

BIOLOGY TZ1 (IB Latin America & IB North America)

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 16	17 - 29	30 - 41	42 - 53	54 - 65	66 - 77	78 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 28	29 - 41	42 - 54	55 - 66	67 - 77	78 - 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 then they are frequently too simplistic. The range of values of the independent variable was insufficient to establish a trend. The number of repeats were 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 candidate 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 - 10	11 - 15	16 - 21	22 - 25	26 - 29	30 - 33	34 - 39

General comments

Of the 99 G2 reports received by the time of grade award, 55% thought that the paper was of a similar standard to that of last year, 10% though it was much more difficult and 8% thought it was a little easier. The remainder thought that it was a little more difficult. However, more than 74% of teachers thought that the level of difficulty was appropriate.

More than 80% thought that the syllabus coverage, clarity of wording and presentation were good and only 5% 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

There has been some concern about the relevance of this question in a Biology paper, although it is part of the mathematical requirement as interpretation of graphs are very important to all Biology candidates.

Question 2

Although many candidates answered this question correctly, some believed the sample size needed to be greater than 30 in order to perform a t-test. The conditions needed for a t-test form part of the use of this test.

Question 4

Some teachers believed that mitosis could be considered a correct answer for the prokaryotic cell division, but this mechanism only occurs in eukaryotes (it requires the presence of chromosomes). Most candidates did very well in this question and it was a very good discriminator.

Question 5

Most candidates had this question wrong, they did not recognize the polysaccharide as a component of the extracellular cell matrix.

Question 11

Although some teachers complained about the wording of this question, it turned out to be a very good discriminator. Some candidates thought a homozygous female always showed normal vision, but a female homozygous for the colour blindness allele would not have normal vision.

Question 13

Most candidates answered this question incorrectly. Although it was a good question, it was perhaps a little bit too complicated for candidates to analyze a pedigree in such a short time. It was agreed at grade award that it would have made a better Paper 2 question.

Question 14

The quality of the diagram here was not as high as it could have been but it was still a discriminating and effective question

Question 15

Although some teachers complained that the term protoctist is not present in the syllabus, the candidates did not seem to have any problems understanding the question. This question had a high discrimination index, showing that the good candidates answered it correctly and the weaker candidates incorrectly.

Question 16

This question presented a lot of controversy so it was decided it should be eliminated. The details of mechanisms of the effect of greenhouse gases need not be known.

Question 17

Many candidates considered that C was a correct answer. This shows a lack of understanding of the process of natural selection, as they considered Lamarckian inheritance part of natural selection.

Question 18

Some teachers were concerned this question was testing the use of dichotomous keys rather than Annelids. Both were being tested. This question had quite a good discrimination index.

Question 19

Although proteases are not secreted in the small intestine, many years ago it was believed that they were. Proteases are membrane bound in the small intestine (but not secreted there). Considering that some books might still use this concept, both answers A and C were considered as correct in order to make this question fair.

Question 20

Many candidates thought that antibiotics are not effective against viruses because these can hide inside the host cell, failing to acknowledge the effect of antibiotics on bacterial enzymes.

Question 23

This question seemed to be a bit complicated as many candidates confused the term packing units, considering they were the histones instead of the nucleosome. The discrimination index was quite good, showing that it did not prove that difficult to good candidates.

Question 24

Most candidates had the incorrect answer C, showing poor understanding of the process of translation. It was a good discriminator, so good candidates did understand this question.

Question 26

This question had a high discrimination index, showing that it did not show difficulty for good candidates. Even if hydrogen bonds are very important in the tertiary structure of proteins, it is the interactions between the side groups of amino acids that determines the tertiary structure.

Question 30

Although the examiners agreed this is a good question, it turned out to be a bad discriminator, as most candidates considered B to be the correct answer. Many candidates failed to realize that there is a negative production of oxygen when there is no light as it is consumed in respiration.

Question 32

This proved to be a very difficult question, but had a good discrimination index. The only correct answer was C, as the other options would open the stomata.

Question 33

Although some teachers complained about this question, all the statements are present in the syllabus.

Question 35

Many candidates confused the production of recombinants with the source of variety. This question did not discriminate well.

Question 38

This question turned out to be a very bad discriminator but many candidates had the correct answer.

Question 39

Many teachers complained that the question was too specific and too much detail about the role of testosterone was expected. 42% of the candidates incorrectly answered A and 58% correctly answered B.

