GCE AS

Biology

Summer 2009

Mark Schemes

Issued: October 2009

MARK SCHEMES (2009)

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.

CONTENTS

A2 1: Module 4	
A2 2: Module 5	9
A2 3A: Module 6A	19

Rewarding Learning

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Biology

Assessment Unit A2 1

assessing

Module 4: Co-ordination, Biochemistry and Environment

[A2B11]

TUESDAY 12 MAY, AFTERNOON

MARK SCHEME

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

Section A

1	**(a)**	Community;	[1]	
	(b)	Climax community;	[1]	
	(c)	Denitrification;	[1]	
	(d)	Eutrophication;	[1]	4

2 Antigens/immunogens
B
plasma
antibodies/immunoglobulins
T
helper
cytotoxic/killer
memory

Eight for [6], seven for [5], six for [4], five for [3], four for [2], three or two for [1] [6] 6

3 ✓ ✗;
✗ ✓;
✗ ✓;
✗ ✓;
✓ ✗;
✗ ✓; [6] 6

4	**(a)**	Pyruvate; glycerate phosphate (GP)/phosphoglyceric acid (PGA);	[2]	
	(b)	Krebs cycle/TCA cycle; Calvin cycle/light independent stage;	[2]	
	(c)	Mitochondrial matrix; chloroplast stroma; cytoplasm;	[3]	7

5 **(a)** At 35 °C the body temperature is relatively evenly distributed around the body;
at 20 °C the body temperature of the extremities becomes cooler/body temperature is not even throughout the body; [2]
or
Core temperature is maintained at 37°C in both/tissues peripheral to core have a lower temperature;
temperature differential is more marked at the lower external temperature of 20° C;

(b) Drop in temperature is (37–28) = 9 °C;
$\frac{9}{37} \times 100 = 24\%$; [2]

(c) Vasoconstriction of the peripheral blood vessels;
reduced heat loss; [2]

(d) Raising of body hair/huddling/curling up to reduce surface area/ reduced sweating/wearing (insulatory) clothes/smaller surface area of extremities/increased sub-cutaneous fat; [1] 7

6 **(a)** **(i)** **Any two from**
- pigment/chlorophyll molecules absorb light and the energy level of electrons is raised
- energy is passed through the pigment molecules by resonance
- different pigment molecules (chlorophyll *a*, chlorophyll *b*, carotenoids) absorb at different wavelengths/increase the range of wavelengths utilised
- energy is passed to reaction centre (type of chlorophyll *a*) and an electron is emitted [2]

(ii) Lamellae/grana/thylakoids; [1]

(b) **(i)** DCPIP turns from blue to colourless; [1]

(ii) Use of a colorimeter/spectrophotometer; [1]

(c) **Any three from**
- the electrons are picked up by an electron acceptor (plastoquinone)
- the electrons pass through a series of carriers (cytochromes) coupled to ATP synthesis (photophosphorylation)
- and are accepted by PSI which is photoactivated
- eventually passing to $NADP^+$/forming NADPH [3] 8

7 **(a)** **(i)** There are no receptor cells at this point/neurones of the optic nerve leave the retina at this point; [1]

(ii) Cones are dense at A, though not at B;
each cone synapses with an individual neurone/more impulses to brain from A/able to discriminate between points close together; [2]

(iii) Rods exhibit retinal convergence/a number of rods synapse with a single neurone; [1]

(b) Retinal convergence allows rods to have an additive effect/summation;
while low light intensity will not allow a single rod to produce a sufficiently large generator potential, a combination of rods will/allow sufficient transmitter substance to be released to effect an action potential/allow threshold to be reached;
or
Rhodopsin (in rods) is broken down at low light intensity;
generator potential more readily produced; [2]

(c) There are three types of cone, each sensitive to a primary colour/blue, green and red;
stimulation of individual or combinations of cone types is perceived as a particular colour/example of this; [2] 8

8 **(a)** Mitochondria;
synaptic vesicles; [2]

(b) **Any five from**
- membrane of synaptic knob becomes permeable to calcium ions/ calcium ions accumulate in the synapse knob
- synaptic vesicles (structure C) move to the pre-synaptic membrane
- exocytosis occurs/vesicles fuse with the pre-synaptic membrane/ secretion of transmitter substance
- transmitter substance diffuses across the synaptic cleft
- this attaches to receptors on the sarcolemma
- the sarcolemma is depolarised and an end plate potential is generated
- if this reached a threshold intensity then an action potential is evoked [5]

