BIOLOGY TZ2 (IB Africa, Europe & Middle East & IB Asia-Pacific)

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 30	31 - 44	45 - 56	57 - 69	70 - 81	82 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 28	29 - 42	43 - 54	55 - 67	68 - 79	80 - 100

The vast majority of the teachers were using the new programme with its changes to the internal assessment. The moderators only indicated a few schools that had persisted in using the old criteria and marking system. A few teachers using the new system slipped back into the old matrix for establishing their marks.

Most schools used appropriate investigations, although a major problem in some schools is the complexity of the investigations that are not up to IB standards.

In many schools the new criteria are being applied rigorously but in a significant number of schools the teachers seem to be ignoring the descriptors of the different aspects. In these cases the moderators were marking down.

Moderators were signalling that there are problems where the class of candidates is being presented for more than one diploma (e.g. IB and AP). The investigations selected for assessment using the IB criteria will need very careful selection and some editing.

There were a number of schools that ignored the fact that the Group 4 Project can only be used for the assessment of Personal Skills and none of the other criteria.

Internal assessment

Component grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 8	9 - 16	17 - 22	23 - 27	28 - 33	34 - 38	39 - 48

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 8	9 - 16	17 - 22	23 - 27	28 - 33	34 - 38	39 - 48

Clerical procedure

Earlier versions of the 4/PSOW form were being used by a lot of teachers. This did not provide space for the moderator's and senior moderator's marks. The latest versions (available on the OCC) should be used.

It seems that some teachers are deducting marks from candidates for incomplete portfolios or work handed in late. This was being done despite the fact that the candidate had completed the minimum amount of work to obtain two marks for the criteria Design, DCP and Conclusion and Evaluation. This is not appropriate. If the teacher feels that a sanction is warranted, then it is an internal issue for the school. It should not affect the IA marks.

Teachers who included the "complete", "partial" and "not at all" breakdown of their marks were providing helpful information to the moderators. This combined with comments and feedback to the candidates made it very clear as to how the teachers were awarding marks. There are a large number of teachers that take a lot of time and trouble to prepare their Internal Assessment sample. This effort is very much appreciated. They should be congratulated for their efforts and their candidates will reap the benefits. It is a lot easier for a moderator to support a teacher's marks when there are clear notes accompanying the sample.

There is a recurrent problem concerning the information provided by the teacher. This directly affects the progression of the moderation. Teachers MUST enclose all the instruction sheets and/or summaries of oral instructions for the investigations in the moderation sample. Most schools complied with this requirement for the investigations involving DCP assessment. It is also necessary, however, for investigations where Design is being assessed and a significant number of teachers are not doing this. Furthermore, when Data Collection and Processing is being assessed, the method (designed by the candidate or provided by the teacher) is required. When Conclusion and Evaluation is being assessed all the steps in the scientific process are needed for moderation.

Some teachers are not designing practical programmes with sufficient numbers of hours, others are inflating the time spent on an activity. There are those who are concentrating all their IA into one small part of the course.

Atypical candidates should be replaced in the sample. These would include candidates whose work is incomplete or transfer candidates where a substantial part of their work has been marked by another teacher.

When the only marks appearing on the 4PSOW form are the two marks required for the internal assessment, it causes concern amongst the moderators. There is no indication that the candidates were marked a number of times using the criteria. One wonders how these candidates receive the necessary feedback to improve their performance.

Some moderators commented on transcription errors between the marks indicated on the work and the mark on the 4PSOW form. This should be verified before it is sent. Some schools are sending photocopies of the candidate's work. Usually these are of good quality. The problem is that graphs and diagrams using colour can be confusing. It would be better to send the originals and keep back a photocopy.

Areas of strength

The variety of investigations, the duration and coverage of the practical programme were generally good.

Areas of weakness

Although the vast majority of teachers had learnt that there were new criteria they were often presenting very similar investigations to the previous programme. This was particularly apparent in those used to assess DCP, which has become more demanding.

Trivial, simplistic investigations that do not generate sufficient data to permit adequate assessment of data processing were too common. If there is one significant area of weakness it is in the processing of data. Candidates are missing quite obvious conventional points (e.g. indicating uncertainties in their data) as well as limiting their processing to the calculation of a mean. Teachers are also missing these points and marking over generously.

Literature sources are not consulted when they could provide valuable background information in determining the initial research question and in the discussion of the results.

Rules applied by the moderator

In the event of the teacher providing too much guidance to the candidates or ignoring the criteria the following scale is applied by the moderators:

Criterion	Problem	Teacher awards	Maximum moderator can award
Design	Teacher gives the problem or research question.	c; c; c = 6	p; c; c = 5 Candidates could have identified their own control variables
Design	It is clear that the candidates have been told precisely what apparatus and materials they require and have not modified it.	c; c; c = 6	c; c; n = 4
Data Collection & Processing	The candidates have used a photocopied data table with headings and units.	c; c; c = 6	p; c; c; = 5 Candidate could have added uncertainties or relevant qualitative observations
Data Collection & Processing	The candidates have been told, on the method sheet, to draw a graph from their raw data and which variables to plot or process the data in a particular way.	c; c; c = 6	c; n; c = 4
Conclusion and Evaluation	The candidate has only indicated as a criticism that they ran out of time and their only suggestion as an improvement is that they should repeat the investigation.	c; c; c = 6	c; n; p = 3

Candidate performance against each criterion

Design

The new programme requires that the investigations assessed should contain quantitative data. Moderators have reported that there are a number of schools still presenting investigations that collect only qualitative data (e.g. microscopic observations of tissues or observations on dissections). They are inappropriate.

Even if the investigations are quantitative, they are frequently too simplistic. The range of values of the independent variable was insufficient to establish a trend. The number of repeats was insufficient to permit statistical analysis. For example, testing the effect of pH on an enzyme using an acidic environment a neutral environment and a basic environment will not establish an optimal pH.

Some moderators reported that teachers are accepting surveys as investigations assessed for Design. This is inappropriate and it will have a negative impact on the assessment of the

other criteria particularly CE aspects 2 and 3. Teachers should counsel candidates to avoid this approach.

It is good practice for candidates to follow through their own designs. Some schools seem to have their candidates design an investigation that remains theoretical. The result is often an unrealistic investigation.

Teachers are setting general themes with little scope for different investigations. The result is that the whole class of candidates selects the same variables and investigates the same system.

Little research is evident or investigations that are designed with little or no consideration of biological principles. It may be a small point but it would be useful for the candidate to give the scientific name of the organism being used or the organism that was the source of the material. The trivial name at least must be given.

The three categories of variables must be clearly identified. Candidates need to be taught what the different variables are and what their relationship is.

Standard protocols will, no doubt, be used by the candidates when they design their investigations. We are not expecting them to re-invent the wheel. HOWEVER these standard protocols must be significantly modified or applied to the candidate's own investigation. For example, if osmosis is being investigated and the candidate uses the method of change in mass of tissue to monitor the effect of solutions of different concentrations on a tissue, this is legitimate. If the investigation is simply to determine the isotonic solution of one tissue then it remains trivial and it repeats many textbook investigations. If the investigation is used to determine the effect of the salinity of irrigation water on different root crops, the investigation becomes more substantial.

In field work, the control of sampling procedures is almost totally ignored by the candidates. If a random sample is to be obtained, how can it be ensured that it is random?

Data Collection and Presentation (DCP)

It may be that class data is required in order for the candidate to gain access to sufficient data for significant data processing and the determination of uncertainties. The moderators understand this, biological systems are often difficult to coax and slow to give data. If class data is to be used and DCP is to be assessed a number of precautions must be respected. The candidates must present their own data or clearly identify which is their own data in a pooled data table. The candidates must plan and produce their own data table. Copying a table from other candidates will be counted as collusion and the school's IA work will be subject to an enquiry. Teachers who provide the candidates with a pre-formatted data table can expect their candidates to be moderated down.

