UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9790 BIOLOGY

9790/03 Paper 3 (Long Answer), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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UNIVERSITY of CAMBRIDGE
International Examinations

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point **;** = separates marking points **R** = reject ( ) = words which are not essential to gain credit __ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording **A** = accept ora = or reverse argument AVP = any valid point

Section A

1 (a) (i) bone marrow **;** [1]

(ii) blood / lymph / lymph node / lymph gland / lymphatic system / spleen **;** [1]

(b) **A** = mitochondrion **;**
B = Golgi (apparatus / body) **;** **A** dictyosome [2]

(c) *structures may be identified by names or by letters*

1 DNA is transcribed into mRNA in nucleus (**E**) **;**
2 mRNA translated (into polypeptide / protein) on, ribosomes / RER **;**
3 any ref to forming, tertiary / quaternary, structure **;**
4 proteins, modified / completed / processed / glycosylated, in Golgi apparatus (**B**) **;**
5 in Golgi apparatus (**B**), proteins are packaged into vesicles (**D**) **;**
6 (protein / antibody released when) vesicles fuse with cell membrane (**C**) / exocytosis **;**
7 protein synthesis / antibody production, is an active process / requires energy **;**
8 ATP released from mitochondria (**A**) **;**
9 ref to amino acid activation **;** [max 6]

[Total: 10]

2 (a) *two of the following*

amino acid(s) / named amino acid ;
nucleic acid(s) / named nucleic acid ;
nucleotide(s) / purine(s) / pyrimidine(s) / named nucleotide / named base ;
chlorophyll ;
ATP / ADP ;
NAD(H) / NADP(H) ;
enzyme(s) / named enzyme ;
AVP ; e.g. any other named amino acid / nucleic acid / nucleotide / base
AVP ; [max 2]

(b) *description to max 3*

1 (as density increases) mean yield m^{-2} for both data sets increases to a, maximum / peak, and then decreases ;
2 comparative data quote – density and yield m^{-2} for both treatments ;
3 (at a given density) mean yield, m^{-2} / per plant, is always lower where nitrogen availability low / ora ;
4 comparative data quote – density and yield, m^{-2} / per plant, for both treatments ;
5 mean yield per plant decreases for both treatments as density increases ;
6 comparative data quote – density and yield per plant for one or both treatments ;
7 decrease in yield per plant is more significant in plots with low nitrogen ;
8 86% decrease in low availability v 73% in high / AW but must be quantitative ;
9 optimum density is higher when nitrogen availability is high (than when nitrogen availability is low) ;
10 comparative data quote – density and yield m^{-2} for both treatments ;

explanation to max 3

11 competition between plants increases as density increases ;
12 more plants per m^2 means better use of space so higher yield / AW ;
13 more leaf area to intercept light / greater root density to absorb nutrients ;
14 nitrogen availability is limiting factor as density increases ;
15 other named factor(s) are also limiting ;
e.g. light intensity, other mineral (phosphorus, magnesium, etc.), water, space
16 AVP ; *other valid suggestion for explanation*
e.g. nitrogen required for, amino acid / protein, synthesis, needed for, growth / yield
[max 5]

[Total: 7]

3 (a) *similarities*

closed circulatory systems ; **A** described as blood flows within vessels
pump / heart ;
valves in heart (to ensure one way flow) ;
(two sets of) capillaries ;
capillaries for gas exchange with, environment / AW ; [max 3]

(b) *advantages of mammalian circulatory system*

1 double circulatory system ;
2 described as pulmonary and systemic ;
3 not single as in fish / not partially double as in amphibian ;
4 two completely separate circuits with different blood pressures ;
5 low pressure circuit to oxygenate blood (in spongy / delicate tissues) ;
6 high pressure circuit to deliver oxygen to respiring tissues ;
7 higher resistance to flow in respiring tissues / AW ; *ora for lungs*
8 hence need for high pressure ; *ora for lungs*
9 separation / no mixing, of, oxygenated and deoxygenated blood ;
10 higher oxygen concentration in systemic circulation / better delivery of oxygen to tissues (than in fish or amphibian) ;
11 supports higher metabolic rate ;
12 supports endothermy ;
13 supports greater muscular activity / AW ;
14 link to greater independence from environmental conditions ;
accept in context of an example such as ambient temperatures
15 AVP ; e.g. decrease in pressure after gills in single circulation
ref to maintenance of diffusion gradients between, blood and tissues / AW