(c) Actin;
myosin; [2]

(d) **Any five from**
- the impulse fires through the muscle fibre, including the sarcoplasmic reticulum (and T-system)
- calcium ions are released into the sarcoplasm
- the myosin heads (of the thick filaments) attach to the actin (of the thin filaments)
- they then rotate ("rock") back pulling the thin filaments over the thick filaments
- the heads then detach with ATP being used in the process
- the cycle of attachment, rotation and detachment is repeated
- the thin filaments are pulled over the thick filaments so that the myofibrils shorten [5] 14

Section A **60**

Section B

9 Thirteen points, with at least five on each of ADH and auxin.

General aspects of chemical communication:
- chemicals released in one part of the organism
- having an effect in another part of the organism
- chemical communication tends to be associated with longer term effects

ADH in mammals:
- changes in the concentration of the blood is detected by osmoreceptors (in the hypothalamus)/osmoregulation is controlled via the hypothalamus
- if the blood becomes more concentrated (e.g. as a result of sweating during exercise or hot weather) then anti-diuretic hormone/ADH is secreted
- ADH is produced by the hypothalamus
- secreted into the pituitary body (posterior lobe) from where it is subsequently released
- ADH causes the collecting ducts to be more permeable to water
- so that more water is reabsorbed from the collecting ducts
- leaving the urine especially concentrated
- if the blood becomes more dilute, less ADH is secreted, less water is reabsorbed and so a copious amount of dilute urine is produced

Auxins in plants:
- auxin is produced in the shoot tip
- and moves down the shoot (to the zone of elongation)
- auxin stimulates cell elongation
- cell elongation is dependent on the elasticity of the cell wall/osmotic uptake of water
- auxin causes protons (H^+ ions) to move into the cell wall
- causing cellulose fibres to slide more readily
- unidirectional light causes movement of auxin to the shaded side
- greater concentration of auxin on the shaded side stimulates differential cell elongation
- greater elongation on the shaded side causes curvature of the shoot towards the light/phototropism [13]

Consider QWC:

2 marks: The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments 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. Arguments may sometimes stray from the point. There are some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks: The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage. [2] | 15

Section B | **15**

Total | **75**

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Biology

Assessment Unit A2 2

assessing

Module 5: Reproduction, Genetics and Taxonomic Diversity

[A2B21]

TUESDAY 19 MAY, AFTERNOON

MARK SCHEME

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

ABLE
'S

Section A

1 (a) Any two from

- two daughter cells produced
- chromatids not separated
- chiasmata visible
- homologous chromosomes paired/separating [2]

(b) During prophase II spindle fibres form at right angles to the previous spindle in meiosis I;
during metaphase II chromosomes (paired chromatids) become arranged at the equator of the cell/become attached to the spindle fibres via their centromeres;
during anaphase II spindle fibres pull sister chromatids to the opposite poles of the spindle;
during telophase II chromosomes disassemble/spindle fibres disappear/nuclear envelope reforms; [4] 6

2 **(a)** **Any two from**

- having separate sexes ensures cross fertilisation
- generates greater genetic variability
- facilitates evolutionary change [2]

(b) Division/phylum
class
order
Plantae
Polytrichum
commune
[1] for left column correct, [1] for right column correct [2]

(c) **Any two from**

- the gametophyte generation is dominant in the moss while the sporophyte generation is dominant in the fern
- the sporophyte of the moss is nutritionally dependent on the gametophyte while it becomes independent in the fern
- in the fern the gametangia are on the underside of the gametophyte
- in the moss there is an embryonic protonema stage [2]

(d) **Any two from**

- there is an alternation of generations/both a sporophyte and gametophyte are evident
- spores are produced by meiosis
- gametes are produced by mitosis
- chemical attraction of the male gamete
- haploid gametes in both
- diploid zygote as a result of fertilisation
- male gamete moves to female gamete [2] 8

3 **(a)** **(i)** $0.16\ (88/550) = q^2$; [1]

