# External Assessment Report 2010

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| Subject | **Biology** |
| Level | **Advanced Higher** |

The statistics used in this report are pre-appeal.

This report provides information on the performance of candidates which it is hoped will be useful to teachers/lecturers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding. It would be helpful to read this report in conjunction with the published question papers and marking instructions for the Examination.

# Comments on candidate performance

## General comments

Script markers (who mark Sections B and C) were mixed in their impressions of this year's candidates. The majority found that the performances were much the same as last year, with scores right across the range from below ten to high sixties out of seventy-five. A number did not see any very good scripts, while others reported marking centres where all the candidates had performed well. The mean score for these sections was almost identical to last year (47%).

Mean scores for both mandatory Units were similar: Unit 1, 51% of marks available; Unit 2, 48% of marks available. The Unit 1 score was a 5% improvement on last year; Unit 2 scores were almost the same as last year's.

Essays were better done than in 2009, with mean scores up about two marks to 7.3/15. Both choices attracted roughly the same number of candidates and the performance in both was much the same. Some candidates' answers in these questions were outstanding, displaying awareness of what the question was about, sound knowledge, and careful expression of concepts. Many, however, were less able to marshal the facts and/or expressed themselves poorly.

Performance in the option topics was more uniform this year but relative popularity was still uneven. The Physiology, Health and Exercise topic was down by one mark on last year's score (to 9.2/20, 81% of candidates), Animal Behaviour was up a little (11.2/20, 15% of candidates) and Biotechnology improved markedly (to 10.6/20, 4% of candidates).

Candidates continue to do very well in Section A where items are in multiple-choice format: the items in this section are selected to sample more widely across the Arrangements than Section B. A couple of Problem Solving items were more challenging than last year's and caught out the unwary. (Average score 17.4/25, down a little on last year.)

Investigation performance is almost identical to last year, 14.3/25. Many markers reported a slight improvement in this component and that many candidates had made more of their time in the lab. But there were also many more Investigations that scored less than 10/25. If SQA Guidance is followed so that a 'daybook' has been monitored for the grading of NAB Outcomes, any candidate ought to be able to score half marks (13/25) for writing up an Investigation report. The standard format is set out in SQA Guidance to Centres/Candidates (revised for 2008) and the official marking instructions (MI) are freely available on the SQA website.

The highest marks for Investigation reports were only achieved by candidates who had proper replicates and controls in their experiments, and were aware of the role of these in evaluating the validity and reliability of results (see below).

There were many outstanding performances in individual components and questions this year. There were many well-conceived and perceptive answers from candidates, who are performing under pressure. Although it has been a little less common to find the same

candidate performing equally well in all the elements, there are still numerous exceptional candidates who do achieve this standard.

## Areas in which candidates performed well

Many candidates did very well in items where they had to process graphical and/or numerical data and arrive at conclusions: Section B Question 1 (d) and (e); Section B Question 7 (b)(i); Biotechnology Question 4 (b); Animal Behaviour Question 1 (c); Physiology Health and Exercise Q4 (b). There were many excellent scores in the long data question about testing potential treatments for a fusion gene mutation. Commonly, it was weak knowledge that prevented candidates scoring full marks rather than an inability to work with indices.

Bonding in carbohydrates was well understood by many and there were large numbers of excellent answers in the sodium-potassium pump short response (Section B Question 3). Many candidates knew the source of Ti plasmids and an application of the process represented in Section B Question 4.

Many candidates had good knowledge of the issues associated with intensive agriculture (Section B Question 8A) and with the role of burning fossil fuels in relation to air pollution (Section B Question 8B). Only the most aware saw that they had to assemble their existing knowledge correctly to focus on the titles. Many of the essays contained excellent knowledge and discussions. Where the essay components matched essays in past papers, the answers were very good.

It was clear that many candidates understood the concept of competition underlying Section B Question 5 by getting Question 5 (b)(i) correct but their powers of expression were not always up to the task of explaining why the data in this example did not fit normal assumptions about interactions (see below).