Question 40

Options B and C are both correct, and therefore both answers were accepted.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 19	20 - 28	29 - 37	38 - 47	48 - 56	57 - 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 remainder were divided between thinking it easier or a little more difficult. The mean mark was very similar to last year's. More than 90% of teachers thought that the paper was appropriate in difficulty and statistics show that 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 7% 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 satisfactory or good and there were few criticisms of specific questions.

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

Question 1

- a) Hydrogen bonds stabilizing the alpha helix & hydrophobic nature of membrane proteins.

Question 2

- a) Correct notation of linked genes and explanation of recombination.
- b) Characteristics of bryophytes and angiospermophytes.

Question 3

Cells: calculation of magnification and showing understanding of relative sizes

Question 4

- a) Correct drawing and labelling of structure of a chloroplast.

Question 5

- a) The process of oogenesis

Question 7

- a) Relating antibiotic resistance in bacteria to natural selection and environmental change.
- c) Benefits and dangers of vaccination

The levels of knowledge, understanding and skill demonstrated

While variation existed between the performances of candidates, some generalizations are possible. Reasonable knowledge of factual information in the syllabus was common among candidates. Candidates were most often able to show adequate comprehension of most basic concepts and principles but many demonstrated a limited ability to apply these concepts. Candidates were able to demonstrate some analysis or evaluation of quantitative or qualitative data, though this depended on the question type. Candidates were able to communicate adequately with clearly written and well structured answers, especially in part B answers. The misinterpretation of questions, especially in part A is an area that was problematic. The inclusion of irrelevant material was common in part B questions. A common scenario was candidates writing down answers memorized from mark schemes from previous exams without being sufficiently discriminating about what the question was asking for. Inaccurate or incomplete use of terminology was also a general weakness. Diagrams were generally of a higher standard than in the past and often gained full marks.

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

Question 1 (Bt modified crop data based question)

- a) In comparison to similar questions in previous years, candidates were relatively successful in answering this question. Where candidates did not answer correctly, it was due to a lack of ability to calculate percent difference rather than a problem with interpreting the data.
- b) Most candidates scored at least one mark. A common error was to interpret the results without comparison to the control.
- c) Most candidates calculated the mean masses correctly and included the correct units.
- d) Most candidates scored at least one mark. A common error was to focus on the difference between male and female rats rather than the food source and to not make reference to growth
- e) Most candidates gained the mark, but some simply repeated their answer to (d). The command term 'comment' requires candidates to give a judgment. Commonly, candidates mistakenly described the data in response to this command term.
- f) Most candidates gained the mark, though many missed the mark because of word choice such as referring to the bacteria 'creating' or 'ingesting' nutrients or acting as detritivores.
- g) Most candidates gained both the marks by recognizing the difference between harvest and flowering. Like answer (f), word choice affected performance with candidates referring to the biomass of flowers for example rather than biomass of soil microbes.
- h) Many candidates scored both marks. A common error was to answer without reference to the hypothesis.
- i) Many candidates identified the alpha helix, though a surprising number referred to the double helix. Most candidates identified hydrogen bonds as stabilizing the structure but very few could identify the parts of the molecule that were connected by H-bonds. Only a minority of candidates recognized the importance of the hydrophobic nature of membrane proteins.

Question 2 (corn seed genetics question)

- a) Most candidates gave the heterozygous genotype but could not express it using the correct notation. Candidates were generally able to identify the recombinants, but explanation of the cause was often incorrectly attributed to independent assortment. Some mentioned crossing over, but could not accurately describe what this involves.
- b) The structure of answers was not always what was expected in response to the command term; i.e., a list of features of one group was followed by a list of features of a second group. Some candidates accurately described the characteristics of one group but did not distinguish them from the other group. Lack of familiarity with terminology such as rhizoids etc. was common. Bryophytes were commonly equated with gymnosperms and pteridophytes.

Question 3 (liver cell electron micrograph)

- a) (i) Most candidates identified the nucleus/nuclear membrane but did not accurately state its function.
- (ii) Relative to magnification questions on previous exams, this question was poorly answered. Correct measurement was common, though precision of measurements was a problem for some. Changing between units proved to be more difficult. Some candidates used the scale bar to determine the width of the micrograph without realizing that the magnification could be calculated from the scale bar itself.
- (ii) This question was correctly answered by most candidates with candidates both recognizing structures and correctly relating structures to evidence of activity.
- b) A surprisingly large number of candidates thought bacteria were larger than the liver cell. Many candidates could outline relative sizes but could not accurately state specific size ranges.

Section B**Question 4**

This was the least popular choice of question.

