# Published Mark Schemes for GCE A2 Biology

## Summer 2010

Issued: October 2010

# MARK SCHEMES (2010)

## Foreword

### *Introduction*

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

### *The Purpose of Mark Schemes*

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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Rewarding Learning

**ADVANCED**
**General Certificate of Education**
**2010**

# Biology

## Assessment Unit A2 1

*assessing*

## Physiology and Ecosystems

**[AB211]**

**TUESDAY 25 MAY, MORNING**

# MARK SCHEME

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold
Comments on marking points are given in italics

## Section A

**1 (a) (i)** On the surface/plasma membrane of the erythrocytes/ red blood cells; [1]

**(ii)** **(**Antigen) A; [1]

**(iii)** Antibodies complementary/specific to the antigen; *[not same structure]*
forms a complex/attach to the antigens;
forming a clump of erythrocytes; *[not clot]* [3]

**(b)** B;
AB;
O; [3] 8

**2 (a) (i)** 37250 $kJm^{-2}y^{-1}$;
1650 $kJm^{-2}y^{-1}$; [2]

**(ii)** **Any two from**
- egestion/faeces/indigestible parts
- excretion/urine
- death/decay/decomposition
- inedible parts
- emigration
- harvesting [2]

**(b)** **Any three from**
- reduces the energy available from producers/energy from producers removed (by harvesting)
- subsequently less energy is available for consumers/food chain
- therefore shorter food chains/possible loss of tertiary consumer level
- less detritus reduces decomposers [3] 7

**3** **(a)** **(i)** The sample after 30 minutes (2.8g solute in 60ml volume); [1]

**(ii)** Sample at 120 min is more concentrated/sample after 60 min is more dilute/difference in concentration indicated by correct values (1.5g in 120ml compared to 1.5g in 160ml);
after 120min a more concentrated solution has a more negative/ lower solute potential (allow converse argument); [2]

**(b)** **Any four from**
- decreased concentration/higher water potential of the blood
- sensed by hypothalamus/osmoreceptors
- less ADH released (from the pituitary)
- permeability of the collecting (and distal) tubules decreased
- more water remains in the urine (less reabsorbed)/larger volume of urine excreted [4] 7

**4** **(a)** **(i)** Contains nitrogen-fixing bacteria;
fix atmospheric nitrogen/which convert atmospheric nitrogen (into amino acids); [2]

**(ii)** Plants/organic nitrogen compounds are decomposed;
released as ammonia/ammonium compounds;
the ammonia is converted by nitrifying bacteria to nitrates; [3]

**(b)** **(i)** **Any two from**
- more root nodules/more nitrogen-fixation (with increased amount of clover in the grass-clover mix)
- release of more ammonia/nitrates
- produces more amino acids/proteins (which increase the crop yield) [2]

**(ii)** Pest control (integrating pest management/IPM) /reduced pesticide use;
as the pest of a crop cannot become established when there is a gap of several years between planting of the same crop/pest life cycle broken;
**or**
Reduced competition from weeds;
using different varieties of crops changes the competition for light, water and minerals;
**or**
Soil structure is improved; *not maintaining soil fertility*
ploughing in of green manure/leaving cereal roots in soil/ other appropriate example;
**or**
Nutrient exhaustion is avoided/fewer fertilisers required;
different crops have different nutrient requirements/animals release faeces/urine which decomposes to add nutrients;
**or**
Biodiversity increased;
due to reduced use of pesticides/fertilisers/variety of plants is encouraged;
**Allow converse argument in the explanation** [2] 9

**5** **(a)** Swirl culture before removing the sample (to avoid settling)/ensure an even distribution of the yeast (over the counting grids in the haemocytometer)/replicate to check that values are relatively similar;
*not just replication* [1]

**(b)** **(i)** 10 yeast cells; [1]

**(ii)** 10 cells found in a volume of $0.00025 mm^3$ ($0.0025 \times 0.1$);
**Allow answer consequential to value in (b) (i)**
40 000 cells per $mm^3$ ($10 \div 0.00025/10 \times 4000$);
**Allow answer consequential to value in above** [2]

**(c)** Dilute the culture (by a known dilution factor);
multiply the final population estimate by the dilution factor; [2]