(ii) frequency of *lineata* ($\mathbf{C^l}$) allele (p) = 0.6 **[p calculated as 1 less the answer below]**;
Frequency of *redimita* ($\mathbf{C^r}$) allele (q) = 0.4 **[q calculated as root of the answer (a)(i)]**; [2]

(iii) Frequency of homozygous *lineata* ($\mathbf{C^l\,C^l}$) (p^2) = 0.36 **[square of answer for p above]**;
frequency of heterozygous *lineata* ($\mathbf{C^l\,C^r}$) (2pq) = 0.48 **[consequential to answers for p and q above]**; [2]

(b) **Any two from**
- apostatic selection
- spatial differences regarding which morph is favoured
- temporal differences regarding which morph is favoured
- a balance of forces favouring the two forms
- heterozygote advantage
- heterozygote reservoir for C^r allele/recurrent mutation [2] 7

4 **(a)** A: Endoderm;
B: Ectoderm;
C: Mesogloea; [3]

(b) Barbs/toxins paralyse/immobilise the prey; [1]

(c) **Any three from**
- digestion initially extracellular followed by intracellular
- partially, extracellularly-digested food is taken into cell in the temporary vacuole/vacuole contains enzymes for exocytosis
- primary lysosomes fuse with membrane of temporary vacuole/ enzymes discharged into temporary vacuole where digestion takes place
- digested products absorbed into cytoplasm (temporary vacuole regresses) [3] 7

5 (a) Any four from

- Geographic isolation/migrate to different islands
- initial populations show genetic variation
- different selection pressures operate/changes in allele frequency
- genetic differences emerge/mutation/founder effect/genetic divergence
- no gene flow between the isolated populations (demes)
- secondary isolating mechanism evolves/different species are recognised when they are reproductively isolated/temporal isolation (e.g. different breeding seasons)/ecological isolation (e.g. different niches)/behavioural isolation (e.g. different courtship displays)/ mechanical isolation (e.g. mismatch of reproductive parts)/genetic incompatibility (e.g. sperm killed in female's reproductive tract)/ hybrid inviability (infertility) [4]

(b) Both species have a modal beak depth of 10–10.5 mm when isolated;
when occurring together, the modal beak depth of *G. fortis* is 12.5–13 mm, while that of *G. fuliginosa* is 8–8.5 mm; [2]

(c) Any four from

- the two species have similar diets when on different islands/same ecological niche
- when occurring together members of the species with similar beak sizes would be in strong competition
- directional selection
- favours a smaller beak in *G. fuliginosa* and a larger beak in *G. fortis*
- thus on Albermarle their diets are different/they eat different sizes of seeds/different ecological niches
- so reducing the competition which would arise with similar-sized beaks [4]

10

6 **(a)** **(i)** 2:1/1.97:1; [1]

(ii) The hairless condition is heterozygous;
the normal (hairy) condition is homozygous;
the other allele is lethal in the homozygous condition; [3]

(iii) A hairless dog in the wild would not be able to conserve heat; [1]

(b) **(i)** B-D-
B-dd
bbD-
bbdd
[$\frac{1}{2}$ each] [2]

(ii) Gamete types shown;
Punnett square to show possible fertilisations;
genotypes correctly shown;
phenotypes correctly shown;

BdDd x BbDd

	BD	**Bd**	**bD**	**bd**
BD	**BBDD** **black**	**BBDd** **black**	**BbDD** **black**	**BdDd** **black**
Bd	**BBDd** **black**	**BBdd** **blue**	**BdDd** **black**	**Bbdd** **blue**
bD	**BbDD** **black**	**BdDd** **black**	**bbDD** **red**	**bbDd** **red**
bd	**BdDd** **black**	**Bbdd** **blue**	**bbDd** **red**	**bbdd** **fawn**

Black	**9**
Blue	**3**
Red	**3**
Fawn	**1**

[4] 11

7 **(a)** Sporangium;
annulus;
sorus; [3]

(b) **(i)** **Any two from**
- red light stimulates germination
- far-red inhibits germination
- these effects are reversed by subsequent irradiation with red (stimulatory) or far-red light (inhibitory)
- there is no germination in darkness [2]

(ii) **Any three from**
- red-light induces the formation of P_{fr}/P_{730}
- P_{fr}/P_{730} stimulates fern spore germination
- far-red light causes an accumulation of P_r/P_{660} (which is physiologically inactive)/removes P_{fr}/P_{730} stimulation
- continuous darkness all the phytochrome is P_r/P_{660} [3]