Despite the clear warnings in the subject guides teachers are still providing instructions on how to present the data and how to process the data. Their marks will be moderated down. The classic investigations (e.g. mark and recapture, chromatography of leaf pigments and osmosis) often create problems. Teachers are using standard textbook protocols without modifications. A little imagination and editing could easily solve the problem.

Moderators often had to reduce the marks of the teachers for the following reasons:

- There were no quantitative data collected
- No uncertainties were given in the tables of data collected using measuring instruments.
- There were inconsistent decimal places in tables.

- The decimal places did not correspond to the precision of measurements.
- There were no associated qualitative data. E.g. an ecological field investigation is incomplete without some kind of description of the site used.
- Raw data were plotted in graphs that do not actually reveal anything (e.g. maxima, minima, optima or intercepts).
- Raw data were plotted when the mean should have been calculated and plotted
- There was no statistical treatment of the data.
- There was no presentation of uncertainties in graphical data either by using trend lines or error bars
- The error bars, when used, were not identified.
- Trend lines were not used to express uncertainties.

Complete may not mean perfect but when the mistakes are consistent they will have an impact on the moderated marks.

When calculations are made it is important that the pathway to the answer is clear. This does not mean there has to be a worked example but a result that springs up out of nowhere will not be credited.

Some schools seem to accept the use of non-metric units (e.g. teaspoon or °F). Conversion programmes exist that are easily available online.

Conclusion and Evaluation (CE)

Investigations that lead to trivial amounts of data will lead to limited discussion of results and weak conclusions. Insufficient data will not reveal uncertainties and this has an impact on evaluation. So although each criterion is marked on its own merits there will be a knock-on effect through a poorly designed investigation that collects a limited amount of data.

Overall literature values were not consulted enough by the candidates. When they were the sources were often not correctly cited. For guidance on the correct way to cite a reference in the Extended Essay the guidelines are very helpful.

As stated above, if the method and the data are not provided, then CE cannot be moderated.

Candidates in some schools show that they have developed a mature sense of criticism of the investigation. Their evaluation of their results is based upon a balanced critical analysis of the data. Candidates who have not developed this skill tend to remain superficial in their evaluation. The weaknesses they identify are hypothetical (“the seeds could have been dead”) without evidence to back it up. For weaker candidates the experimental weaknesses are restricted to having a limited amount of time or errors in their own manipulation that once again remain hypothetical (“I could have incorrectly measured the temperature”). Evaluation is a good discriminator of the high achieving candidates and teachers would do well to remember this when they are marking their candidates.

Suggested modifications were sometimes superficial and yet marked over generously.

Manipulative skills

There is evidence of the candidates being exposed to a sufficient range of investigations. This ensures that the manipulative skills can be assessed correctly.

Ethics and Safety

There was a significant increase in the number of moderators commenting on investigations that were unsafe or unethical. Inflicting pain deliberately on a fellow candidate to see what effect it has on heart rate is clearly inappropriate for both ethical and safety reasons. However, using fellow candidates for investigations into the effect of exercise on the heart rate can also be considered unsafe if the health status of the candidates is not determined first. The IB does not wish to inhibit investigations but it does want to stimulate a responsible attitude towards experimentation. The safety and ethics of science investigations have recently been reviewed. New guidelines have been posted on the OCC.

Some examples of unsuitable work carried out this year as part of the practical hours, or submitted for Internal Assessment or for extended essay included:

- Taking repeated blood samples from guinea pigs/rats
- Subjecting molluscs to severe dehydration leading to death
- Force-feeding of rats with caffeine
- Subjecting animals to pain by placing them on a hotplate
- Experimenting on fish, moving them repeatedly between tanks and precipitating the death of some individuals
- Adding repeatedly greater quantities of sugar to the water in which goldfish were kept, resulting in distress and death

ICT coverage

This was generally covered adequately by the majority of the schools.

Schools seem to have made an effort to equip themselves with the necessary materials to carry out data logging. However, the use of this material in investigations for internal assessment of the criteria was not always appropriate. Teachers and candidates are strongly advised to read the relevant section of the subject guide.

Graph plotting using software was perhaps the easiest and most widespread use of software for schools to apply. There are signs however that the candidates still need to be taught the correct conventions of graphing. There is a tendency to use bar charts for everything amongst the weakest candidates, perhaps because it is the default setting. Legends (keys) are not always necessary and candidates do not seem to know how to de-select them. When they are needed the candidates often have difficulty labelling them appropriately – candidates often present the different curves as “series 1” and “series 2” When the candidates used scatter plot, a trend line was not always used when it was appropriate.

The use of spreadsheets for data processing was less apparent in the sampled investigations. When spread sheet tables are inserted into document files the conventions of presenting tabulated data were often ignored or forgotten (e.g. Centring numbers, adjusting the number of decimal places, column headings).

Some schools are not fulfilling the requirement for a range of ICT applications to be used in their practical programme. It is the use of databases and computer modelling/simulation that are most often missing.

The Group 4 Project

The Group 4 Project can ONLY be used for the assessment of Personal Skills. Indeed it is the only occasion when it is assessed. The Group 4 Project CANNOT be used for the assessment of Design, DCP, CE or Manipulative Skills. In the next session schools that use the Group 4 Project inappropriately will be sanctioned.

Recommendations for the teaching of future candidates

- Read feedback from the previous session and act upon it.
- Consult the Online Curriculum Centre (OCC) for teacher support material (TSM)
- Apply the internal assessment criteria rigorously.
- Ensure that the open-ended theme that you set has enough scope to provide a variety of research questions.
- Give the candidates experience in identifying independent, dependent and controlled variables.
- Be sure that investigations used for assessment produce quantitative data.
- Encourage the candidates to make additional observations about their experiment.
- Ensure that the investigations have the potential to generate sufficient data for substantial processing.
- Teach the candidates that plotting graphs of raw data is often insufficient.
- Encourage the candidates to carry out research into the background literature both before starting an investigation and once the results are complete.
- **Do not** use the Group 4 Project for assessment of D, DCP CE or MS. Only use it for Personal Skills. Inappropriate use will be sanctioned in subsequent sessions.
- Make sure that you are using the most up-to-date version of the 4/PSOW form (available on the OCC).
- Check to be sure that all the parts of the 4PSOW form are completed correctly.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 16	17 - 23	24 - 27	28 - 31	32 - 35	36 - 38

General comments

Of the 136 G2 reports received by the time of grade award, 62% thought that the paper was of a similar standard to that of last year, 6% though it was much more difficult and 7% thought it was a little easier. The remainder thought that it was a little more difficult. However, 90% of teachers thought that the level of difficulty was appropriate. More than 97% thought that the syllabus coverage, clarity of wording and presentation were good and only 3% of the teachers thought that the paper was poor in any of these respects. There were many discriminating questions on this paper and a small number of questions that performed less well.

The strengths and weaknesses of the candidates in the treatment of individual questions

Some questions performed in a predictable way and no comments need to be made about them. The comments that follow relate to questions where candidate performance was very good or very poor or questions that aroused comment from teachers on G2 forms.

Question 1

This seemed to be a very difficult first question; usually the first question is easy. The discrimination index was good, showing that better candidates were able to answer it correctly and the weaker candidates incorrectly.

Question 2

Some candidates believed that bacteria divide by mitosis, but this process only occurs in eukaryotes.

Questions 3 and 4

The quality of the micrograph was not good; nevertheless this did not affect the performance of the candidates.

Question 5

This question required the candidates to know what occurs during the cell cycle. Good candidates were able to answer this question correctly.

Question 6

Candidates had to know that cellulose is a polysaccharide and that these contain hydrogen in their structure. The structure of polar amino acids had to be known too.

Question 7

This question proved to be too easy, as almost all candidates answered correctly.

Question 9

Although there were some complaints about the wording of this question, it also proved to be a very easy question.

Question 11

Both A and B were accepted as the correct answer.

Question 12

Answers A and C were accepted as correct. As the origin of mitochondrial DNA is not in the syllabus, candidates could not be expected to know that mitochondrial DNA is only inherited from the mother.