**(d)** **(i)** Reference to **yeast population** and growth/period of time; [1]

**(ii)** **×** at steepest part of the curve ($2\frac{1}{2}$ to 4 days); [1]

**(iii)** The (maximum) population size that can be supported by the available resources; [1] 9

**6** **(a)** A: cornea;
B: retina/ganglion cell layer/bipolar cells;
C: choroid;
D: optic nerve; [4]

**(b)** Circular muscle of the iris contracts (and radial muscle relaxes);
iris expands/pupil constricts; [2]

**(c)** **(i)** F, since it is more convergent/lens thicker/short focal length; [1]

**(ii)** The ciliary muscle relaxes;
lens is pulled by taut suspensory ligaments/by tension in the wall of the eye (caused by the vitreous humour);
*not contraction of suspensory ligaments* [2] 9

**7** **(a)** **(i)** Red light; [1]

**(ii)** $P_{730}$ ($P_{FR}$); [1]

**(iii)** $P_{730}$ promotes flowering in long-day plants (and so a build up of $P_{730}$ is required);
long days allow for the conversion of $P_{660}$ to $P_{730}$/maintain a high level of $P_{730}$;
short nights not long enough to remove $P_{730}$; [3]

**(b)** **(i)** Leaves receive a short-day treatment;
the plant responds by flowering;
apical bud receives a long-day treatment which does not influence/ inhibit flowering; [3]

**(ii)** To confirm that the plant is a short-day plant/ to confirm that short-day treatment stimulates flowering in this plant/allows for comparison (with experiment two);
*not just control* [1]

**(c)** Grafted leaves contain/produce the chemical messenger/introduce the chemical messenger into the recipient plant;
which stimulates flowering/overcomes the effect of the inhibitory light treatment;
**or**
Chemical messengers are diffusable/transferable;
so move from the leaf to the flowering buds/other parts of the plant; [2] 11

**8** **(a)** **(i)** Bacteria and fungi use oxygen (respire)/decomposition is an aerobic process; [1]

**(ii)** **Any two from**
- the organic matter is being decomposed
- reducing the populations of the bacteria and fungi
- the organic matter is diluted by the flow of water in the river [2]

**(b)** **(i)** The high BOD means there is a low level of dissolved oxygen in the water/tolerant animals have adaptations for obtaining oxygen;
the rat-tailed maggot can obtain oxygen at the surface;
the haemoglobin in the sludge worm's tail has a high affinity for oxygen/ can pick up oxygen at low pp$O_2$/oxygen absorbed by haemoglobin in exposed tail can be carried to rest of body; [3]

**(ii)** As distance from the discharge increases the level of oxygen increases/ BOD decreases;
some organisms (or appropriate examples) are only able to live where there is plenty of oxygen/clean water/different animals are adapted to different oxygen levels; [2]

**(c)** **(i)** The decomposition of the organic pollutant releases mineral ions/ appropriate example; [1]

**(ii)** **Any three from**
- algal bloom
- subsequent death through self-shading/nutrient depletion
- dead algae decomposed by bacteria
- bacterial respiration uses up oxygen/increased BOD [3] 12

**Section A** **72**

## Section B

**Sixteen points, minimum of six points from each part.**

Generation of an action potential and transmission of the nerve impulse:

- at rest the membrane of an neurone is polarised/has a resting potential
- has a potential difference of about -70mV / is negative on the inside
- stimulation must be strong enough to reach a threshold potential
- this causes an action potential in which the inside becomes positive / potential difference is reversed / membrane is depolarised / influx of $Na^+$ ions
- which results in sequential depolarisation of the neighbouring part of the axon membrane / local circuits
- the action potential is 'all or nothing' in its generation / below the threshold the action potential (impulse) does not fire / above the threshold there is no increase in magnitude of action potential
- after which the membrane becomes repolarised / recovers its resting potential
- causing a refractory period during which no further stimulation of the axon is possible / which ensures a one-way movement of the action potential
- this propagation of action potentials along a neurone is the transmission of the impulse
- speed of transmission is faster in axons with a wider diameter
- speed is also faster along myelinated neurones (with nodes of Ranvier)
- as there is saltatory conduction / the action potential "jumps" from node to node

Transmission across a synapse:

- when an action potential reaches the synaptic knob it causes an influx of $Ca^{2+}$ ions
- this causes synaptic vesicles to move towards the pre-synaptic membrane
- and fuse with it, resulting in exocytosis of the transmitter substance
- which is generally acetylcholine (ACh) in peripheral nerves
- the acetylcholine diffuses across the cleft / travels across the 20nm wide cleft
- and attaches to receptors on the post-synaptic membrane
- this causes an influx of $Na^+$ ions / depolarises the post-synaptic membrane
- causing an excitory post-synaptic potential (EPSP)
- an action potential is evoked if the EPSP reaches threshold level / if enough receptors are stimulated / if enough transmitter is received
- summation (spatial/temporal) of neurotransmitter from several synaptic knobs may be needed to promote an action potential
- the acetylcholine is broken down by acetylcholinesterase (AChE)
- which prevents continued stimulation of the post-synaptic membrane
- the choline and acetyl components diffuse back towards the pre-synaptic membrane where they are reabsorbed and used in the synthesis of acetylcholine

**For each point award equivalent descriptions.** [16]

Quality of written communication:

2 marks: The candidate expresses ideas clearly and fluently through well-linked sentences, which present relationships and not merely list features. Points are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.

