and 120; **[2 max]**
- (d) the Caribbean region will have a greater extinction rate;  
because of the great number of endemic species occurring in small numbers;  
small numbers of a species are more vulnerable to extinction than high numbers;  
for Caribbean ubiquitous species the percentage of species occurring in high numbers / >32 is lower than in the Pacific; **[2 max]**
- (e) the Arctic; **[1]**
- G3.** *Rhizobium* adds nitrogen to the soil whereas *P. denitrificans* releases nitrogen from the soil;  
*Rhizobium* fixes nitrogen into nitrates / ammonia whereas *P. denitrificans* converts nitrates into nitrogen;  
*Rhizobium* lives as a symbiont in root nodules of leguminous plants whereas *Pseudomonas* lives as a free-living bacteria in water-logged soil;  
*Rhizobium* lives in aerobic conditions and *Pseudomonas* in anaerobic conditions; **[3 max]**

**Option H – Further human physiology**

- H1.** (a) 93 %  $\pm$  1 % **[1]**
- (b) (i) increases by 0.63 mmol l<sup>-1</sup> of blood / rises from 15.59 to 16.22 mmol l<sup>-1</sup> **[1]**
- (ii) dissolved CO<sub>2</sub> **[1]**
- (c) CO<sub>2</sub> makes the blood more acidic and the pH drops;  
 pH of venous blood at rest has decreased compared to arterial blood;  
 because the blood is carrying waste CO<sub>2</sub> (from cellular respiration) back to lungs  
 for removal;  
 pH of venous blood after exercise has decreased compared to arterial blood;  
 and dropped even further than venous blood at rest;  
 because the blood is carrying more waste CO<sub>2</sub> than normal due to exercise; **[3 max]**
- H2.** (a) ileum epithelial cell membranes pump sodium ions out into lumen;  
 maintains concentration gradients;  
 passive re-entry of sodium ions is accompanied by nutrients;  
 such as glucose / amino acids;  
 which pass through epithelial cells;  
 and enter capillaries; **[3 max]**
- (b) hepatic artery from aorta brings blood to liver;  
 hepatic portal vein (from gut) bring blood to the liver;  
 incoming blood flows merge in sinusoids of liver;  
 sinusoids are liver capillaries;  
 sinusoids merge to form hepatic vein;  
 hepatic vein carries blood away from liver to vena cava; **[3 max]**
- (c) *Any two of the following.*  
 amino acids, urea, bilirubin, globin, iron, haem **[1]**
- H3.** SA node fires (electrical) signal throughout walls of atria to begin cycle;  
 causing atria to undergo systole;  
 SA signal reaches atrioventricular node;  
 which spreads signal throughout (Purkinje fibres);  
 causing ventricles to undergo systole;  
 atrioventricular valves slap shut;  
 causing “lub” sound;  
 after ventricles are emptied semilunar valves close;  
 causing “dub” sound;  
 atrioventricular valves open;  
 ventricles begin diastole and start filling;  
 all four chambers are in diastole and filling;  
 when atria filled and ventricles 70 % filled cycle has ended; **[7 max]**  
*Accept bicuspid and tricuspid valves as alternatives to atrioventricular valves.*
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