Question 13

This question proved to be a very good discriminator, as most good candidates answered correctly.

Question 14

This question had a high discrimination index. Good candidates realized the function of the diaphragm in breathing in.

Question 15

This question also had a high discrimination index, where the good candidates knew that antigen presentation by the phagocytes is the first event after a pathogen is ingested by a phagocyte, although the word phagocyte in the answer possibly gave the answer away.

Question 16

This question proved to be too easy for these candidates.

Question 18

This question had a high discrimination index.

Question 19 and 20

Assessment statement 5.2.2 says to analyze the changes in concentration of atmospheric carbon dioxide using historical records. This means candidates should have used the data provided, or data of a very similar nature. Most candidates found the questions easy. Although in question 20 other options might seem correct, answer A was the most correct.

Question 23

This question was deemed to be unfair, as it tested information required by the previous syllabus and was therefore discounted.

Question 25

Almost 84% of the candidates recognized that highly repetitive DNA sequences are not transcribed.

Question 27

Although the quality of the diagram has been criticized, 70% of the candidates had the right answer.

Question 28

This question was discounted as knowledge of CAM is not explicitly required by the syllabus and is a choice of adaptations of xerophytes listed in the teachers' notes. It was therefore deemed to be an unfair question.

Question 32

This question was very difficult for most candidates. C and D should have been eliminated by candidates as they do not have a membrane.

Question 33

Although the syllabus states that three characteristics of dicotyledonous plants should be known (not necessarily those asked in this question), most candidates had this question right and it had a good discrimination index.

Question 34

This question seemed to be easy, but was also a good discriminator.

Questions 38 and 39

One teacher comment suggested that the term trisomy in the source could have confused the candidates but this did not seem the case, as the questions were answered correctly by most candidates.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 8	9 - 16	17 - 26	27 - 36	37 - 47	48 - 57	58 - 72

General comments

Of teachers who commented on G2 forms, three quarters felt that this paper had been of a similar standard to last year's and the others were evenly divided between thinking it easier or more difficult. The mean mark was very similar to last year's. More than 95% of teachers thought that the paper was appropriate in difficulty and statistics show that the it discriminated effectively between candidates, with a very wide mark range and a pleasing number of candidates accessing marks in the upper end of the range, above 60.

The main criticism from G2 forms related to syllabus coverage, with nearly 10% of teachers feeling that it was poor. This is probably inevitable with Paper 2, unless questions in Section A target widely ranging parts of the syllabus. This has sometimes been done in past papers but these questions lack coherence and are felt to be rather confusing to candidates.

Syllabus coverage is achieved in Paper 1, and the intention in Paper 2 is to look in detail at fewer areas of candidates' knowledge.

All teachers felt that the clarity of wording and the presentation of the paper were good and there were few criticisms of specific questions.

The areas of the programme and examination that proved difficult for the candidates

The areas that appeared difficult varied from centre to centre. Difficulties arose either from candidates not having been taught according to the specific wording of assessment statements or from candidates not knowing what they had been taught. For example, the specific eukaryotic cell type used as an example is the liver cell, and the type of DNA replication studied in prokaryotic rather than eukaryotic. Candidates find some of the command terms difficult, especially *analyse* and *evaluate*.

The levels of knowledge, understanding and skill demonstrated

Many candidates demonstrated good levels of skill in data analysis in Question 1. There was mostly very good knowledge of DNA structure and substantial numbers of candidates knew the structure of the nucleosome and understood polygenic inheritance and the sex-linked inheritance of colour blindness. In Section B, there was good knowledge demonstrated of the structure of the dicotyledonous leaf and of the heart. Some candidates demonstrated good understanding of the light-dependent reactions of photosynthesis, prokaryotic DNA replication and blood clotting. Drawing skills were varied but in many cases were good

The strengths and weaknesses of the candidates in the treatment of individual questions

Question 1 (PAN, edaravone and nephrotic syndrome data based question)

The style used to display details of experimental design at the start of this question was novel for most candidates.

a) This was intended to be an easy start to the question and almost all candidates answered it correctly. It was also intended to encourage candidates to think carefully about the time scale on the *x*-axis. It was clear that some candidates did not do this. The numbers 0, 1, 2 and so on could either be interpreted as the number of days after the start of the experiment, or the start of Day 0, Day 1, Day 2 and so on. In

b) Many candidates scored a mark for stating that there was one injection of saline at the end of Day 0, the start of Day 1 or after one day. Far fewer pointed out that two oral doses of saline were given each day. This could be deduced from the twenty open circles in the ten-day period of the experiment. Part

c) This was answered correctly by about half of the candidates. The commonest fault was failure to state clearly when edaravone was administered. The answer, *over the first 4½ days* was not accepted, because there were two administrations per day and ten in total.

d) Most candidates correctly calculated the increase in protein and only a few forgot to give units. The question should probably have used the command term *calculate* rather than *state* but few candidates only stated the values without carrying out the subtraction.

e) Answers to were very varied, with marks evenly spread between 0, 1, 2 and 3. The question was easier to answer if the instruction to give similarities as well as differences in *compare* questions was remembered. Quotation of numerical values rarely gains many marks in IB Biology exams. Some answers consisted only of this, but scored a maximum of one mark.

f) It was essential to remember that in *evaluate* questions implications and limitations are the focus. The experimental results for late administration of edaravone supported the hypothesis, but those for early administration did not. Candidates were expected to explain this partial support. Few were able to evaluate this. They seemed reluctant to say that it was only "partially correct" opting to say either correct or incorrect instead. Questions are never set to trick candidates but they need to be aware that much data is inconclusive and requires further testing of a hypothesis before it can be confirmed or rejected.

g) Candidates mostly found the last two parts of the question difficult. As this was an *analyse* question, the expected answers were interpretations of the data to reach conclusions. This involved more than merely describing or comparing the results. In particular, it was essential to separate the effects of PAN and edaravone. PAN caused the highest TBArs levels, indicating damage to membranes by oxidation. When edaravone was also administered, it prevented this damage. Many candidates talked about the combined effects of the two drugs, even though the stem of the question, on page 2, explained that edaravone is a proposed treatment for nephrotic syndrome, and PAN causes symptoms of the disease so can be used to simulate it. Only a minority of candidates coped well with part (g) and this was the only part of the question that aroused critical comments from teachers on G2 forms. It was again necessary to bear in mind statements in the stem of the question, especially that the presence of protein in urine is a symptom of nephrotic syndrome. Candidates were expected to recall how the structure of the glomerulus normally prevents proteins passing from blood in the glomerular capillaries to filtrate in the Bowman's capsule. Candidates tended to score three marks or none, depending on whether they keyed in to the question correctly or not.

h) The examining team did not feel that this part was too hard. Partly because of (h) there was a better correlation between candidates' performance in Question 1 and their overall standard in this paper, than in some other recent papers.

Question 2 (Structure of DNA, nucleosomes and enzymes)

Many of the stronger candidates scored full marks in this question. Some of the weakest candidates left parts (b) and (c) blank, and in a few cases the entire question was untouched.

a) This was often well answered, with many candidates scoring four marks. The sugar was sometimes labelled as ribose rather than deoxyribose, or simply as sugar. Another common error was to link the phosphate groups to the oxygen in the sugar ring, rather than to C_4 via C_5.

Stronger candidates often drew impressively detailed and accurate diagrams, with the antiparallel orientation of the strands, the numbers of hydrogen bonds and the molecular structure of deoxyribose and phosphate groups correctly shown. It was possible to score four marks without all of this detail, but it was good to see such high quality answers.

b) This was also well answered by properly prepared candidates. A few misread the question and outlined the structure of nucleotides rather than nucleosomes.

c) This was more poorly answered than expected. Perhaps candidates who knew about the primary and tertiary structure of proteins were unable to transfer this knowledge to a question about enzymes, though they surely knew that enzymes are globular proteins. Many of the candidates who did write about primary and tertiary structure failed to include the essential detail that primary structure is the sequence or order of amino acids. There was some confusion between secondary and tertiary structure and also some over-simplified accounts of tertiary structure. Some candidates stated simply that tertiary structure is three-dimensional structure. It was expected that candidates should at least include the idea that enzymes are globular in their three-dimensional structure.