1 mark: The candidate expresses ideas clearly, if not always fluently. The account may stray from the point or may not indicate relationships. There are some errors of grammar, punctuation and spelling.

0 marks: The candidate produces an account that is of doubtful relevance or obscurely presented with little evidence of linking ideas. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the account. [2] 18

**Section B** **18**

**Total** **90**

Rewarding Learning

**ADVANCED**
**General Certificate of Education**
**2010**

# Biology

## Assessment Unit A2 2

*assessing*

Biochemistry, Genetics and Evolutionary Trends

**[AB221]**

**TUESDAY 8 JUNE, MORNING**

# MARK SCHEME

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold
Comments on marking points are given in italics

## Section A

**1** **(a)** A endoderm
B mesogloea
C ectoderm
**Three for [2], two for [1]** [2]

**(b)** **Any three from**
- Annelida have three body layers/triploblastic/possess mesoderm
- possess a coelom
- body is bilaterally symmetrical
- metamerically segmented
- through gut/regional specialisation
- other appropriate difference [3] 5

**2** **(a)** **(i)** Pyruvate/pyruvic acid; [1]

**(ii)** Cytoplasm; [1]

**(iii)** B: Krebs cycle;
C: Electron transport chain/oxidative phosphorylation; [2]

**(b)** **Any two from**
- fatty acids are broken down into 2C lengths
- each 2C length forms a molecule of acetyl-CoA
- enters Krebs cycle/respires aerobically [2] 6

**3** **(a)** Longer chromosomes have more genes/allow converse; [1]
*Answer must indicate dependency*

**(b)** X chromosome and chromosomes of a similar length have almost the same numbers of genes (X length 164 with 1020 genes, chromosome with length 171 has 995);
Y chromosome is relatively "empty" compared to similar sized chromosomes (Y length 59 with 160 genes, others 56 length with 501, smallest at 50 has 386); [2]

**(c)** Males will have only one copy of many of the genes on the X chromosome/ sex-linkage; [1] 4

4 **(a)** **(i)** X: sporophyte;
Y: gametophyte; [2]

**(ii)** Diploid/2n; [1]

**(iii)** Well-developed rhizoids reach water deeper in the substratum/provide greater anchorage;
growth in dense tufts reduces water loss/prevents interspecific competition/other appropriate response; [2]

**(iv)** Mosses maintain their turgidity to keep them upright/dense tufts provide mutual support; [1]

**(b)** **Any two from**

- waterlogged soil limits gaseous exchange/oxygen/no ATP for cellular processes/anaerobic respiration causes the death of the lower half of the plant/dead lower part can hold water
- water is easily absorbed over the entire suface/bog environment limits the possibility of desiccation/not needed for water absorption
- not anchored and readily dispersed/other appropriate suggestion

Gametophyte has no vascular tissue;
therefore water must be absorbed over the entire surface/there is no means of transporting water;
**or**
The moss gametophyte is not covered by a cuticle/Tracheophyta are covered by a cuticle; water readily absorbed without a cuticle/a cuticle is water repellent; [4] 10

**5** **(a)** **(i)** Glycerate phosphate/GP; [1]

**(ii)** ATP from the light dependent stage/photophosphorylation; [1]
*Do not allow the term 'energy' for ATP*

**(iii)** Less carbon dioxide is fixed;
less carbohydrate is produced (meeting demands of respiration with little excess)/reduced net production; [2]

**(b)** **(i)** **Any two from**
- light limiting
- RuBP slowly regenerated/GP to TP light limited/lack of ATP/NADPH
- higher levels of Rubisco in the control plant are of no advantage in these lower light intensities/lack of Rubisco has no effect [2]

**(ii)** The reduced Rubisco plant has limited amounts of enzyme/Rubisco is the limiting factor/smaller leaves can utilise less light/take in less carbon dioxide due to reduced stomata;
RuBP is rapidly produced at higher light intensities resulting in the higher rate of carbon dioxide assimilation in the control plant [2]