[max 7]

[Total: 10]

4 **(a)** Joules per square metre per second ; [1]

(b) 1 temperature increases, rate of photosynthesis increases and becomes constant ;
2 at 1.5% O_2 rate of photosynthesis is always higher ;
3 rate begins to level off at a lower temperature in 21% O_2 / reduction in rate caused by oxygen becomes more pronounced at high temperature ; [max 3]

(c) at light saturation light intensity ceases to be a limiting factor in affecting the rate of photosynthesis ; [1]

(d) 1 at, high / 21%, oxygen concentration ;
2 at high temperature / above about 23 °C ;
3 at high light intensity / higher than (about) 100 J $m^{-2}s^{-1}$; [3]

(e) 1 oxygen and carbon dioxide compete for the enzyme, rubisco / ribulose bisphosphate carboxylase ;
2 relative concentrations of oxygen and carbon dioxide affect the competition ;
3 the higher the oxygen concentration the less readily carbon dioxide can combine with the enzyme's active site ;
4 the higher [O_2] the lower the rate of carbon fixation ;
5 detail ; e.g. lower rate of, CO_2 combines with RuBP / RuBP converted to GP
6 at high light intensity and high temperatures there is an increase in photorespiration ;
7 (more photorespiration means that) less, GP / triose / triose phosphate, produced ;
8 at high light intensity more oxygen is produced by, photolysis / light-dependent reaction ;
9 this further increases inhibition by oxygen of the light-independent reaction ;
10 ref *A. patula,* C3 / not C4 or CAM ;
11 use of data in, Fig. 4.1 / Fig. 4.2, in support of argument ; [max 5]

[Total: 13]

[Total for Section A: 40]

Section B

5 (a) endosymbiosis ; [1]

mitochondria evolved from, bacteria / prokaryotes ;
these were aerobic ;
and invaded early eukaryotic cells giving them the benefit of, aerobiosis / AW ;
supporting evidence ;
e.g.
similar in, size / shape, to bacteria
form by division of pre-existing mitochondria
presence of circle of DNA
70S ribosomes
antibiotic sensitivity [max 2]

(b) 1 mitochondria, the site of aerobic respiration / where ATP is produced ;
2 (these substances) are enzymes involved in, (aerobic) respiration / ETC ;
3 NADH dehydrogenase involved in, re-oxidation / regeneration, of NAD ;
4 NAD is an, electron acceptor / oxidising agent ;
5 (NAD) involved in, Krebs / TCA / citric acid, cycle ;
6 cytochrome oxidase (at end of) electron transport, chain / system ;
7 genes **not** in nucleus ;
8 ref to some advantage of having genes in mitochondria ;
e.g. trafficking from cytosol to mitochondria not necessary
9 AVP ; e.g. male mitochondria destroyed [max 3]

(c) 1 new mitochondria form by, division / binary fission, (of pre-existing) mitochondria ;
2 mitochondrion originates in (cytoplasm of), ovum / oocyte (of mother) ;
3 no mitochondria from father pass into the ovum through the sperm / paternal mitochondria degenerate ; **A** only nucleus
4 muscle cell arises from (successive) division of (single) zygote ;
5 AVP ; [max 3]

(d) Y chromosome ; [1]

[Total: 10]

6 **(a)** 1 use of, PCR / polymerase chain reaction ;
2 DNA (double) strands separated by, thermal cycling / heat treatment ;
3 single strands used as, template / primer, to produce new strands ;
4 by complementary, base / nucleotide, pairing ;
5 ref to, DNA polymerase / Taq polymerase ;
6 DNA template is amplified exponentially / AW ;
7 ref to semi-conservative replication ;
8 any further detail of PCR process ;
e.g. addition of primer
9 AVP ; e.g. cloning DNA in bacteria [max 4]

(b) 1 variation only due to mutation (as little recombination) ;
2 enough mutations / appropriate rate of mutation, to act as molecular clock / AW ;
3 no recombination means no mixing of, genes / DNA, from different ancestors ;
4 there are methods to correct mutations in chromosomal DNA (not in mitochondrial DNA) ; [max 2]