- a) Diagrams were variable in quality. The poorest were very unclear and labelling was often inaccurate. The double membrane, grana, stroma and thylakoid were most often correctly labelled. The connection between the thylakoid and intra-lamellar membrane was often not shown.
- Failing to close lines when drawing membranes was also problematic. In some cases thylakoids were coloured in obscuring connections.
- b) The importance of adhesion and cohesion was covered well, although these were not often related to the molecular properties of water.
- It was the process of transpiration and the resultant force created that was less often mentioned or just given a brief treatment, losing marks for many candidates. Commonly, how water moves from soil into the root was detailed.
- c) Phytochrome was known about and that it exists in 2 interconvertible forms. A number showed evidence of memory of facts but with lack of understanding because details were confused and terms interchanged.

Question 5

- a) Most of the candidates gave trisomy 21 and non-disjunction, but fewer were able to accurately describe how it comes about. Confusion between genetic mutation and chromosome mutation was common especially when discussing causes.
- b) Quite a few candidates described the process of ovulation in detail, gaining no marks. Most candidates did refer to the formation of the polar body in oogenesis, but missed out on many of the changes given in the mark scheme. Detailed discussions of the menstrual cycle were common. Some obviously understood it but could not write clearly and logically/a general lack of detail.
- c) Most candidates gained a fair number of marks, but often limited their score by focusing on the negatives of IVF rather than the positives. But then again, the mark scheme only listed 4 pros vs 7 cons.

Question 6 (most popular question)

- a) Many of the candidates scored full marks.
- b) Despite some confusion about which enzyme does what and confusing DNA replication with transcription/translation, many candidates managed to gain full marks. A good number indicate that an RNA primer begins replication on the lagging strand only. Another common error was to refer to the gaps rather than the fragments as Okazaki fragments. Some candidates confused replication with translation.
- c) Many candidates lost marks by focusing on factors affecting the rate of enzyme controlled reactions and inhibition and missed the basics. Nearly all mentioned the lowering of activation energy, but many were not able to describe how this is done. Diagrams that were included could have earned more marks if they were more carefully drawn, with axes labels being more carefully included and differences in energy between reactants and products being more accurately represented. Few indicated that the enzyme was not used up in the reaction.

Question 7 (also a popular choice)

- a) Most candidates scored few marks, failing to mention gene transmission in bacteria, variation, or widespread use of antibiotics as the environmental change.
- b) Surprisingly few candidates could define immunity well. Some detailed accounts of how immunity is gained were given, but failure to describe accurately what happens if the same pathogen enters again or the different types of immunity meant that many candidates gained a low score.

Vague, rambling accounts about T and B cells were provided quite often. There was too much detail on the sequence of events leading to the development of memory cells (named as T or B) and less on how this resulted in immunity. Antibodies and antigens were sometimes confused.
- c) Candidates were generally better at giving the benefits rather than the dangers, but few candidates could give four of both. Misunderstanding about vaccinations was common which is quite a worry for candidates who have been through an advanced biology course. Many mentioned autism without substantiation.

Recommendations and guidance for the teaching of future candidates

Candidates should be encouraged to:

- Understand what is required of command terms; e.g., give both sides of an argument for 'discuss' and 'evaluate' answers.
- Develop a strategy for questions requiring the evaluation of an hypothesis.
- Use organizing diagrams for their answer such as t-charts. Sketches of processes such as replication and non-disjunction can help candidates organize their responses to part B extended response questions.
- Be more critical in the application of memorized answers from previous markschemes. This will avoid mark deduction from the quality of construction marks due to the inclusion of irrelevant material.

- Unpack their answers fully; i.e., do not leave the obvious unstated and include specific details. In the question where candidates were asked to compare relative sizes of bacteria, eukaryotes and viruses, candidates would have benefited from providing more detail in their answers. Also full details of calculations should be given. Similarly, abbreviating the DNA bases to A,T,C and G should be avoided.
- Use the language of biology wherever possible for example in Q6b enzymes include DNA or RNA in the names of the polymerase and primase etc. Use 'active site' rather than activation site or binding site. A similar issue is the use of recombinant notation.
- Use specific language; e.g., increase rather than change; gained mass rather than grew bigger; specific names rather than it, they etc.
- Practise % difference and magnification calculations.
- Label drawings in such a way that labels clearly indicate a structure. This was a common issue with the labeling of the thylakoid.
- Close lines in diagrams so that structures are shown as continuous. This was an issue in the drawing of the various chloroplast membranes
- Study the section on classification and plant diversity in greater detail
- Always include units in quantitative answers

Teachers new to the programme should endeavour to obtain a library of past papers or use the CD Question Bank so that old exams and mark schemes can be used in teaching as classroom based reinforcement exercises, homework assignments and revision exercises. These resources are also essential so that candidates can be given practice in analyzing data presented in different formats.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 8	9 - 11	12 - 16	17 - 21	22 - 26	27 - 40

General comments

The comments on the G2 forms indicated that over 80% of the teachers felt the paper to be of a similar standard to last year's paper, while the majority of the remainder thought it be slightly more difficult. As to the paper's suitability, 96% thought that it was of an appropriate level of difficulty. Most considered the syllabus coverage to be either good or satisfactory, although 6% indicated it to be poor, an inevitable problem due to the limited number of questions covering the specific content of each option. Almost 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 award.