**(c)** **(i)** **Any two from**
- enzymes are temperature sensitive
- temperature is another independent variable which must be controlled/ensuring a valid experiment design/fair test/controlled variable
- 25º C is a near optimal temperature
- high temperature to ensure temperature is not limiting [2]

**(ii)** **Any two from**
- increased $CO_2$ concentration increases assimilation by both plant types
- at low $CO_2$ concentrations the assimilation of $CO_2$ is the same for both plants
- Reduced Rubisco plant will have a lower $CO_2$ assimilation (at higher $CO_2$ concentrations)/or converse [2]

**(iii)** The lack of available enzyme (active sites) is limiting at the higher $CO_2$ levels/smaller leaves with fewer stomata reduce the utilisation of the $CO_2$; [1]

13

**6 (a) Any two from**

- island species tend to be either smaller or larger than their mainland relatives
- most island rodent species are larger than their mainland relatives
- most island carnivores/artiodactyls are smaller than their mainland relatives
- some island lagomorphs are smaller than their mainland relatives
- different selection pressures/different environments
- may lead to speciation [2]

*Answer must draw a conclusion not just quote figures*

**(b) (i)** There is no significant difference between the mean mass of the Rathlin field mice and that of the mainland field mice/any difference is due to random factors/chance; [1]

*Do not accept simply 'no difference' in sample means*

**(ii)** Numerator 33.15 – 23.8 = 9.35;
denominator $\sqrt{(2.56^2 + 1.65^2)} = 3.046$, and so t = 3.070; [2]

**(iii)** (17 + 120 –2) = 135d.f.; [1]

**(iv)** $0.01 > p > 0.002$ **[consequential to value given in (ii) and (iii)]**; [1]

**(v)** The null hypothesis is rejected/the difference is significant/Rathlin mice are (significantly) heavier; [1]
**[consequential to answer in (iv)]**

**(c) (i) Any three from**

- an appropriate suggestion for a selective advantage for larger mice (e.g. more aggressive in finding a mate)/selective advantage leads to directional selection
- survivors (large mice) will breed and leave more offspring
- increasing the frequency of their genes (large size genes) in the next generation/pass on their genes (genotypes) [2]

**(ii) Any two from**

- geographical isolation/allopatric speciation
- increased divergence of gene pools/mutations increase genetic difference/no gene flow between the populations/island colonisers had a limited gene pool/'founder effect'
- sexual isolation/critically those genes preventing interbreeding due to changes in genitalia/behaviour [2]

12

7 **(a)** **(i)** bbEE; [1]

**(ii)** Epistasis; [1]

**(b)** Gamete types shown;
Punnett square to show possible fertilisations;
genotypes correctly shown;
phenotypes correctly shown;
phenotypic ratio correctly shown/9 black, 4 yellow, 3 brown;

**BbEe X BbEe**

| Gametes | BE | Be | bE | be |
|---|---|---|---|---|
| BE | BBEE black | BBEe black | BbEE black | BbEe black |
| Be | BBEe black | BBee yellow | BbEE black | Bbee yellow |
| bE | BbEE black | BbEe black | bbEE brown | bbEe brown |
| be | BbEe black | Bbee yellow | bbEe brown | bbee yellow |

[5]

**(c)** **(i)** Yellow male: ee genotype prevents the black or brown expression;
black female: Ee heterozygous as there are yellow pups there must have been ova carrying the e allele; [2]

**(ii)** **Any two from**

- to produce brown pups both parents would need to be heterozygous
- if both parents heterozygous there is a low probability of brown pups, not achieved in a small sample/small sample size so brown was not produced
- no brown pups if one parent is BB (irrespective of other parent)
- so all pups inherit a B allele (and so black) [2]

11

**8** **(a)** 11055/3 =3685 amino acids/3683 if terminal codons are included; [1]

**(b)** The appearance of the disease in previous generations; [1]

**(c)** **Any two from**
- the genetic code is changed
- removal of a nucleotide will displace all other nucleotides in the sequence/frame-shift
- the amino acids making up the protein are changed (from the point of the deletion) [2]

**(d)** **(i)** **Any two from**
- only DMD sons have the genetic marker ii
- mother does not have marker ii/mother is not a carrier
- DMD sons lack the genetic marker i common to the rest of the family
- the DMD sons and the rest of the family share markers iii, iv, v and vi [2]

**(ii)** The mother is a carrier/heterozygous;
mother possesses both vii and viii/marker vii contains the mutant allele/ marker viii contains the 'normal allele'/mother has the 'normal allele'/ DMD allele is recessive; [2]