(c) 1 the differences between the DNA of modern humans are much less than the differences between modern humans and Neanderthals / AW ;
2 data quote e.g. (members of the sample group of) modern humans showed approx / on average), 7 / between 6 and 8 / between 0 and 17 / 18 / 19 / 20, differences in mtDNA ;
3 the sample of Neanderthal DNA lay outside this range / Neanderthal DNA is distinctly different to that of modern humans ;
4 data quote e.g. Neanderthal DNA had an average of 26 / 25 to 27 differences to DNA of modern humans ;
5 the difference (is probably) statistically significant / carry out statistical test (to find out if statistically significant);
6 example of discontinuous distribution ;
7 the difference between, human / Neanderthal, mtDNA, and that of the chimpanzees was greater than between Neanderthals and humans ;
8 (this suggests) Neanderthals (though distinctly different) are evolutionarily closer to humans than to chimpanzees / AW ;

evaluation to max 2

9 there was only one sample of Neanderthal mtDNA available, not representative ;
10 a much larger number of Neanderthal samples of mtDNA are needed to confirm any conclusions ;
11 might have been an atypical Neanderthal ;
12 differences unlikely to be, adaptive / influenced by selection ;
13 AVP ; e.g. data from humans most valid
no Neanderthal – chimp differences [max 5]

[Total: 11]

7 **(a)** 1 were unlikely to have an effect on the person's chance of survival ;
2 therefore unlikely to be influenced by natural selection ;
3 change in triplet without changing amino acid ;
4 change in amino acid without any effect (on phenotype) / AW ; [max 2]

(b) 1 comparison of fossils ;
2 analysis of, chromosomal DNA / genome ;
3 cultural features ; e.g. ritualistic ways of burying the dead
4 whether modern humans and Neanderthals could (interbreed and) produce fertile offspring ;
5 (whether humans and Neanderthals could interbreed) would be a key piece of evidence but this is impossible to obtain ;
6 AVP ; e.g. protein sequencing / immunological comparisons / DNA hybridisation [max 2]

(c) 1 original population very small / population fell to a low level / reference to evolutionary bottle neck ;
2 natural selection intense / chances of survival low / high child mortality rates ;
3 example of causes of the above ;
lack of, food / water, resulting from climate change
overpopulation
deforestation / desertification
competition for, food / territory / resources, from Neanderthals
climate change / glaciations, leading to harsher conditions for survival
newly encountered disease
increased predation / encounter with predators not encountered before
4 Eve / Eve's clan, (might have) had adaptations (that made them more likely to survive than others) such as, intelligence / ability to cope with extreme conditions ;
5 Eve's offspring survived by chance when the other humans died / correct reference to founder effect ;
6 Eve's offspring, out-competed / killed, existing types of human ; [max 5]

[Total: 9]

[Total for Section B: 30]

Section C

Marking Strategy

Sequence of maker activities for each essay:

1 Familiarise yourself with the expected content.

2 Read through the essay.

3 Write marginal notes on script, highlight evidence of breadth, exemplification and argumentation as well as major and minor errors of fact and irrelevant material.

4 Apply the general descriptions for:
- Breadth
- Argumentation
- Communication
- Spelling, punctuation and grammar.

5 Match the content of the essay with a descriptor for Scientific Content (20, 16, 12, 8, 4, 0 as appropriate) and then decide whether:
- all sub-descriptors at that level have been met so that the full mark for that level can be awarded
- three out of the four sub-descriptors have been met so that intermediate marks can be awarded (18, 14, 10, 6, 2)
- two of the sub-descriptors at that level have been met so that the full mark for the level below can be awarded.

Marks should be written at the end of the essay as follows:
B = …
A = …
C = …
S = …
SC =…
Total = …

Breadth **Maximum 3 marks**

Mark	Descriptors
	Candidate has:
3	given a balanced account including most of the relevant topic areas and selected a wide range of facts, principles, concepts and/or examples pertinent to the title
2	given a fairly balanced account including some of the relevant topic areas and selected some of the appropriate facts, principles, concepts and/or examples pertinent to the title
1	given an account including a few of the relevant topic areas and selected a few of the appropriate facts, principles, concepts and/or examples pertinent to the title
0	given an account that relies on one topic area alone and selected a few of the appropriate facts, principles, concepts and/or examples pertinent to the title.