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

- One main area of difficulty seen was that of interpreting and answering precisely what the question requires, that is, understanding and responding to the command terms. Many found interpretation of graphs difficult and many were not answering the longer answer questions with sufficient details or depth of knowledge. Definitions were poorly stated.
- Biochemical evidence for the common ancestry of living organisms
- Describing an experiment investigating innate behaviour in invertebrates
- Soy sauce production
- Diversity in structure of viruses
- Epidemiology
- K-strategies
- Mechanisms used by ileum to absorb amino acids
- *Helicobacter pylori*
- Coronary heart disease

Levels of knowledge, understanding and skill demonstrated

Some good scripts were seen. However many scripts demonstrated only a superficial knowledge of the options chosen. Many were better at the data analysis questions and calculations rather than the long answer questions. One main area of difficulty seen was that of interpreting and answering precisely what the question requires, that is, understanding and responding to the command terms. Many found interpretation of graphs difficult and many were not answering the longer answer questions with sufficient details or depth of knowledge. Definitions were poorly stated.

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

Option D: Evolution

Many candidates chose this option.

Question 1

- a) Many were able to calculate the percentage increase required.
- b) Few candidates gained two marks here. Some did suggest that the species may have spread out and so evolved.
- c) Other than stating that the valve length increases over time as the average temperature decreases, few gained a second mark here. Those that did indicated areas on the graph where the valve size varied whilst the temperature was fairly constant.

Question 2

- a) Quite a few answered either the assembly of molecules into polymers, or the origin of self-replicating molecules that could be inherited. A number of candidates did not achieve the first point as they had not referred to **non-living** synthesis of simple organic molecules.
- b) Many did make the link between prokaryotes, the ability to photosynthesis and the production of oxygen.

Question 3

- a) Candidates here could state what allopatric and sympatric speciation are. Some successfully went on to write about the process of speciation.
- b) Some good answers were seen here. Those that had studied this in sufficient detail were gaining in general 4 marks. There were many candidates incorrectly writing about fossil evidence and the pentadactyl limb and some incorrectly wrote about the endosymbiont theory.

Option E: Neurobiology and behaviour

A number of candidates chose this option. This may have been perceived as an easy option to attempt by the candidates because the bar chart in the data analysis section appeared to be simple to interpret.

Question 1

- a) Nearly all candidates successfully responded here.
- b) Many stated that the behavior was learned as following previous exposure more bees demonstrated flights associated with the odour.
- c) Very few candidates associated the odour with food and the increased survival related to having an advantage in finding food with such behavior.

Question 2

- a) Some could correctly label the parts of the ear. Most candidates however only gained one mark here.
- b) (i) Many did not indicate this was a **rapid** unconscious or involuntary response, so did not gain the mark here. This definition is stated in the specification.
(ii) Many could successfully name two inhibitory psychoactive drugs.

Question 3

- a) This was very poorly answered with many candidates writing about pigeons, ducks or rats. The few that used woodlice as an example only gave very vague responses, for example, dividing a box into two sides with light shining on one side. Put in 10 woodlice and see where they move to. This sort of response only gained one mark for choosing a stimulus that appears to change behavior.
- b) MRI had been studied, but rarely did candidates gain more than two marks here, usually for stating a stimulus and that stimulus could then be related to various regions of the brain.. Some stated that MRI records changes in blood flow.

Option F: Microbes and biotechnology

Very few candidates chose this option.

Question 1

- a) Many did not calculate this correctly, although stated the correct units regardless of the answer.
- b) (i) Of those attempting this option, this question was either answered well or left blank.
(ii) No candidate from the scripts seen, referred to lag phase or adaptation of the culture of the environment to explain the drop in removal percentage of terephthalate.
- c) No candidate answered chemoheterotroph from the scripts seen.
- d) Many candidates did state that removal of the terephthalate was close to 100% throughout the experiment but few gained two marks here.