Question 3 (polygenic inheritance and sex-linkage)

This was another question that discriminated very effectively between candidates, with some leaving it blank and at the other end of the range answers comfortably scoring full marks.

a) This was the most successfully answered, with many giving an acceptable definition of polygenic inheritance. The usual confusion with multiple alleles was evident in some answers.

b) Answers were varied in quality. Some candidates were not clear about the nature of continuous variation and therefore either described how a small number of skin colours could arise, or described another example of variation with only a small number of phenotypic variants. The best answers explained how continuous variation results from the alleles of different genes acting in combination, with no single allele being dominant over the others. As there is considerable uncertainty about the number of genes influencing the quantity of melanin in human skin, the mark scheme accepted a wide range of answers.

c) This was well known by the stronger candidates, who had no difficulty in scoring three marks. There were some long answers describing particular mating and the offspring that they could produce, which sometimes scored few marks, as they did not make general points about the inheritance of colour blindness. Where crosses are used in an answer to a general question about the inheritance of a trait, they should be used to exemplify the pattern of inheritance, with annotation to make general points, rather than focusing too much on specific ratios.

Section B

All of the four questions were answered by substantial numbers of candidates, but Questions 4 and 7 were more popular than 5 and 6. There was no escape from the obligation to draw diagrams. This is still regarded as an important skill for IB biologists and as a gradual improvement in drawing skills has been evident over recent years, it is clear that many teachers are giving their candidates plenty of opportunities to build their skills.

Question 4

a) Diagrams of leaf structure were mostly good, with many candidates scoring four marks, as expected by the examining team. The assessment statement that was being tested here (9.1.1) indicates that a plan diagram should be drawn. This does not include details of specific cells, although in this case a mark could be scored by drawing guard cells adjacent to a stoma. Candidates who drew individual cells throughout the leaf often did so carelessly and lost marks for aspects of the accuracy of the diagram as a result.

b) This gave the stronger candidates an opportunity to demonstrate the sophistication of their understanding of the photochemistry of the light-dependent reactions. There were some exemplary answers. Weaker candidates tended to give partial accounts with errors of understanding and the weakest candidates gave only a broad outline of what is achieved by photosynthesis.

c) The challenge was to explain in sufficient detail the effects of light intensity and temperature on the rate of photosynthesis. Weaker candidates tended outline the effects (assessment statement 3.8.8) rather than explain them (assessment statement 8.2.8), which often only gave them two marks. Rather few candidates gave convincing explanations of light intensity and temperature in terms of rate-limiting steps. This question was therefore highly discriminating, helping to separate the most able and best prepared candidates from others.

Question 5

a) Whenever the structure of the male or female reproductive system has been set in IB Biology exams, the quality of drawings has ranged from excellent to worryingly inaccurate. There were a few drawings in this session that displayed almost total ignorance, but most were largely correct in the relative positions of the organs. In some cases marks awarded were still low, as the details were so unrealistic. Oviducts often led into the wall of the uterus rather than the lumen. The cervix would often have been unable to carry out its functions if it had the structure represented. Ectopic pregnancies would have been the norm rather than the exception in many cases. Most diagrams were drawn as a view from the front. The minority of diagrams were drawn as a side view tended to be better in terms of proportions and relative positions.

b) Many answers were unfocused, with candidates recalling their knowledge of the whole of the hormonal control of the menstrual cycle, rather than extracting the roles of progesterone and estrogen, as required by the question. Answers therefore tended to be over-long, with examiners having to pick out the relevant points. Quality marks for Section B questions are reduced if there are significant amounts of irrelevant material.

c) This was also answered more poorly than expected, perhaps because most of the stronger candidates did not choose this question. There were few answers that earned all of the eight marks, despite both structure and function of the placenta being included. In many cases answers were too vague and failed to make it clear what is transferred from maternal to fetal blood and vice versa.

Question 6

The first part of this question clearly puzzled some candidates, who had probably been taught the ultrastructure of a eukaryotic cell, but did not realise that it was a liver cell. Assessment statement 2.3.1 indicates that candidates should know the structure of a liver cell as an example of eukaryotic cell structure, so the question was acceptable.

a) In the light of answers seen by examiners, perhaps the question should have given candidates a clearer pointer to what was expected. The quality of drawings was very variable. Marks were only awarded for structures clearly drawn and labelled. The mark scheme for this paper gives details of the criteria that examiners used. It was not necessary to draw a whole cell, as this would have involved drawing organelles repeatedly, but at least one of each organelle type, accurately drawn, was needed.

b) This was often answered by means of a table. This was particularly appropriate here as the question asked for prokaryote and eukaryote cell structure to be distinguished, rather than compared, so only differences were required. Tables help to ensure that candidates give both sides of a distinguishing feature. This approach only works if candidates fully understand the features, which they did not in some cases. For example, naked DNA in prokaryotes was often matched with DNA enclosed in a nucleus in eukaryotes, rather than with DNA associated with histone proteins. Mesosomes were given as an equivalent of mitochondria although most bacteriologists now regard the mesosome as an artefact of preparation for electron microscopy, rather than as a functionally significant structure. The current IB Biology programme does not refer to mesosomes.

c) This may also have discouraged answers from some candidates, as it referred to DNA replication in prokaryotes. This is how assessment statement 7.2.2 is phrased, so the wording of the question was acceptable, but there were some answers that showed some candidates had been confused. Some wrote about binary fission, about the replication of a circular DNA molecule, or even about the cell cycle and mitosis. However, stronger candidates coped extremely well and quickly amassed eight marks. The best answers explained the method of replication on the leading strand and then explained how and why the process was different on the lagging strand.

Question 7

a) Candidates are often pleased to be able to demonstrate their knowledge of heart structure and many were able to do so successfully here. The commonest errors were to misrepresent the relative sizes of the atria and ventricles, or relative thickness of the walls of the four chambers. Weaker candidates were confused about the connections of vessels to chambers, with vessels connected to the wrong chamber or to the muscle in the wall, rather than the lumen through which blood flows. There were some truly impressive diagrams that were a pleasure to mark and a demonstration of the quality of many of this year's generation of IB biology candidates.

b) The requirement was only to give an outline of the process of blood clotting. Some candidates gave far more detail than this and had already scored six marks in the first paragraph of their answer. The most frequent errors were to state that thrombin is converted to prothrombin or fibrin to fibrinogen. A point that might be stressed more in teaching is how clot formation is localised in a cut or other wound. The mechanism described by some candidates would lead to clotting throughout the blood system!

c) The last part of this question proved problematic for many candidates. There was no difficulty in giving enough benefits of vaccination. The problem came with finding enough genuine risks. Many of the answers given by candidates were simply untrue or were so unlikely that they should not be taught as risks or dangers of vaccination. There are of course some mild and temporary side effects at the site of the vaccination and rare allergic reactions. Also, some vaccinations have to be repeated or booster shots are necessary. There were dangerous misunderstandings in some candidates' answers, for example that there is a significant risk of actually contracting the disease from the vaccine or that multiple vaccines weaken the immune system. Some answers were not risks of the actual process of vaccination, for example its unaffordability in poorer countries, the fact that used hypodermic needles could spread disease, or that there are irrational fears about particular vaccines. Risks of vaccination are so much fewer and less significant than benefits that risks should probably not be included in future versions of the IB Biology programme. To be fair to candidates, it was challenge to express more than one or two risks in a way that was accepted by examiners, so part (c) was more discriminating than teachers commenting on G2 forms expected. One teacher commented that 8 marks was too much for this question and in retrospect this is possibly true.

Recommendations and guidance for the teaching of future candidates

There was clear evidence from scripts that many centres prepare their candidates extremely well for IB Biology exams and that candidates take the revision period before the exams very seriously. For those teachers who feel the need to improve the preparation of their candidates, the following advice is offered.