(c) **Any three from**
- Any of the solutions containing ions will have an osmotic effect/water alone does not
- germination occurs when spores receive calcium in the culture solution
- either as a single solution or in the complete mineral nutrient solution
- sodium ions/water do not induce germination
- role of calcium ions in the fern cells (calcium pectate for cell wall development)
- complete mineral nutrient solution produces less germination than the calcium solution suggesting possible competition for mineral uptake [3] 11

Section A **60**

Section B

8 Thirteen points (with at least three from each section).

Artificial insemination:

- animals with desired traits are selected for breeding (other animals lacking the desired qualities are not used to breed)
- artificial insemination involves obtaining semen from a relatively few chosen males
- semen screened for potential diseases/motility/semen diluted
- the semen is stored in liquid nitrogen
- ultimately placed into the reproductive tract of the female
- artificial insemination allows semen from one male to be used to fertilise a large number of females
- there is no need for farmers to keep a bull on the farm/bulls do not have to be moved from farm to farm/semen can be stored even after the death of the bull/in zoo breeding programmes animals don't have to be transported from zoo to zoo
- in humans, artificial insemination may counter infertility due to low sperm count/poor sperm mobility
- detailed records required to prevent problems caused by inbreeding

In vitro fertilisation:

- IVF is used to counter infertility as a result of blocked fallopian tubes/ fallopian tubes cut in a sterilisation procedure/hostile cervical mucus/low sperm count/poor sperm mobility;
- it involves initial hormone treatment which stimulates ova production/ super-ovulation
- eggs are then extracted through vaginal/abdominal wall/use of ultrasound/ laproscope
- and fertilised *in vitro* with obtained semen in a suitable sterile medium/ controlled
- the zygote is allowed to develop into an embryo to ensure that an egg has been fertilised/check the viability of the embryo
- the time allowed for embryo development matches the natural time before implantation
- there is a relatively low success rate for IVF/premature births
- use of the frozen embryos in a second attempt/surrogacy

Embryo transfer

- embryos are obtained from genetically superior females
- either by in vitro fertilisation or naturally, following super-ovulation which are then flushed from the uterus
- embryos so obtained may then be transferred to surrogate mothers
- whose uterus is made receptive for implantation by hormone treatment
- in humans, the use of surrogate mothers overcomes infertility as a result of non-receptive uterus
- in animal breeding programmes, the reproductive rate of genetically superior females can be considerably increased
- embryos formed can be cloned since separation of cells at an early stage can result in identical twins

- embryos can also be sexed, tested for certain genetic diseases, screened for STI's or a gene can be transferred into the embryonic cells (embryo manipulation)
- embryos can be transferred to the uterus of a smalll mammal for transport around the world, the embryos are recovered and re-implanted into hormonely prepared surrogates. [13]

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Section B **15**

Total **75**

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Biology

Assessment Unit A2 3A

assessing

Module 6A: Synoptic Paper

[A2B31]

TUESDAY 26 MAY, AFTERNOON

MARK SCHEME

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

Section A

1 **(a)** The numbers of red and grey squirrels remain relatively stable/reds high, greys low for the first 10 years;
thereafter reds decline in number while greys increase; [2]

(b) The red squirrels suffer an epidemic of parapox virus/more reds now affected by virus since greys are carriers;
the greys moved in to fill the gap/reduced competition allows an increase in greys; [2]

(c) The niches don't quite overlap/reds are better adapted to conifer plantation, greys to deciduous woodland/both habitats are available; [1]

(d) **Any two from**
- a genetically variable population has a greater reservoir of alleles
- less chance of homozygosity/greater chance of heterozygosity
- population more adaptable
- capable of evolving in response to environmental change [2]

(e) The proportion of non-albino squirrels is gradually increasing/the proportion of albino squirrels is gradually decreasing;
there is selection against albinos (possibly because they are more obvious to predators);
the allele for albino is decreasing in frequency; [3] 10

2 **(a)** Nitrate supplies N for the synthesis of amino acids/proteins/nucleotides/nucleic acid/chlorophyll;
phosphate is required for the synthesis of ATP/nucleotides/nucleic acid/phospholipids/any sugar-phosphate; [2]