Question 2

- a) Some could state the role of either *Rhizobium* or occasionally *Nitrosomonas*, but the mark was very rarely awarded as often the role of only one type of bacterium was seen.
- b) Some candidates could name *Aspergillus oryzae*, but could not clearly outline the production of soy sauce, few gained two marks here.

Question 3

- a) Some answered well here, but the majority could not clearly indicate the diversity in structure of viruses.
- b) Some candidates gained up to four marks here, but many candidates could not give a coherent answer with details of pandemics answering only that pandemics are larger than epidemics and that they rapidly spread between humans.
Some qualified this last statement, stating humans in cities or in transport, hence gaining this second mark for humans in close contact.

Option G: Ecology and conservation

This was a very popular option.

Question 1

- a) Few candidates were able to interpret the data correctly here.
- b) The majority of candidates successfully stated the general trend of less small trees further from the road with either illustrating this with supporting data, or, indicating the deviation in the trend at 4km to gain the two marks.
- c) Many correctly stated that small tree density also declines the further you go from the main road, for each small tree diameter (apart from the deviation in the trend at 4km).

Parts (b) and (c) although the candidates sometimes gained marks for answering in a similar fashion to both parts, the two questions reinforced the idea of the link between distance, overall there are less trees further from the main road and small tree density that decrease further from the road.

Again, it did not seem that the candidates had really understood the data given. Some candidates restated data given for all diameters of trees, but without giving overall trends.

- d) Many candidates successfully compared the distribution of trees in the two areas, and some did arrive at the idea both areas had higher large tree densities due to less or no logging. Some answers also went onto give a reason that logging so far from the main road was may have been difficult. Overall there were some very pleasing, logical follow on answers seen here. However some candidates were again restating data.

Question 2

- a) A definition that included dry mass, and organic matter was expected. Many were giving answers that wrote of total mass of organisms in a community. Suitable rigorous definitions are expected.
- b) Many wrote of DNA damage, skin cancer or an effect on plant productivity. Many candidates did not gain a second mark here though as they wrote of cancer in general rather than skin cancer.

Question 3

- a) Many candidates gained three or four marks here. Exactly how chemical substances accumulate in the body the further you go along the food chain was rarely seen. Strong candidates should be able to clearly articulate this for example illustrating the fat soluble properties of DDT and hence accumulating in fat stored in the body.
- b) For those candidates that had studied this, many gave very good answers gaining 4 or 5 marks. Section G3 in general, for those that had studied this fully, pleasing answers were seen.

Option H: Further Human Physiology

Question 1

- a) (i) Candidates are still having difficulties with percentage increases, as seen in this section.
- (ii) Many candidates successfully made the link between high lactate and anaerobic respiration.
- b) Many candidates did state that as glucose concentration decreased the lactate concentrations increases, hence gaining one mark. Few added supporting data to illustrate these trends or made more detailed observation concerning the trend lines, for example the lactate levels increase then start to level off.
- c) The stronger candidates gave good answers here. Some were confused by the slight increase in the glucose concentration with some candidates writing about the need for more glucose at high altitude.

Question 2

- a) Other than endocytosis being correctly outlined by some candidates, the mechanisms for amino acid absorption were not outlined clearly. Transport proteins of channel protein were very rarely stated.
- b) Most achieved on mark here.

Question 3

- a) This section was very difficult to mark because it was evident that candidates did have knowledge on this section, but there were just not answering the question asked. Candidates were listing factors that affect the incidence of heart disease, whereas the question required outlines of these factors.
- b) Stronger candidates started writing about *Helicobacter pylori* and clearly stating how these bacteria may lead to ulcers. Weaker candidates only described ulcers without linking these to the bacteria, only stating that stomach acid causes ulcers.

Recommendations and guidance for the teaching of future candidates

- Practise the use and understanding of the required command terms.
- Throughout the course use a variety of data for interpretation and analysis.
- Practise reading trend from data rather than restating data.
- Practise constructing the longer answers. So many candidates wrote on extra paper
- When with a little thought and a better constructed answer this would have been unnecessary. Many were even only writing one or two line per extra paper used, with up to 5 sheets attached sometimes. There is sufficient space in the answer booklet.
- Practise calculating involving percentage differences, increases or decreases.
- The teacher where possible should attend workshops, especially when the school is new to the IB.
- Allow sufficient time to teach the options.
- Some candidates we seen to attempt all the options.