- The command terms used in exam questions should be used throughout the IB Biology course, so that they become very familiar. Definitions of command terms, formerly referred to as action verbs, were an initiative by IB biologists in the mid 1990s. The aim was to make it clear to candidates what was expected in the answer to every question.
- Candidates need to know what they have been taught. For example, it should be clear to them that the example of eukaryotic cell structure that they have drawn is a liver cell and the details of DNA replication given to them describe the process in prokaryotes rather than eukaryotes. In some cases teachers need to check the precise phrasing of the Guide that was first examined in this session. During the revision period, candidates might find it useful to have a copy of the syllabus with assessment statements but not teacher's notes. This should include the core, AHL and options that they have studied.
- In data-based questions, it is rarely sufficient merely to quote figures. Comparison involves actually stating which value is larger or which has risen more. Otherwise the examiner has to do the work of making comparisons or drawing conclusions, so marks are unlikely to be awarded.
- Candidates should all be encouraged to practise their drawing skills, however highly or lowly they rate their own ability. They should use a pencil for the drawing itself, pencil or ink for the labels and a ruler for labelling lines. Highly stylised diagrams, of the heart for example, may be easier to remember, but they can lose marks for aspects being too unrealistic.

- The predictable but inevitable other piece of advice is that all candidates should take the revision period seriously, to ensure that their knowledge of the Biology programme is comprehensive and their understanding is secure.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 16	17 - 21	22 - 26	27 - 31	32 - 40

General comments

The comments on the G2 forms indicated that the majority of the teachers felt the paper to be of a similar standard to last year's paper, while equal numbers thought it be slightly easier or slightly more difficult. As to the paper's suitability, 95% thought that it was of an appropriate level of difficulty. Most considered the syllabus coverage to be either good or satisfactory, although 12% indicated it to be poor, an inevitable problem due to the limited number of questions covering the specific content of each option. Essentially all respondents thought that the wording and presentation of the paper was good or satisfactory. As always, teachers' comments on each particular question were carefully considered at grade awards.

The areas of the programme and examination that appeared difficult for the candidates

- Some candidates had difficulty in the data analysis questions in their options, especially in response to the command terms of objective 3, such as "explain", discuss", "analyse", "evaluate" and "deduce", giving very simplistic answers which do not satisfy the criteria. This also applies to other questions. The cumulative or stacked bar graph in Option G was not understood by some candidates.
- Hardy-Weinberg equation
- Rhythmical behaviour patterns, use of fMRI
- Reverse transcriptase
- Biomagnification, r-strategies and K-strategies
- Specific liver damage caused by excessive alcohol consumption

Levels of knowledge, understanding and skill demonstrated

The majority of the candidates attempted to answer all parts of all questions. Many demonstrated well developed skills in interpreting the graphs and data in a variety of formats. Most candidates could extract values from data and make simple comparisons.

The strengths and weaknesses of the candidates in the treatment of individual questions

Option D: Evolution

Question 1

a) The answer was very straightforward as was (b) for most candidates, neither causing major problems.

b) Few candidates received 3 marks, the majority getting one or 2 marks for marking points b and c.

c) There were some good discussions as to the evolutionary significance although many candidates did not really "discuss" the data which should include arguments for and against.

Question 2

a) Many candidates gained the mark giving any one of various aspects of cultural and genetic evolution.

Question 3

a) Many candidates were fairly knowledgeable about analogous and homologous characteristics, but others had no idea at all, or confused the two.

b) Some candidates showed excellent comprehension of the application of the H-W equation, but there were some who could do little more than give the equation at best, or vaguely discuss albinism. Marks were possible for both the specific calculation and/or a more general explanation, making it fairly accessible to gain full marks. A common mistake was omitting to mention that "p" and "q" refer to the *frequency* of the alleles.

Option E: Neurobiology and behaviour

Question 1

Virtually all candidates answered the first two parts correctly.

c) Most gave the relationship correctly, although some candidates used incorrect terms such as "bright colours" or "lighter colours" instead of using the necessary one of "colour contrast" as used on the graph.

d) This was very discriminating with widely varied answers, from ones evaluating the data very clearly and correctly, to ones that showed little understanding of the question or what it means to "evaluate" data.

e) This was generally answered well, although some candidates did not gain the mark as they did not include an explanation of how the behaviour could affect their survival. Some very weak candidates gave "altruistic behaviour" or even "conditioned responses".

Question 2

a) Most candidates could identify at least 2 of the parts of the ear and many all four.

b) There was a wide range of correct answers, but many only gained one mark, some giving very vague examples.

Question 3

a) In spite of this question having been taken directly out of the study guide (AS E 6.7), the use of rhythmical behaviour patterns caused problems for some candidates, confusing it with musical or social behavioural patterns such as the waggle dance of bees. The best answers usually included mating behaviour (ie. red deer in the fall so young are born when there is food, adequate temperatures, etc.), diurnal/nocturnal behaviour and/or migratory behaviour. Some missed marks by not specifying the animal, stating only "*birds* migrate" or "*deer* reproduce".

b) This question was very well answered by some candidates, but unfortunately some had no knowledge of the topic or were very confused between brain lesions and fMRI. Also there was a lack of understanding of "*discuss*", just giving some technical details without arguments for and against the use of the two methods of studying brain function nor the limitations to their use.

Option F: Microbes and biotechnology

Very few candidates chose this option.

Question 1

a) (i) and (ii) were well answered by many, although some confused the data of the various bacteria.

b) was more discriminating, with some candidates unable to read the value of the standard deviation on the graph while few could correctly state it's significance.

c) Some candidates were able to answer this question well with 2 good comparisons, but some only cited values with no comparison.

d) Most candidates correctly identified the Ac bacteria.

Question 2

a) There were 2 different interpretations given in this question both of which were accepted, either variation of DNA/RNA or variation caused by biotechnological intervention or irradiation.

b) There were some excellent answers but many confused, incomplete ones where the candidates were not even able to give a named example.

Question 3

a) There were some very complete answers, but many wrote very vague answers on general food poisoning (causing diarrhoea, etc.) but with no identification of the specific organism or why they could be transmitted by food. Some even confused food poisoning with other bacterial infections, such as *Staphylococcus*.

b) Although there were some good answers here, others were far too general, barely naming a method but with no *evaluation* of the methods.

Option G: Ecology and conservation

Question 1

a) Some candidates were able to state the biomass correctly, but many had no understanding of stacked bar graphs and could not do the calculation in (b).

b) Surprisingly, many candidates still cannot calculate percentage increases.

c) There were some very good answers here, but many candidates had difficulties in this part of the question. Some confused the terms HNF (a specific group) and heterotrophic plankton (all of the groups), thus missing the point of the question.

Question 2

[A surprising number of candidates answered this question as though it were the continuation of G1.]

a) Most candidates had no problem with this question, although some did not give a named biome, but instead referred to “forests” or “tropics”.

b) Those who knew the term *biomagnification* had no difficulty, but a surprisingly large number of candidates had no idea, some confusing it with eutrophication.

Question 3

a) As expected, most candidates had no difficulty here, although some candidates confused *ex situ* with *in situ* measures.

b) Some candidates provided complete, accurate answers but others were unable to discuss r-strategies and K-strategies. The most common answers included knowledge of unstable and stable environmental conditions favouring each strategy as well as the general type of reproductive strategies of each.

Option H: Further Human Physiology

Question 1

a) Most candidates answered this well, but some confused the oxygen conditions.

b) There were again problems in calculating percentage change.

c) Most candidates were able to identify the conditions of greatest power output but did not *analyse* it, thus gaining only one mark.

d) Many candidates gave variations of the expected answers, thus gaining the mark, but some were unable to give a concise suggestion.

e) Many candidates could name adaptations but lost the marks as they did not *explain* them by giving causes, reasons or mechanisms.

Question 2

a) There were some very clear, correct answers, but some candidates confused the two types of hormones while others discussed general effects of steroids on the body or simply left it blank.

b) Many candidates gained the mark here, but many answers were too vague, not stating in scientific terms the action of *H. pylori* in causing stomach ulcers.