(b) Degrees of freedom = 18;
$p > 0.1$; [2]

(c) **Any five from**
- $p > 0.1$ (nitrate comparison) indicates that the difference is not significant **[as appropriate for *p*-value determined in (b)]**
- nitrate by itself does not (significantly) increase phytoplankton growth
- $p < 0.05$ (phosphate comparison) indicates significant difference
- phosphate by itself does significantly increase phytoplankton growth
- $p < 0.001$ (both comparisons) indicates a very high significant difference
- nitrate and phosphate together have the greatest effect on phyloplankton growth [5]

(d) Chlorophyll *a* estimates the total biomass/chlorophyll as a pigment is readily measured/other appropriate response;
cells may differ in size or some may be 'dead'/chlorophyll *a* is not the only photosynthetic pigment/other appropriate response; [2] 11

3 **(a)** The electron transport/respiratory chain is disrupted/carriers are in the reduced state;
so cell can no longer aerobically produce ATP; [2]

(b) Cyanide is stored within vesicles so that it does not affect the plant cell's own respiration/does not have a toxic effect on a plant cell;
the other toxins act on animals (nerves/muscles)/not harmful to plant cells; [2]

(c) Atropine prevents synaptic transmission/prevents further impulses/ prevents functioning neurotransmitter;
so impulses cannot be passed on from pain receptors/to brain; [2]

(d) Muscles cannot function;
reference to circular muscles (in iris); [2]

(e) Digitalis causes an increase in calcium ions;
reference to any action involved in sliding filament hypothesis; [2]

(f) The neurone membrane remains depolarised;
no recovery/no refractory period/resting potential not achieved/ no repolarisation/neurone fatigued; [2]

(g) They are all proteins;
since protein function is dependent on its shape/a precise site on the molecule/a site which is not blocked; [2] 14

Section A **35**

Section B

4 Thirteen points

General:
- ATP provides energy
- during its hydrolysis
- catalysed by ATPase
- to ADP and inorganic phosphate
- only a small proportion of energy released by breakdown of ATP is utilised

Synthetic reactions:
- ATP is used in the synthesis of macromolecules
- in protein synthesis
- for peptide bonding between amino acids
- in the synthesis of starch (glucose is phosphorylated before bonding)
- in the synthesis of lipids
- in the synthesis of nucleic acids
- in the synthesis of creatine phosphate

Resynthesis of biochemicals:
- ATP provides energy for the resynthesis of biochemicals
- resynthesis of acetylcholine in synaptic knobs
- resynthesis of rhodopsin in rods

Glycolysis:
- ATP is used in the initial steps of glycolysis
- glucose is phosphorylated
- to fructose bisphosphate
- 2 ATP are used per glucose

Photosynthesis:
- ATP (from the light stage) is used in the Calvin cycle
- substrate is glycerate phosphate
- to triose phosphate/glyceraldehyde phosphate
- and in the phosphorylation of RuP to RuBP

Membrane pumps:
- ATP provides energy for active transport
- energy used by membrane protein
- to alter its shape
- allows solutes to be moved against a concentration gradient
- example of ATP usage in active transport

Cytosis (bulk transport):
- ATP is required during exocytosis/endocytosis
- for the formation of vesicles
- for the movement of vesicles to/from the cell membrane
- for the assembly/disassembly of the microfilaments/microtubules (of the cytoskeleton)

Muscle contraction:
- ATP is used in the contraction of muscle
- attaches to myosin head
- allows detachment of myosin from actin filaments
- allows cycle of attachment, rocking of myosin heads, detachment/sliding filament hypothesis/ratchet mechanism

Cell division:
- ATP is required during cell division/mitosis
- for condensation of chromosomes
- for the formation of the spindle
- for the action of spindle microtubules in pulling chromatids apart

Heat generation:
- ATP breakdown provides heat
- important in maintaining biochemical activity
- extra heat may be generated in endothermic animals

Bioluminescence:
- ATP used in bioluminescence
- during luciferin–luciferase reaction
- transformation of chemical energy to light energy
- used in firefly/some deep sea fish/dinoflagellates

Others:
- translocation in the phloem
- recovery of resting potential/generation of nerve impulses
- movement of cilia/flagella
- action of DNA ligase
- other appropriate usage of ATP [13]

Consider QWC:

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Section B **15**

Total **50**