Standard level paper one**Component grade boundaries**

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 11	12 - 16	17 - 19	20 - 22	23 - 25	26 - 29

General comments

Of the 55 G2s received by grade award, 68% considered it similar in difficulty to last year's paper but most of the remaining G2 forms suggested that it was a little more difficult. G2 forms gave a generally favourable response to this paper, with 85% reporting that it was appropriate in terms of level of difficulty, with the remainder considering it too difficult. More than 96% 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

There has been some concern about the relevance of this question in a Biology paper, although it is part of the mathematical requirement as interpretation of graphs are very important to all Biology candidates.

Question 3

Some teachers believed that mitosis could be considered a correct answer for the prokaryotic cell division, but this mechanism only occurs in eukaryotes (it requires the presence of chromosomes). Most candidates did very well in this question and it was a very good discriminator.

Question 4

Most candidates had this question wrong; they did not recognize the polysaccharide as a component of the extracellular cell matrix.

Question 6

Seemed to be an easy question and had a good discrimination index, this means good candidates had it right and weaker candidates were incorrect.

Question 7

Most candidates recognized that the embryological development required mitosis. Many weak candidates believed it was cell growth.

Question 11

Most candidates realized that as enzymes become denatured they work more slowly.

Question 14

The wording of the stem in this question seemed confusing, as a set of alleles could have been interpreted as all of the alleles of an organism and not just the pair of alleles. Nevertheless, the question turned out to have a good discrimination index.

Question 15

Many candidates confused metaphase of mitosis with metaphase II of meiosis.

Question 16

Most candidates answered this question incorrectly. Although it was a good question, it was perhaps a little bit too complicated for candidates to analyze a pedigree in such a short time. It was agreed at grade award that it would have made a better Paper 2 question.

Question 18

The quality of the diagram here was not as high as it could have been but it was still a discriminating and effective question.

Question 20

Although some teachers complained that the term protoctist is not present in the syllabus, the candidates did not seem to have any problems understanding the question. This question had a high discrimination index, showing that the good candidates answered it correctly and the weaker candidates incorrectly.

Question 21

This question had a very high discrimination index, showing that good candidates were able to distinguish the correct answer.

Question 22

This question presented a lot of controversy so it was decided it should be discounted. The details of the effect of greenhouse gases need not be known.

Question 24

The examiners agree with some teachers who suggested adding diagrams for this type of question.

Question 25

Although proteases are not secreted in the small intestine, many years ago it was believed they were. Proteases are membrane bound in the small intestine (but not secreted there). Considering that some books might still use this concept, both answers A and C were accepted as correct in order to make this question fair.

Question 26

Many candidates thought that antibiotics are not effective against viruses because these can hide inside the host cell, failing to consider the effect of antibiotics on bacterial enzymes.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 12	13 - 18	19 - 25	26 - 31	32 - 38	39 - 50

General comments

As in past years, performance on standard level paper 2 ranged from of dreadful to stellar. Collectively, candidates achieved maximum marks on every question of the exam. In Section A, many candidates showed good comprehension of the data analysis question, despite gaps and weak knowledge of content areas.

In Section B, minor improvement was seen in the quality of diagrams. Many candidates managed to gain at least one quality mark for their essay. Question eight was a popular choice.

G2 forms were received from 45 teachers, which was an increase from last year. 80% of respondents found the paper to be of a similar standard to the previous year, with 10% believing it to be a little more difficult. 96% of respondents considered the paper to be of an appropriate level of difficulty. 67% of teachers regarded coverage and clarity of wording as good. 78% 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.

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

Section A

For data analysis, many candidates were unable to calculate percentages using information from graphs. Also, the tendency continues for candidates to merely quote data without developing an answer that responds to the command term leading a question. Few candidates could identify the pilus and give its function in the electron micrograph of *E. coli*. Comparisons of prokaryotic and eukaryotic cells were marred when candidates wrote separate paragraphs in which features were simply listed. More direct comparison is expected where a specific difference or similarity is cited, followed by another specific difference or similarity etc.

When candidates explained enzyme-substrate specificity, special fit was often mentioned. Additional reference to three-dimensional shape or consequences of the fit would have been welcome. In general, candidates offered limited explanations for changes in atmospheric CO₂. Candidates were only vaguely familiar with the precautionary principle. Details of *type I* and *type II* diabetes were frequently mixed up.

Section B

Candidates stumbled in their outlines of how vesicles transport materials secreted by a cell. There was confusion about the meaning of a single strand of DNA so that the drawings of some candidates showed nucleotides linked 'horizontally' through hydrogen bonds instead of being linked 'vertically' through covalent bonds.

In their drawings of the male reproductive system, candidates rarely showed any accuracy in how various parts were connected or associated. Many candidates lacked an understanding of sex-linked genes as portrayed by inaccurate haemophilia genotypes.