Question 3

a) Although many candidates showed a good knowledge of factors affecting the incidence of CHD, many only listed the factors or gave an overly simplistic outline of the effects (which should be a brief account or summary), such as stating age affects CHD as there is more risk as you get older.

b) There were some excellent answers on liver damage due to excessive alcohol consumption, but many vague ones with insufficient use of biological concepts to gain full marks.

Recommendations and guidance for the teaching of future candidates

- Candidates should be encouraged to use subject-specific vocabulary in their answers.
- Candidates need more practice with data analysis using previous exams, paying attention to accuracy of reading data. Units should always be given with an answer to a calculation or when quoting data from a graph. More practice is needed in manipulating data and in calculating percentage changes, in particular. A wide variety of graphic representations should be used during the two years, including stacked bar graphs as they require practice to master their interpretation. It is important to incorporate evidence given by the data itself when discussing, explaining or evaluating results or hypothesis.
- Candidates need guidance in how to consider the depth of their answer and the mark allocations. The command term must be considered carefully, as well as the number of marks for the question. If a question is worth six marks, at least six specific statements must be made. The sequence of the statements should be carefully considered, as well as using examples to illustrate an idea. Throughout the two year programme candidates should have plenty of opportunity for writing extended response answers.
- Candidates should have studied the whole syllabus two options and attempt to answer only those two. It is apparent that some candidates are answering ones simply because the data analysis looks easier, but they gain no marks on the content portion of the option.
- It is important that teachers attempt to cover all AS in the chosen options as the nature of the exam means syllabus coverage is not complete due to the limited number of questions on specific content. Teachers are advised to read the teachers' notes for guidance on the expected depth and breadth of each topic. The vocabulary utilized in the AS and teachers' notes is normally utilized in the specific content questions.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 11	12 - 15	16 - 18	19 - 22	23 - 25	26 - 30

General comments

Of the 115 G2s received by grade award, 74% considered it similar in difficulty to last year's paper. 17% of the remaining G2 forms suggested that it was a little more difficult, 2% thought it was much more difficult and 7 % that it was a little easier. G2 forms gave a generally favourable response to this paper, with 86% reporting that it was appropriate in terms of level of difficulty, with the remainder considering it too difficult. More than 98% felt that this year's paper had good or satisfactory syllabus coverage, clarity of wording and presentation.

The strengths and weaknesses of the candidates in the treatment of individual questions

Some questions performed in a predictable way and no comments need to be made about them. The comments that follow relate to questions where candidate performance was very good or very poor or questions that aroused comment from teachers on G2 forms.

Question 1

This seemed to be a very difficult first question; usually the first question is easy. The discrimination index was good, showing that the good candidates were able to answer it correctly and the weaker candidates incorrectly.

Question 3

Some candidates believed that bacteria divide by mitosis, but this process only occurs in eukaryotes.

Question 4 and 5

The quality of the micrograph was not good; nevertheless this did not affect the performance of the candidates. Although the term chromatin is not in the syllabus, most candidates had question 5 correct.

Question 6

Some teachers complained about the quality of the diagram, but the examiners did not agree with this conception.

Question 7

Good candidates realised that cells in G2 phase have more mitochondria than in G1 phase.

Question 9

This question turned out to be a good discriminator. Many candidates did not consider the chromatids, but merely counted chromosomes.

Question 10

Some teachers complained about the language used in this question, but most candidates had this question right.

Question 13

Both A and B were accepted as correct answers.

Question 15

This question proved to be a very good discriminator, as most good candidates had it correct.

Question 16

The question clearly states which event directly leads to the action potential, so the only possible answer is C

Question 17

This question had a high discrimination index. Good candidates realized the function of the diaphragm in breathing in.

Question 20

The stem should have asked to which phylum do the sponges belong.

Question 21

Candidates should know that natural selection reduces variety within a population.

Question 23

Assessment statement 5.2.2 says to analyze the changes in concentration of atmospheric carbon dioxide using historical records. This means candidates should have used the data provided, or data of a very similar nature. Most candidates found the questions easy. Although in question 20 other options might seem correct, answer A was the most correct.

Question 25

This question had the highest discrimination index of the whole exam.

Question 28

This question seemed to be quite easy for most candidates.

Question 29

This question seemed to be easy for many candidates. There was some concern with the term embryo, but this is present in the subject guide.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 18	19 - 25	26 - 31	32 - 38	39 - 50

General comments

In section B the overall quality of responses and diagrams in particular appeared to be of a similar standard to May 2008. Diagrams appeared improved with more appropriate subject content this year.

G2 forms were received from 95 teachers, which was an increase from last year. Seventy-seven percent of respondents found the paper to be of a similar standard to the previous year, with 9% believing it to be more difficult. Ninety-three percent of respondents considered the paper to be of an appropriate level of difficulty. Seventy percent of teachers regarded coverage and clarity of wording as good. Eighty-six percent of the respondents rated the presentation of the paper as good. G2 forms are always read and considered at the beginning of the Grade Award process so detailed completion of them is most helpful in the process of awarding grades. Please complete a G2 form for every examination your candidates are involved in.

In Section A, though all parts of the data analysis question were eventually answered well by the candidates as a group, overall success by any particular candidate usually fell well short of the maximum number of marks available. Candidates needed to scrutinize the data (primarily graphical analyses) more precisely and make better use of the background information that was presented. Also, especially in the data analysis questions, candidates often failed to match their responses to the leadoff action verb of the question.

In Section B, candidates overwhelmingly chose to answer Question 5. The popularity of this question was probably based on the fact that it was based on human physiology and was perhaps the most straightforward to answer of the three questions in section B. Achievement in Questions 6 and 7 was not as strong, though many candidates who attempted these provided very good responses to the questions.

The areas of the programme and examination that appeared difficult for the candidates

Section A

This year analysis of the data proved to be a challenge to many candidates, with candidates having most difficulty comparing and evaluating data. In the question 2, many candidates were unable to explain how cells become differentiated or outline outcomes of the sequencing of the human genome. In question 4, a surprising number of candidates were unable to recall definitions of the terms *species*, *community* and *population* and found it difficult to precisely outline the flow of energy in ecosystems.

Section B

As in the past, candidates found the longest parts of these questions (worth 8 marks each) the most difficult. They should carefully consider these parts before attempting the question. Most who chose questions 6 or 7 were strong on parts (a) and or (b), but weak in (c). As always, candidates showed variable drawing skills, with many untidy and poorly labelled diagrams denying candidates marks. Linking of relevant ideas to form a fluid flow of ideas *within* at least 2 parts of a question still remained a challenge to many.

The areas of the programme and examination in which candidates appeared well prepared

Section A

Most were able to identify that the human genome project is useful in terms of the development of medical technology to assist in the diagnosis and treatment of genetic conditions. Most also were able to describe the concept of optimal pH in enzyme catalysed reactions. Many could recall the ecology definitions and were able to explain the concept of an energy pyramid.

Section B

There were many excellent diagrams drawn for part (a) each question. Most candidates appeared to understand the command term in the questions and what the answer required. The answers to question 5 were especially well done with candidates displaying a good knowledge of the structure of blood vessels and the process of ventilation.

