

**MARK SCHEME for the May/June 2012 question paper
for the guidance of teachers**

9790 BIOLOGY

9790/03

Paper 1 (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.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2012 question papers for most IGCSE, Pre-U, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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Section A

- 1 (a)**
- 1 ability to resist, toxins / venom ;
 - 2 mouth able to break crystals of silica ;
 - 3 eats animals that other predators do not eat so little interspecific competition ;
 - 4 tolerate / breakdown, toxins / venom ;
- [max 1]
- (b)**
- 1 (slow growing) must survive, 30 years / (relatively) long time, to reproduce ;
 - 2 lack of undisturbed beaches / increasing (human) disturbance of beaches ;
 - 3 loss of food species / AW ;
 - 4 eating plastic bags / tangled in fishing equipment / hunted by humans ;
 - 5 rarity increases value for poachers / easily found on beaches (which are known to be regular nest sites) by poachers / slow moving on the beach (returning to the sea) therefore vulnerable to predators *or* poachers ;
- [max 2]
- (c)**
- 1 difficulty in finding mates ;
 - 2 *idea that* difficult for / slow, population numbers to increase ;
 - 3 loss in genetic diversity / smaller gene pool ;
 - 4 any consequence; e.g. less resistance to environmental change / vulnerability of entire population to the death of a few individuals due to stochastic events / AW ;
 - 5 AVP ; e.g. rarity increases value for poachers
- [max 2]
- (d)**
- 1 location of nesting sites (for protection) ;
 - 2 mating / breeding, sites ;
 - 3 understanding of migratory habits ;
 - 4 evaluating effects of environmental change e.g. climate change on migratory patterns ;
 - 5 location of regions of high predation ;
 - 6 location of hunting regions ;
 - 7 detection of other human impacts (e.g. shipping) ;
 - 8 AVP ; first type of protection e.g. exclusion zones
 - 9 AVP ; second type of protection

[max 3]

[Total: 8]

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2 (a) transport proteins / active transport / carrier molecules / channel proteins / cell recognition proteins / receptor molecules / for cell adhesion / enzyme ; [1]

(b) (i) 1 unsaturated fatty acids are, bent / not straight ;
 2 ref to the effect of the molecule shape on how closely packed the phospholipids may be in the bilayer ;
 3 less densely packed, molecules / phospholipids / phospholipids and proteins ;
 4 move around more easily in the membrane ;
 5 appropriate reference to, hydrogen bonds / (named) intermolecular forces ; [max 3]

(b) (ii) 1 these molecules pass through by diffusion ;
 2 between the non-polar chains (of fatty acids) ;
 3 through spaces in the membrane / passing between the phospholipids / through spaces in the bilayer ;
 4 easier, less obstructed passage if the fluidity of the membrane is higher / when more / bigger spaces between the phospholipids are available ; [max 3]

(c) 1 suggests membrane is fluid / provides evidence for fluid mosaic model ;
 A 'fluid mosaic model is correct
 2 protein molecules, do not have fixed positions within the membrane or can move freely / are mobile ;
 3 shows that phospholipids of membranes of different organisms are the same ; [max 2]

[Total: 9]

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- 3 (a) (i) 1 human proteins seen as, foreign / non-self ; A pathogenic
2 act as antigens / ref epitopes ;
3 stimulates, T/B cells/lymphocytes ;

[max 2]

- (ii) 1 *idea that* chicken-human reaction, (positive) control / was the highest ; A 100% of the antibodies react / AW
2 therefore taken as 100% for comparison with the rest / AW ;
3 *idea that* (antibodies) specific for human proteins / antigens ;

[max 2]

- (b) 1 & two marks for description of relatedness e.g.
2 human more closely related to chimpanzee than baboon
chimpanzees are the most closely related to humans
dogs are not (closely) related to humans
baboons are closer to human than dogs are to humans ; ;
3 chimpanzee and human antigens are (most) similar / ora ;
4 gives strongest (immunological) response / ora ;
5 ref to (recent) common ancestor ;

6 & any further details to max 2

- 7 ref to amino acid sequence homology ;
further detail: ref to, tertiary structure / 3D shape / Ag-Ab interaction ;
further detail: e.g. relationship between amino acid sequence and gene sequence ;

[max 5]

[Total: 9]

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4 (a) Y = atrioventricular node ; R AVN
 Z = Purkinje / Purkine, fibres / tissue / bundle / bundle of His ;
[2]