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

Section A

Question one involving data analysis was mostly handled well. This shows that candidates have a good grasp on how to interpret information. It was pleasant to see how many candidates recognized the control. Most candidates identified the flagella in the electron

micrograph of *E. coli* and knew its function. There was widespread ability to define *active site*.

Section B

Membrane structure was well understood as evidenced by accurate thoroughly-detailed diagrams. Candidates knew key ideas about the structure and function of the villus in the small intestine. Fundamental understanding was occasionally seen in the outlines of gene transfer and the explanation of translation.

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

Question 1

- a) (i) The best answers identified the control as maize that did not have Bt gene added, rather than just untreated maize.
(ii) The best approach was to find the difference in mm^2 (38) between the control and type H and then divide by 50 to find the percentage difference (based on the control). Other methods of calculation were shown and credited.
- b) Weaker candidates misread the question (perhaps a language issue) and wrote how maize type A damaged the three species of stem borers instead of how the stem borers affected maize type A. This caused a variety of ambiguous answers which caused difficulty in awarding marks.
- c) Few candidates analyzed the data in its entirety. They didn't consider that no type of Bt maize controlled *Busseola* well or that all types of BT maize decreased *Sesamia* damage. An astute evaluation made by some candidates who recognized that type B maize was most efficient in controlling all three species if they were considered together as a group.
- d) The only problem here was that some candidates did not include the unit of grams.
- e) Though the question used the term "female rats," there three lines on the graph because there were three different groups of female rats depending on which diet they were fed. Candidates needed to qualify their answers by naming the group(s) of female rats which correlated to the change they were describing.
- f) Most candidates answered that Bt maize causes the same amount of growth as non-Bt maize and that both types appeared to have caused less growth or mass gain than the rat food. No candidates mentioned the small sample size being too small to give trends of that only female rats were tested.

Question 2

- a) The flagella and its function were usually known. Although the pilus was often known, its function was not. Low achievers sometimes labeled the pili as cilia.
- b) It was essential for candidates to make valid precise comparisons of the features for prokaryote and eukaryote. For example,
 - "naked DNA" (prokaryote) was confused to mean DNA outside a nucleus so it was paired with "DNA enclosed in nuclear envelope"

- (eukaryote) instead of “DNA associated with proteins” (eukaryote). For organelles, there had to be reference to membranes as in “no”
- membrane-bound organelles” (prokaryotes) paired with “membrane-bound organelles” (eukaryotes).
- When referring to differences in ribosomes or cell sizes, a quantified answer was required e.g. “70S ribosomes” (prokaryotes) paired with “80S ribosomes (eukaryotes)
- “smaller than 10 microns” (prokaryotes) paired with “larger in size, up to 100 microns (eukaryotes). Most candidates did not provide similarities,
- the command term “compare” includes similarities and differences. A few candidates produced tables which clearly represented similarities and differences.

Question 3

- a) A few candidates mixed up the location by stating that the active site was on the substrate.
- b) Many answers simply mentioned a compatible fit such as a “lock and key.” More marks could have been gained by also mentioning specificity of shape or any reference to the result of the specificity in terms of catalysis or breaking of bonds to form products. Few candidates gave an example of an enzyme and its substrate.

Question 4

- a) Few candidates gained three marks. The increasing trend of atmospheric CO₂ was commonly given with the combustion of fossil fuels as the reason. Sometimes, there was no explanation at all. Many candidates reported the seasonal/annual fluctuations in the trend.
- b) It was clear that many candidates had never heard of the precautionary principle and guessed at the answer. Conversely, there were candidates who wrote terrific answers which got at the heart of the answer, i.e. that *those responsible for change* must prove it will cause no harm *before* proceeding. Good examples were limited.

Question 5

Information given here was frequently in error, incomplete, or just mixed up. Many candidates thought that Type I diabetes is present at birth. Sometimes, if one correct idea was given about Type I or Type II there was no contrasting idea given for the other item. Few candidates earned full marks.

Section B

Question 6

- a) Many good membrane diagrams were seen. Phospholipids usually were shown with two tails. There was some uncertainty about the appearance of glycoproteins.
- b) There were a variety of confused answers written about vesicles transporting materials produced by the cell. Some candidates mistakenly began with endocytosis and the formation of vesicles as the plasma membrane pinched inwardly. Only a few

candidates stated that vesicles formed from rER and that proteins were carried to the Golgi apparatus.