The strengths and weaknesses of the candidates in the treatment of individual questions

Question 1

The style used to display details of experimental design at the start of this question was novel for most candidates.

a) This was intended to be an easy start to the question and almost all candidates answered it correctly. It was also intended to encourage candidates to think carefully about the time scale on the *x*-axis. It was clear that some candidates did not do this.

b) The numbers 0, 1, 2 and so on could either be interpreted as the number of days after the start of the experiment, or the start of Day 0, Day 1, Day 2 and so on. Many candidates scored a mark for stating that there was one injection of saline at the end of Day 0, the start of Day 1 or after one day. Far fewer pointed out that two oral doses of saline were given each day. This could be deduced from the twenty open circles in the ten-day period of the experiment.

c) This was answered correctly by about half of the candidates. The most common fault was failure to state clearly when edaravone was administered. The answer, "*over the first 4½ days*" was not accepted because there were two administrations per day and ten in total.

d) Most candidates correctly calculated the increase in protein and only a few forgot to give units. The question should probably have used the command term calculate rather than state but few candidates only stated the values without carrying out the subtraction.

e) Answers were very varied, with marks evenly spread between 0, 1, 2 and 3. The question was easier to answer if the instruction to give similarities as well as differences in compare questions was remembered. Quotation of numerical values rarely gains many marks in IB Biology exams. Some answers consisted only of this, but scored a maximum of one mark.

f) It was essential to remember that in evaluate questions implications and limitations are the focus. The experimental results for late administration of edaravone supported the hypothesis, but those for early administration did not. Candidates were expected to explain this partial support. Few were able to evaluate this. They seemed reluctant to say that it was only "partially correct" opting to say either correct or incorrect instead. Questions are never set to trick candidates but they need to be aware that much data is inconclusive and requires further testing of a hypothesis before it can be confirmed or rejected.

Question 2

a) Candidates either seemed very clear that differentiation was the process that produced specialized tissue or not aware of it at all.

b) Again, candidates found it difficult to explain how specialized tissue *develops*. The best answers explained how cells used genes selectively and gave specific examples of specialized tissue and their functions.

c) Many candidates confused the human genome project with karyotyping of individuals. However most candidates gained marks by mentioning that the project had been valuable in increasing our knowledge of and ability to treat diseases of genetic origin.

Question 3

a) Knowledge of the characteristics of active transport was generally well expressed. Many candidates understood that protein pumps, requiring energy were required as opposed to protein channels that may be used in facilitated diffusion.

b) This question was answered well with candidates aware of the concept of an optimal pH with activity trailing off on either side. The best answers liked this to the structure of the enzyme active site being changed by the changing pH.

c) Most candidates had no difficulty indicating the end products of respiration. A large number of answers indicated that pyruvate was a common source in each case of respiration, though weaker answers did not.

Question 4

a) Candidates either knew these definitions well or did not. It is valuable to stress to candidates that many marks come from command term objective 1 questions, which are overwhelmingly "state" or "define". These questions require commitment to learn these statements and definitions. Such commitment is always rewarded when candidates meet questions such as these in examinations

b) Many candidates were able to describe the flow of energy through ecosystems well with the best answers including diagrams of an energy pyramid with the tropic levels labelled.

Section B:

Most candidates attempted Question 5. Relatively fewer tried Questions 6 and 7.

Question 5

a) On the whole the diagrams of the heart were well drawn receiving full marks. A sizable number of candidates drew schematic diagrams, which did not distinguish, between the relative size of the various chambers or the relative wall thickness. Some candidates squandered the opportunity for marks by drawing small or untidy diagrams

b) The structure of the blood vessels was outlined well, though some candidates lost marks here as they referred to e.g. the arteries, rather than the artery walls as being thick. A number of answers simply listed the features of the vessels without linking these to their function as required by the question.

c) This section was generally very well done with candidates outlining the sequence of events in the ventilation of lungs. Weaker answers did not distinguish between internal an external inter-costal muscles which have opposing roles in ventilation.

Question 6

a) On the whole the diagrams of the adult female reproductive system were well drawn receiving full marks. A sizable number of candidates drew schematic diagrams, which did not distinguish, between the relative thickness of the uterine wall. As with other questions, some candidates squandered the opportunity for marks by drawing small or untidy diagrams

b) The role of natural selection in evolution was not well answered even though it is a fundamental concept in biology. The best answered laid out a step-wise sequence of events that lead to evolution with real life examples to illustrate the explanation such as Galapagos Island Finches.

c) The consequences of altering a base in the genome of an organism should be a straightforward question to answer but many candidates rambled without giving specifics. The best answers laid out a step-wise sequence of events that explain the consequences with real life examples to illustrate the explanation such as Sickle cell anaemia.

Question 7

a) On the whole the diagrams of a prokaryotic cell were well drawn receiving full marks. A sizable number of candidates drew hybrid cells with features of prokaryote and eukaryotes. Contradictions in answers cannot be rewarded and such answers did poorly. As with other questions, some candidates squandered the opportunity for marks by drawing small or untidy diagrams

b) This question was straight from the subject guide but many candidates were unable to identify the relevant factors. Those who could generally did well. Many good answers used annotated graphs to illustrate the changing effect of the factor on photosynthesis.

c) The impact of gases on the Earth's temperature was, in most cases, not well answered with many candidates confusing the greenhouse effect with the hole in the ozone layer.

Recommendations and guidance for the teaching of future candidates

- Read and use ALL information provided in the question. If you can, re-read it quickly and try to apply it in responses.
- Teachers should try to familiarize candidates with the meaning of the command terms in the subject guide. Incorporate these wherever possible in local school testing and assignments.
- Candidates should be succinct in their answers, writing their answers in the spaces provided or asking for extra paper if they do not have enough space in the examination booklet.
- Teachers could train their candidates more, or at length, on aspects of quality response to questions in section B. Many candidates miss out on the quality marks on offer since many just waffle.
- When calculating data, measure figures as accurately as possible and always show working.
- Use a 2B pencil for drawing and a ruler for labelling lines in diagrams.
- Candidates should consider their section B choices carefully and respond to the question to which they can confidently attempt *all* sections.
- Teachers could also spend some more time on the section of the syllabus dealing with genetic engineering and natural selection. It appears these are usually rushed through without due regard to in-depth understanding by the candidates.
- All candidates should be given a copy of the new Biology Guide (first exams 2009) so they realize the content that will be examined.
- Candidates should be taught how to write answers that reflect the direction of the "Command Terms" on pages 11 and 12 of the new guide.
- Teachers should integrate the analysis of data in tables and graphs and calculations with units wherever possible throughout the SL course. Percentage calculations must be included.
- Candidates must practise drawing the diagrams given in the subject guide. Attention should be given to accurate labelling, juxtaposition of structures, relative size, and continuity (as in a continuous tube for the digestive system).
- A good review programme, including use of old papers and problem solving, is essential to good preparation of candidates for the exam.
- Candidates should be aware that they are expected to write at least as many facts/clearly stated ideas as the mark value of the question, shown in brackets at the end of the question.

- Candidates should be shown how to write a plan/rough draft for a well-constructed answer, as an approach to writing organized answers. This is especially important for questions that start with discuss or explain. It is important for candidates to practise linking information in their answers. There is no need to repeat the question, since this takes up time and space.
- It is recommended that teachers emphasize the importance of legible handwriting. If a candidate's answer is correct but unreadable, the candidate may lose marks if deciphering the handwriting is impossible and the examiner misinterprets the script.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 8	9 - 14	15 - 19	20 - 24	25 - 29	30 - 36

General comments

104 G2 forms were submitted. Of these, 75% thought that the paper was of a similar standard to that of last year and 8% thought it was a little easier. The remainder thought that it was a little more difficult. However, 92% of teachers thought that the level of difficulty was appropriate. 94% thought that the syllabus coverage was good and this rose to 99% for clarity of wording and of the presentation. Only a few teachers thought that the paper was poor for syllabus coverage, none for the other aspects.

The accessibility of different Options seemed to be very close, with no obvious differences in the difficulty. Options A and E appeared to be the most popular and Option F the least popular, in terms of the number of schools that had prepared candidates for them.

The standard of performance showed a wide spread, with few very low and few very high marks being awarded. It was however a little disappointing to see some candidates who obviously had had a poor experience, benefiting little from the course and producing very low marks It was surprising to note that many candidates continued their answers on separate sheets, often including many pages. Candidates should realise that the space allocated for an answer is a good guide to the length of an answer, and remember that quality rather than quantity is important. A few candidates wrote all their answers on separate sheets rather than using the script. Application of skills seemed to be as much a problem as knowledge and understanding with marks not being awarded for a wide variety of reasons.