The Animal Behaviour option was generally well done and there were substantially more good answers in the Biotechnology option than in previous years: there were many good answers in the short response on the preparation of polyclonal sera. In Physiology, Health and Exercise there were many accurate accounts of insulin in NIDDM and the link between oestrogen decline and osteoporosis.

## Areas which candidates found demanding

Lack of factual knowledge caused many candidates problems. Knowledge questions are often put in at the start of a sequence designed to test reasoning and understanding, to key candidates into the theme being assessed. The items commonly ask for terms to be defined or explained and are not usually intended to be difficult. The main errors are outlined below.

Question B1: Oncogenes act as dominant alleles; the terms confluent and monolayer describe normal growth of animal cell cultures; FBS is providing growth factors. These all lead on to considering evidence about the nature of abnormal cell growth (‘foci’) and how a particular mutation might be treated.

Some candidates found working with indices quite tricky. In B1 (e), where they needed to show 1010 is 100 times bigger than 108, they subtracted the numbers, ie 1010–108 (= 10000 M–100 M), rather than the powers.

Question B3: Common misconceptions in this question concerned phosphorylation and the link between conformation change and affinity as the pump operates.

Phosphate for phosphorylating the pump comes from ATP. The breakdown of ATP is coupled so that it drives the outward movement of Na+ by causing conformational change. The pump has its own enzyme capability, acting as an ATPase. (Kinase and phosphatase enzymes are not involved.)

The inward facing conformation has 3 high affinity sites for Na+ binding; the outward facing conformation has 2 high affinity sites for K+. Binding of Na+ triggers phosphorylation and binding of K+ triggers dephosphorylation.

Question B4: Transgenic organisms have DNA from another species/type of organism. The kanamycin Question 4 (b) tests understanding of the role of the medium for growing protoplasts — the medium is selective for plants cells having the plasmid (page 19 of the Arrangements). In this case, kanamycin in the medium is selecting for cells with the kanamycin resistance gene, hence the transgene too.

Question B5: The intensity of competition between members of the same species is expected to be high because they all have identical resource needs, ie. they occupy the same niche. The data present an interesting challenge to this expectation.

Candidates were often unclear when talking about interspecific competition. Many said that different species have different resource needs, yet if they are in competition they are implicitly trying to use the same resource. In the context of competition with meadow browns, other species are using the same resource; their niches clearly overlap.

Finally, if other species can pollinate the bramble flower and the meadow brown feeds elsewhere too, the co-evolved and intimate association needed for mutualism is missing.

Question B6: Many students found this question difficult because of the experimental context and because the graphs show mass remaining while the questions ask about mass loss.

The data shows the impact of fragmentation by detritivores on the subsequent rate of decomposer activity. The important underlying idea is the distinction between role of detritivores in increasing the surface area of detritus (humification) and the breakdown of humus by decomposers (mineralisation).

Question B7: This question was poorly done because most candidates had not come across the idea that species may be favoured or susceptible when environmental conditions change (page 29 of the Arrangements); these concepts underpin our use of indicator species.

Other weak concepts here were persistence in relation to toxins in the environment and susceptibility. Diclofenac generally has low toxicity and, having low persistence, it would soon be degraded. The vulture species, being 'unusually susceptible', are dying when they ingest even the low concentrations that exist for only a short period after a cow's death.

The question was commonly taken to be about bioaccumulation or biomagnification, which relate to substances that are relatively persistent. Candidates thought that vultures gradually accumulate a toxic dose — even though the substance is not persistent.

Question B8A: Intensive crop production was approached in this question from the point of view that it can be used to sustain large/growing human populations. There was some confusion about the functions of different pesticides (insecticides, herbicides, fungicides) and about what the 'pest' was doing to reduce crop yield. It was not uncommon for pesticides to be confused with inorganic fertiliser and for them to be blamed for eutrophication, algal bloom and oxygen depletion in ponds.