(b) 1 initiates / AW, wave of excitation / (electrical) impulse ; R nerve impulse
 2 spreads across, atria / cardiac muscle ; A atria to contract
 3 impulse reaches / AW, atrioventricular node / AVN ; ecf from (a)
 4 ref to myogenic ;
 5 ensures heart beat is regular ;
 6 responds to stimuli (external to the heart) via, CNS / hormones ;
[3 max]

(c) 1 Y passes a wave (of electrical excitation) between Y and Z ;
 2 with delay ;of (approximately) 0.1 – 0.2 ms ;
 3 (delay) allows time for atria to contract before ventricles start to contract ;
 4 ensuring that the ventricles are full (before they contract) ;
[3 max]

(d) (i) $60/0.8s = 75 \text{ beats min}^{-1}$; ;
reading the appropriate values from the graph = 1 mark
correct result (even if working not shown) and units = 2 marks [2]

(ii) 1 atria not, functioning / working normally ; A atrial / heart, fibrillation
 2 ref to poor functioning of the, SAN / pacemaker / X ;
 3 ventricles not filling with blood (before contracting) ;
 4 some, control / coordination, remains (as regular QRS waves) ;
 5 very short, atrial / ventricular, contractions ; A more frequent ventricle contractions
 6 detail of likely effect on SAN ;
[4 max]

[Total: 14]

[Total for Section A: 40]

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Section B

- 5 (a)**
- 1 lack of immune response/tissue rejection ;
 - 2 no foreign, tissue / antigens ;
 - 3 no need for, immunosuppressant / AW, drugs ;
 - 4 bronchus cells can be, obtained / cultured, in large quantities ;
 - 5 healthy culture of patient's stem cells can be stored for future needs ;
 - 6 overcomes problem of finding suitable donors ;
 - 7 no need to do, tissue / blood, match ;
 - 8 fewer, ethical sourcing, issues than when using embryonic stem cells ;
 - 9 AVP ; e.g. no risk of infection in donor tissue / no need to decide who is eligible
- [max 4]
- (b)**
- 1 multipotent cells give rise to limited range of cell types ;
 - 2 totipotent cells can give rise to, whole range of cells / whole organism ;
 - 3 cannot give rise to organs ;
 - 4 totipotent = zygotic / AW ;
- ora for totipotent ;
[max 3]
- (c) any three from:**
- erythrocyte / red blood cells ;
 - granulocyte / monocyte / neutrophil / phagocyte / macrophage ;
 - lymphocyte / agranulocyte ;
 - basophil ;
 - eosinophil ;
 - megakaryocyte / thrombocyte ;
 - B cell / T cell ;
- A leucocyte if no other white blood cell given**
[max 3]
- [Total: 10]**

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- 6 (a) (i) 1 virus / viral vector ;
2 plasmids ;
3 liposomes ; R vesicle
4 microprojectiles / AW ; [max 2]
- (ii) *either two different methods, e.g. antibiotic or fluorescence or one method and how to detect cells*
1 transfer, marker / AW, gene(s) ;
2 ref to antibiotic resistant marker gene(s) ;
3 marker genes(s) coding for fluorescent protein ;
4 identify, gene / gene product ;
5 method of identifying, gene / gene product ; [max 2]
- (iii) they are promoter genes / they switch other genes on or off / they code for transcription factors ; [1]
- (c) 1 TERT plays a part in increasing the length of the telomere ;
2 telomere at the end of a chromosome ;
3 shortens after each division ;
4 overcomes end replication problem / DNA cannot replicate right to the end ;
5 (telomeres) can limit, the number of times a chromosome can replicate / number of times cell can divide ;
6 (mechanism involving) TERT counteracts this/extends chromosome ;
7 this gives the iPS cell capacity to divide repeatedly ; [max 5]

[Total: 10]

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- 7 (a) 1 in the mitochondria ;
 2 (mitochondrial DNA) from the cow / not of human origin ; [2]

(b) *unethical:*

- 1 presence of human and animal DNA means it is partly human and partly cow / a human-animal hybrid which would not happen in nature ;
- 2 claims of the benefits of embryonic stem cell research are over-rated / few (if any) examples of success in medical applications ;
- 3 dangerous precedent / thin end of the wedge argument / current applications (may be benign) but will lead to abuse in future ;
- 4 possibility of unforeseen (irreversible) consequences ;
- 5 unnecessary because, there already are / will soon be, alternative techniques (to the use of embryonic stem cells) ;
- 6 e.g. use of adult stem cells/umbilical cord cells ;

ethical:

- 1 the amount of non-human DNA is very small/negligible ;
- 2 protocol limits keeping 'embryo' to 14 days (to guard against abuse) so cannot develop into a whole organism ;
- 3 provides a more ethical alternative to the use of embryonic stem cells from humans ;
- 4 can provide many more stem cells than is possible from embryonic stem cells ;
- 5 it would be unethical *not* to use cybrids to relieve, human suffering / e.g. diseases such as Parkinson's disease ;
- 6 techniques which offer alternatives to embryonic stem cells builds on work done initially on embryonic stem cells ;
- 7 *idea that ovum* has bovine proteins which would be rejected at implantation ;

Allow other reasonable arguments on either side. If a candidate does not express an opinion, limit score to one mark unless an attempt has been made to argue that it is a finely balanced matter. Ignore references to 'playing God' and 'against religion'.

[max 3]

- (c) 1 cancer is uncontrolled cell division ;
 2 where rate of cell division exceeds rate of, cell death / apoptosis ;
 3 (leading to a) tumour – a mass of (relatively) undifferentiated cells ;
 4 *idea that* cancerous cells break off and move through blood system to other parts of the body / metastasis / where they may cause secondary tumours ;
 5 stem cells may also undergo uncontrolled cell division ;
 6 risk of developing tumour where stem cells have been implanted ;
 7 when exposed to carcinogens stem cells may become cancerous ;
 8 appropriate reference in context to oncogenes / tumour suppressor genes ;
 9 AVP ; e.g. genetic predisposition to cancer

[max 5]

[Total: 10]

[Total for Section B: 30]

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Section C

Marking Strategy

Sequence of marker 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)
 - one or 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 =

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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 2 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

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Spelling, punctuation and grammar

Maximum 2 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

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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 all of these areas and others may write in more detail about these 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 both in the candidate's answers and in the following expected content may not be directly on the syllabus, but it is important to credit such responses where they are given and thus they are included here.

Question 8

Much of the material for this essay will come from Section 3.

- The origins of chloroplasts and mitochondria according to the endosymbiotic theory.
- Changes in atmospheric content over time in relation to autotrophic nutrition including the photosynthetic origin of atmospheric oxygen.
- Photosynthesis and respiration as energy transformations.
- The evolutionary significance of these changes in relation to changes in the composition of the atmosphere.

The following learning objectives are directly relevant:

2.1 (b), 3.1 (a), (d), 3.2 (a), 3.2 (c), 3.3 (a), (d), (e), (g), (h), (i), (j).

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Question 9

Much of the material in this essay will come from Sections 2 and 4.

- Linnaeus' understanding of the species concept in a creationist context.
- The modern understanding of the species concept in an evolutionary context.
- The hierarchical nature of Linnaean classification system suggesting a phylogeny.
- The development of the Linnaean system into the modern one reflecting increased biological knowledge e.g. cladistics, comparative cell biology and biochemistry, the genetic code, palaeontology, immunology.
- Likely future development of classification e.g. increased use of amino acid and nucleotide sequencing to determine evolutionary relationships, use of fossil DNA.

The following learning objectives are directly relevant:

2.1 (f), (g), (h), 4.1 (l), (w), (x).

Question 10

Much of the material for this essay will come from Section 2.5.

- Xylem and phloem in flowering plants as mass flow systems powered by hydrostatic pressure,
 - negative in xylem generated by evapotranspiration: stomata, narrow tubes, adhesion-cohesion. Transport of water and mineral salts in one direction after initial absorption
 - positive in phloem generated by osmosis and active loading and unloading. Bidirectional transport of soluble molecules
- Range of vertebrate examples
 - Blood vascular system mass flow powered by positive hydrostatic pressure generated by heart muscles. Importance of one-way valves in veins
 - Respiratory system: maintaining diffusion gradients through muscle action. In fish, water flow over gills and in other vertebrates, movement of air into and out of the lungs.
 - Lymphatic system: lymph ducts return intercellular fluid to the blood system powered by general muscular activity facilitated by one-way valves
 - Alimentary canal: description of peristalsis
- Comparative issues
 - Relative merits of transport systems driven by
 - Evaporation as opposed to energy released by respiration
 - Muscles
 - Single versus double circulatory systems
 - Value of a mass flow system in which transported substances are dissolved in water
 - Many fine tubes (e.g. xylem) as opposed to wider tubes (e.g. arteries) which become progressively narrower as they branch

The following learning objectives are directly relevant:

2.5(a), (b), (e), (f), (g), (h).