Argumentation **Maximum 3 marks**

Mark	Descriptors
	Candidate has:
3	developed and sustained a coherent argument throughout the essay leading to an appropriate conclusion showing insight
2	introduced an argument and partially developed it but has not sustained it coherently throughout the essay
1	shown evidence of an argument, but has not developed it successfully
0	shown no evidence of argumentation

Communication **Maximum 3 marks**

Mark	Descriptors
	Candidate has:
2	organised and presented information clearly and used correct terminology in appropriate contexts
1	not organised material very well and not used terminology appropriately so that answer has to be re-read
0	presented an unstructured answer with poor use of terminology

Spelling, punctuation and grammar **Maximum 3 marks**

Mark	Descriptors
	Candidate has:
2	used spelling, punctuation and grammar accurately
1	used spelling, punctuation and grammar accurately, but has made significant errors
0	not used spelling, punctuation and grammar accurately

Scientific Content **Maximum 20 marks**

Mark		Descriptors
		The candidate:
20	a	recalls and consistently uses all facts and principles (relevant to the essay)
	b	shows sound understanding of all principles and concepts
	c	writes accurately with no major errors, very few minor errors
	d	gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university
16	a	recalls and consistently uses most facts and principles (relevant to the essay)
	b	shows sound understanding of most principles and concepts
	c	writes accurately with no major errors, few minor errors
	d	gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university
12	a	recalls and consistently uses some facts and principles (relevant to the essay)
	b	shows sound understanding of some principles and concepts
	c	writes some material accurately with not more than one major error, some minor errors
	d	gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university
8	a	recalls some facts and principles (relevant to the essay)
	b	shows some understanding of some principles and concepts
	c	writes some material accurately with more than one major error or many minor errors
	d	gives some detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university
4	a	recalls a few facts and principles (relevant to the essay)
	b	shows limited understanding of a few principles and concepts
	c	writes material including many errors some of which may be major errors
	d	gives a little detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university
0	a	recalls no relevant facts and principles
	b	shows no understanding of relevant principles and concepts
	c	writes irrelevant material or includes many major errors
	d	gives no detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university

Expected content

For each of the questions, guidance is given as to the kind of content from the syllabus that may be appropriate to answering the question. Some candidates will include many of these areas and others may write in more detail about some of them or may include other relevant topics, in each case reflecting the candidate's reading-around the subject and personal research and other interests. Some topics in the candidate's answers may not be directly on the syllabus, but it is important to credit such responses where they are given.

The main points that may be considered as the scientific content.

Question 8

Much of the material in this essay will come from Section 5.

- Definition of sustainability
- Loss of keystone species
- Importance of genetic diversity
- Biodiversity and conserving biodiversity
- Potentially useful products from ecosystems
- Threats to human health and to agriculture
- Sustainable use of plant and animal resources

The following learning outcomes are directly relevant.
5.1 (f), (j), (k), (l), (p); 4.1 (q), (s).

Question 9

Much of the material in this essay will come from Section 2.

- Introduction that includes explanations about multicellularity, cell signalling and the endocrine system
- General principles of cell communication
- Discussion of negative feedback
- General principles of cell signalling

The following learning outcomes are directly relevant.
1.3 (a), (b), (c); 2.3 (c), (h); 2.4 (e); 2.7 (b), (l), (m), (n), (p); 4.2 (g), (i).

Question 10

Answers may draw material from across the syllabus, but are likely to dwell on the characteristics, origin and evolution of life.

- Introduction discussing fundamental characteristics of life on Earth
- Discussion of properties and characteristics of living organisms on Mars
- Discussion of properties and characteristics of extinct organisms on Mars
- Discussion of implications for origin of life on Earth
- Discussion of implications for future exploration / colonisation of other planets

The following learning outcomes are directly relevant.
1.1 (a), (b), (c), (d); 1.2 (a) to (m); 1.3 (a) to (f), (h) to (l), (s), (u), (v); 2.1 (c); 2.2 (a), (c), (d); 2.3 (a), (j); 2.4 (a); 3.1 (a) to (d); 3.2 (a) to (c), (f); 3.3 (a); 4.1 (r); 5.1 (d), (j), (m).