The areas of the programme and examination that appeared difficult for the candidates

Many candidates had difficulty in understanding and comparing data from graphs and charts. They tended to simply describe patterns or repeat data without any analysis or processing. It is obvious that some responses are the result of not reading the question properly and/or not relating it to the mark allocation.

Candidates continue to struggle with calculating a percentage increase. Significant proportion of candidates failed to calculate % differences/increases (A1 (b), D1 (b) and G1 (b)) and since

A, D and G were the most frequently answered some candidates could lose 3 marks as a result.

Biomagnification was poorly explained by about 1/3 of candidates who answered G

Option C seemed to provide the greatest challenge; this might in part be due to the "tough" data used but also very few understood that metabolic pathways referred to end-product inhibition. Option G produced a wide variation in response with both very poor and very high marks. G1 (c) seemed particularly challenging with almost no candidates scoring the max 3 marks.

Two Options had two questions worth 4 marks [A3(b) & D3(b)] and meant that it was harder to demonstrate mastery in these two questions due to the number of marking points required, especially coupled with the fact that PKU was apparently not well enough understood to the depth required.

The areas of the programme and examination in which candidates appeared well prepared

It was difficult to pick out any general strengths and weaknesses in biological knowledge. Many answers tended to be "centre specific", i.e. candidates from one centre producing good answers, yet candidates from another centre producing very poor answers to the same question. This emphasises the need for all topics on the options to be taught carefully. It is clear that candidates can extract data from tables of values quite easily Eg Option A1. Option B1 Graph together with the table helped candidates with their responses but Option D1(c) many candidates made comparisons but these did not always fit the mark scheme and often required considerable skill in interpretation.

The strengths and weaknesses of the candidates in the treatment of individual questions

Option A: Human nutrition and health

Question 1

a) (a) & (c) well answered

b) Correct in about 75% scripts

d) Only about 25% managed to actually evaluate the hypothesis; the significance of HDL was not recognized by many nor the link with arteriosclerosis or CHD – often "bad for you or your heart"

Question 2

a) Just over ¾ gained the mark

b) This was answered well by about 50% candidates – weaker candidates referred to feeling hungry so eat food. Some candidates really understood the process of appetite control, even mentioning the hormones involved.

Question 3

a) Generally well answered by significant majority of candidates but several made reference to obesity being a symptom of diabetes

b) This was only answered well by about 25% candidates – many made only vague references to consequences of PKU or that it is a genetic disorder. Many candidates confused PKU with diabetes.

Option B: Physiology of exercise

Question 1

a) (a) & (b) answered very well (data was slightly easier to interpret compared with some other options)

c) This was poor with few candidates explaining the data and linking it to anaerobic/aerobic respiration

d) This was reasonably answered but very few scored 2 marks.

Question 2

a) Well answered (generally 2 marks or 0 marks)

b) (i) too little space for the answer but most scored 2 marks

(ii) some rambling answers but most scored 2 marks and about 1/3 all 3 marks.

Question 3

a) About half answered correctly

b) Most scored 2 marks but many did not explain what increased performance might look like. Some confused EPO with steroids.

Option C: Cells and energy

Question 1

a) (a) & (b) were well answered although some candidates seemed to struggle with the English. Maybe better wording would have been “distinguish between the yeast a-glucosidase activity in 2% maltose and 2% glucose”

c) Hardly any good answers seen with almost no candidate scoring 3 marks – clearly most either did not understand the notion of enzyme regulation or simply did not connect it to the metabolic pathways

d) Many put in many steps of glycolysis not knowing whether several points had to be made for 1 mark

Question 2

c) Generally not very well answered, with few being able to accurately explain primary and secondary structure; many distinguished between globular and fibrous but often only gave one example.

d) Well answered

Question 3

a) Most scored both marks

b) Few could explain sufficiently to get more than 1 or 2 marks – clearly an area that needs reinforcing. Most could identify that light was absorbed and the electrons went from molecule to molecule, but few scored a third mark.

Option D: Evolution

Question 1

a) This was very straightforward as was (b) for most candidates, neither causing major problems.

b) Few candidates received 3 marks, this question part caused problems with many candidates not able to distinguish between range (length of bars) and degree of variation (differences between bars) and thus many answers had repetitive comments.

c) There were some good discussions as to the evolutionary significance although many candidates did not really “discuss” the data which should include arguments for and against.

Question 2

Both parts very well answered

Question 3

a) (a) & (c) well answered; a many referred to genes in whole species rather than population

b) challenged a significant number of candidates– partly due to available space; comparison was not always stated obviously but was implied. Few scored full marks.

Option E: Neurobiology and behaviour

Question 1

a) (a) & (b) Virtually all candidates answered these first two parts correctly.

b) Most gave the relationship correctly although some candidates used incorrect terms as “bright colours” or “lighter colours” instead of using the necessary one of “colour contrast” as used on the graph.

c) This question was very discriminating with widely varied answers, from ones evaluating the data very clearly and correctly, to ones that showed little understanding of the question or what it means to “evaluate” data.

d) Was generally answered well, although some did not gain the mark as they did not include an explanation of how the behaviour could affect their survival. Some very weak candidates gave “altruistic behaviour” or even “conditioned responses”.

Question 2

a) This was very well answered

b) 2 marks for a discuss question is not enough but most scored the two marks. Some candidates confused learned behaviour with learning in an academic sense.

c) Candidates produced many very long answers with many scoring full marks.

Question 3

a) Stimulus was well answered but significant numbers did not mention “rapid” in the reflex

b) A variety of answers with many scoring full marks

Option F: Microbes and biotechnology

Question 1

a) (i) and (ii) were well answered by many, although some confused the data of the various bacteria.

b) This was more discriminating, with some candidates unable to read the value of the standard deviation on the graph while few could correctly state its significance.

c) Some candidates were able to answer this question well with 2 good comparisons, but some only cited values with no comparison.

d) Most candidates correctly identified the bacteria.

Question 2

a) Some candidates gave quite good answers.

b) Many candidates explained the function of reverse trasnscriptase in HIV, not answering the question.

Question 3

a) Many correct answers were seen.

b) Some answers were too vague, but many candidates knew the use of *Saccharomyces* in the production of beer.

Option G: Ecology and conservation

Question 1

a) Some candidates were able to state the biomass correctly, but many had no understanding of stacked bar graphs and could not do the calculation in b).

b) Surprisingly, many candidates still cannot calculate percentage increases.

c) There were some very good answers here, but many candidates had difficulties in this part of the question. Some confused the terms HNF (a specific group) and heterotrophic plankton (all of the groups), thus missing the point of the question.

Question 2

a) This was well answered generally; most common error referred to production by all organisms rather than autotrophs/producers

b) There were some excellent answers by about 25% of candidates but many others produced answers that were too vague e.g. vegetation – lots or little. This was partly caused by lack of space for the answers – the first column was too wide.

Question 3

a) There were many good answers and many poor ones – including many guesses.

b) Answers were generally weak all round – an area that needs attention

Recommendations and guidance for the teaching of future candidates

- The importance of the command terms/verbs cannot be overemphasized; Comparisons require comparatives (more, greater, fewer than….etc) or a clear table to distinguish differences (or similarities if relevant). Similarly "Evaluate" a hypothesis requires information that supports or refutes it and the candidate must state as such, not just regurgitate data from the question etc.
- To avoid (–1 mark) for lack of Units stress that candidates should always put units – even if not really required e.g. Calculate the % difference = 4%
- Similarly explain to candidates why occasionally arbitrary units are used in expressing data.
- Many candidates run out of space for their answers – it is not a requirement to write full sentences nor is it necessary (or wise) to rewrite the stem of the question. Pertinent phrases that make the point are often better.
- Try to get candidates to avoid restating the words in the question because they will gain no marks. For example: B3(b) "EPO benefits athletes since it increases their performance" gets no mark; greater depth is required but "EPO can increase flow of oxygen to muscles" gains 1 mark and "thereby allowing sprint runners to increase their speed and get faster times" gains another 1 mark.