Question B8B: This question was about the benefits of biomass as an alternative to fossil fuels. The discussion required candidates to define the concepts of productivity, gross primary productivity and net primary productivity. Candidates could usually present the NPP = GPP– R equation but they did not grasp that NPP as a rate of adding new biomass is the key idea for the essay. NPP supplies the energy as food for the next trophic level and it is the source of biomass to use as a sustainable, possibly carbon neutral alternative to the combustion of highly polluting fossil fuels.

For a discussion of the methods used to find the cause of the vulture decline (Townsend et al pp 30–34) and accessible definitions and discussions of production, monoculture and pollution (both books) see:

- Townsend CR, Begon M and Harper JL (2008) *Essentials of Ecology* 3rd edition, Blackwell Publishing, Oxford.
- Jones AM (1997) *Environmental Biology*, Routledge, London.

In Section C, the weak response to some Physiology, Health and Exercise questions causes most concern because of the high proportion of candidates who study this option.

Question 1: The most common error was the evidence to answer Question 1 (a). It is not enough to compare extensive exercise (bar 4) with no exercise (bar 1); no other level of exercise generates significant changes. Other errors were of the type 'As exercise increases, resting heart rate decreases', which is wrong in a variety of ways.

Question 2: Poor answers in the question on insulin were those based on knowledge from Higher. Candidates were unclear that the pancreas (B cells) detects glucose concentration; following glucose absorption, B cells in the pancreas release insulin. Very commonly, candidates wrote that insulin converts glucose to glycogen as if it has enzyme activity. From other parts of the Course, they should be aware that insulin is a peptide hormone and it does not enter cells; a transduction process triggers the events that produce glycogen and concurrently inhibit glucose secretion from the liver.

Glucose enters cells via different types of transporter or carrier molecule. In muscle and fat cells, the transporters (GLUT 4) are recruited to the plasma membrane and increase glucose uptake in response to increased insulin (and separately by increased exercise). In liver cells, the uptake is different: insulin induces the formation of glucokinase, which causes a constant low glucose concentration inside the cells.

NIDDM is associated with obesity. Typically there is resistance to insulin, so the hormone can be present in high concentrations yet not trigger glucose uptake and also not stop glucose secretion. It is thought that the receptors for insulin become less active or less common. Glucose uptake continues in all cells at a relatively low level via transporters that are not insulin stimulated (GLUTs 1 and 3).

(Barrett KE, et al (2010) *Ganong's Review of Medical Physiology* 23rd edition, McGraw Hill, USA, pp318–323.)

Question 3: Bone density is the important idea in understanding osteoporosis. When bones grow to reach their full length and thickness, bone strength depends on the density of the bone. If a bone does not change in overall size (ie volume), then bone mass is equivalent to bone density.

About 80% of bone is compact bone and 20% is spongy (made of little beams, the trabeculae). The density of bone material gives it strength. The progress of osteoporosis is monitored by determining how far a person's bone density deviates from average peak bone density.

Two cell types are involved in bone remodelling: osteoblasts form new bone and osteoclasts resorb existing bone. Oestrogen promotes the apoptosis of osteoclasts and is involved in inhibiting their formation. Declining oestrogen, most marked following menopause, alters the balance of osteoclasts to osteoblasts and bone resorption increases.

Spongy bone is more active metabolically and it is remodelled faster: compact bone is renewed at a rate of 4% a year whereas spongy bone is renewed at about 20% a year (in patterns that relate to weight bearing activity). Spaces in spongy bone are areas that have been resorbed. As osteoporosis develops, the trabeculae become less dense and the spaces get larger, making areas of spongy bone more prone to fractures, eg wrists, hips and vertebrae.