**(iii) Any three from**
- in family A the appearance of DMD is caused by mutation
- as the novel genetic marker is not present in parental blood sample (marker ii)/present in ovary tissue only/mother A not a carrier
- in family B the DMD is inherited from a carrier mother
- as their mother has the genetic marker vii in common with her sons/she does not pass this on to her daughter
- boys only needed to inherit one allele as it is sex linked
- it's a regular occurrence 43 out of 77/mutation in ova production [3]

11

**Section A** **72**

## Section B

**9 (a) Ten points**

DNA:

- DNA sequence of bases represents the genetic code
- a sequence of three nucleotides (bases) codes for one amino acid
- DNA is a degenerative code as some amino acids are coded for by more than one triplet of DNA nucleotides/is an non-overlapping code

Ribosomal RNA:

- synthesized at the nucleolus/associates with protein to form a ribosome

Transcription and translation:

- a gene is a short section of DNA
- DNA unzips (by breaking the H-bonds between the bases)
- one strand acts as a template
- ribonucleotides enter opposite their complementary bases
- with U opposite A and A-T, C-G
- condensation between sugars and phosphates is catalysed by RNA polymerase
- the mRNA now detaches and leaves the nucleus via a nuclear pore/ travels to the ER where a ribosome attaches to it
- in the cytoplasm tRNA picks up specific amino acids
- an anticodon for each amino acid
- the anticodon on the tRNA is attracted to the complementary codon on the mRNA
- the ribosome holds two adjacent tRNAs together until a peptide bond/ condensation occurs between the adjacent amino acids
- the ribosome then moves along the mRNA to assist the joining of subsequent amino acids in turn (until a stop codon is reached)
- the chain of amino acids represents the primary structure of the protein
- removal of non-coding sections (introns)/edited mRNA is produced [10]

**(b) Six points (three from each section)**

Safety preparations taken when using genetically modified organism:

- use strains of GEM which grow more slowly than normal wild type intestinal bacteria and thus would be out-competed by the latter
- use strains of GM with a minimum temperature tolerance above human body temperature so that they will not multiply in the human body
- use strains of GM which contain 'suicide genes' these are activated outside certain pH or temperature limits
- use of containment mechanisms for example highly efficient air filters/ regular monitoring of the atmosphere within purpose-built laboratories
- legislation, where work on potentially dangerous GM's is restricted to purpose-built laboratories/is carried out by highly trained staff

Ethical issues [arguments both for and against developments of GEM organisms]:

- improving life expectancy of patients requiring drug treatment/more successful drug treatment (e.g. human insulin)
- the possibility of cures for genetic traits using gene therapy (trials with cystic fibrosis etc)

- diagnosis (development of 'chips'), prevention and the management of inherited diseases caused by defective genes (5000 single gene disorders
- the difficulties of using prenatal information – 'designer babies'
- carrier testing for cystic fibrosis, Tay-Sachs etc
- pharmacogenomics, 'the right drug for the right patient', could avoid adverse side-effects and save valuable health care resources
- prevention of communicable diseases by DNA analysis of the pathogen and vectors (manipulation of mosquito DNA so that parasites which cause malaria and Leishmaniasis/dengue fever cannot survive in the mosquito)
- identification of markers for bowel cancer, Alzheimer disease pathways to allow drug treatment at an early stage of the disease development
- financing genomic research and drug development may limit the use of resources for other forms of treatment
- detailed knowledge of the genetic basis of sickle cell disease has lead to little health benefit
- gene disruption may trigger cancer
- genetic research has lead to the storing of large amounts of information about individuals DNA, 'who owns the DNA'. Access to confidential information could produce a 'genetic sub-class' of individuals excluded from employment, insurance etc.
- population screening should be for preventive treatment and not just information
- genetic risk profiling for complex diseases is not sufficiently predictive (disposition to bowel cancer, breast cancer)
- cost-effective food production through improved disease resistance in plants/reduction in the use of pesticides
- in animals successfully transformation and expression of the desired gene is frequently low
- 'faulty' alleles remain in the gene pool and may be passed on
- recombinant DNA may be taken in by 'non-target' organisms, e.g. weeds may take up a gene for herbicide resistance/spread of antibiotic resistance in non-target organisms (gut bacteria can take up genes from ingested food products)/the danger of GM plants cross-breeding with wild species
- unfair competition between sponsored GM crops and less productive plants available to farmers/limitations placed on third world countries unable to pay for GM crops [6]

Quality of written communication:

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**Section B** **18**

**Total** **90**