(Barrett KE, et al (2010) *Ganong's Review of Medical Physiology* 23rd edition, McGraw Hill, USA, pp371–374)

Question 4: Although the numerical work was generally done well here, many candidates were unaware of simple facts about direct and indirect calorimetry. Some stated correctly that heat is measured by direct calorimetry but would measure it by submerging the subject (confusing it with densitometry) or by having the subject in an 'airtight' chamber. The chamber has controlled and monitored airflow, minimal heat loss through the walls and a way to measure the heat. Indirect calorimetry derives energy values from total oxygen consumption, which is the focus of the question.

## Advice to centres for preparation of future candidates

Candidates should be briefed on the format of the exam and receive advice on time-management. A number of candidates do both of the essays or all the options or write too much for an item's mark allocation and consequently find themselves under pressure to complete the exam.

Candidates should have opportunities to discuss concepts so that they are not just memorising definitions. KU questions in the exam are often aimed at assessing depth of understanding rather than just recall. Centres could use selected past paper questions and marking instructions as teaching exercises to generate discussion about the subtlety of concepts and to show how accurately candidates have to express answers to score marks. External Assessment (EA) Report commentaries on exams should help to clarify common errors. Exams, marking instructions and EA reports are available on the SQA website (**www.sqa.org.uk**).

Questions regularly have graphs and charts with error bars (Section B Question 1, Biotechnology Question1, Physiology Health and Exercise Question 1). If error bars are present there will generally be a question relating to them. Answers should refer to the significance of differences or the degree of variation in measured values.

Extensive advice was given on Investigations in the 2008 EA Report. It is worth reiterating that the highest marks in Investigations are scored by candidates who do good evaluations (Section 5 of the Investigation MI). A significant part of an evaluation discussion relies on the investigation having adequate controls and replication (MI Section 3). Just as with the error bars in graphical questions, variation in data from replicates has to be discussed to establish the validity of conclusions. If proper replicates have not been included in the design of an experiment, it is difficult for candidates to assess the reliability of measurements and the significance of treatment results.

## Statistical information: update on Courses

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| **Number of resulted entries in 2009** | 2095 |
| **Number of resulted entries in 2010** | 2177 |

## Statistical information: performance of candidates

### Distribution of Course awards including grade boundaries

| Distribution of Course awards | % | Cum. % | Number of candidates | Lowest mark |
|---|---|---|---|---|
| Maximum mark — 125 | | | | |
| A | 20.3% | 20.3% | 441 | 80 |
| B | 27.8% | 48.0% | 605 | 68 |
| C | 24.7% | 72.8% | 538 | 57 |
| D | 12.1% | 84.9% | 264 | 51 |
| No award | 15.1% | 100.0% | 329 | – |

### General commentary on grade boundaries

While SQA aims to set examinations and create marking instructions which will allow a competent candidate to score a minimum of 50% of the available marks (the notional C boundary) and a well prepared, very competent candidate to score at least 70% of the available marks (the notional A boundary), it is very challenging to get the standard on target every year, in every subject at every level.

Each year, therefore, SQA holds a grade boundary meeting for each subject at each level where it brings together all the information available (statistical and judgemental). The Principal Assessor and SQA Qualifications Manager meet with the relevant SQA Head of Service and Statistician to discuss the evidence and make decisions. The meetings are chaired by members of the management team at SQA.

The grade boundaries can be adjusted downwards if there is evidence that the exam is more challenging than usual, allowing the pass rate to be unaffected by this circumstance.

The grade boundaries can be adjusted upwards if there is evidence that the exam is less challenging than usual, allowing the pass rate to be unaffected by this circumstance.

Where standards are comparable to previous years, similar grade boundaries are maintained.

An exam paper at a particular level in a subject in one year tends to have a marginally different set of grade boundaries from exam papers in that subject at that level in other years. This is because the particular questions, and the mix of questions are different. This is also the case for exams set in centres. If SQA has already altered a boundary in a particular year in say Higher Chemistry this does not mean that centres should necessarily alter boundaries in their prelim exam in Higher Chemistry. The two are not that closely related as they do not contain identical questions.

SQA's main aim is to be fair to candidates across all subjects and all levels and maintain comparable standards across the years, even as Arrangements evolve and change.