Many candidates eventually stated that vesicles fuse with the plasma membrane but some thought that the vesicles again form around the cell product to transport materials outside the cell. Generally, candidates did not know this topic.

- c) Candidates knew that villi increase the intestinal surface area for greater absorption. They also knew that the thinness of the villi surface layer facilitates the passage of digestive products into the villi. Explanations usually included the role of capillaries but less often the role of lacteals. There was little mention of mitochondria, ATP, protein pumps or active transport. A few candidates mistakenly thought that villi help pass food along the digestive tract.

Question 7

- a) Many candidates gained full marks for their diagrams of joined DNA nucleotides. As mentioned earlier, the problem for some candidates was their misinterpretation of “a single strand of DNA.” Though appropriate shapes were given, the bonding was improper.
- b) In their outlines of gene transfer, candidates (as a group) eventually included each of the ten marking points. A number of candidates thoroughly understood the topic, while others wrote about meiosis and crossing over! The nature of the topic allowed candidates to express their ideas in a logical sequence.
- c) The process of translation has been examined frequently on past papers. Though the topic involves many different molecular structures and events, some candidates seemed to correctly grasp much of the detail and overall result. Some excellent answers appeared. However, as in previous years, there were candidates who confused translation with transcription (perhaps a reading error after glancing at the question?) and those who mixed accurate with inaccurate information.

Question 8

- a) The drawings of the male reproductive system were generally poor. Organs were suspended and not connected to one another in many drawings, while in others they were improperly connected. The relative sizes of structures showed little sense of proportion.
- b) Candidates usually knew the role of sex chromosomes in controlling gender but were weak explaining how sex-linkage affects the inheritance of hemophilia. Some stated that dominance changed depending on the gender of the person; others put the gene on the Y chromosome. Punnett squares were evident but had irrelevant crosses. Confusion was apparent over whether hemophilia was a recessive trait, and subsequent lettering systems for genotypes were unclear and muddled.
- c) Since this question involved a discussion of ethical issues associated with IVF, both positive and negative arguments should have been included. This did not always happen. Some candidates limited their answers to only negative arguments such as why IVF was not natural or why it was against religious beliefs and did not expand this. Several candidates wrote about the process of IVF while others confused IVF with artificial insemination or even cloning. Fortunately, there were a few candidates who wrote thoughtful and balanced discussions.

Recommendations and guidance for the teaching of future candidates

- All candidates should be given a printed copy of the new Biology Guide (first exams 2009) so they realize what content they are responsible for knowing.
- Candidates need to practise writing answers that respond to the command terms: describe, distinguish, compare, explain, discuss, and evaluate. (These, along with other command terms, are given pages 11 and 12 of the new guide.) Candidates should be shown how to write a plan/rough draft to produce a well-constructed organized answer. This is especially important when explanations of complex processes must be developed. For example, candidates could be taught to bullet point their answers to help structure their ideas, or to use a flow diagram to help explain processes such as Q6b or Q7c. The command term 'discuss' is sometimes associated with ethical issues and, in such cases, both pro and con points of view are necessary as in Q8c. For those questions which ask candidates to compare or distinguish between two things such as in Q2b and Q5, it would be advisable for candidates to devise a table showing similarities as well as differences. If a table is not used, then careful attention should be paid to direct comparison, item by item, as opposed to two separate paragraphs for each. Finally, more time should be spent explaining to candidates how the quality of construction marks can be achieved. The majority of candidates were not awarded both of those marks.
- Teachers should integrate data analysis (of tables and graphs etc.) and calculations with units wherever possible throughout the SL course. Percentage calculations must be included. Precision and accuracy is important when doing calculations based on a graph. Rulers should be used to pinpoint the positions on x and y axes-this will reduce the amount of error, as acceptable ranges for answers may be narrow.
- Candidates must regularly practise drawing the diagrams given in the syllabus. Attention should be given to accurate labelling, juxtaposition of structures, relative size, and connections between parts as in Q8a.
- Teachers should give candidates more exam-pacing guidance.
- 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 taught how to thoroughly and carefully read the exam question.
- 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.
- It is recommended that teachers emphasize the importance of legible handwriting. If a candidate answer is correct but unreadable, the candidate loses marks because deciphering the handwriting often becomes impossible.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 3	4 - 7	8 - 11	12 - 17	18 - 21	22 - 25	26 - 36

General comments

39 G2 forms were submitted. Of these, 71% thought that the paper was of a similar standard to that of last year, 7% thought it was a little easier, and 4% that it was much easier. At the other end of the scale, 18% thought that the paper was a little more difficult, but 95% of teachers thought that the level of difficulty was appropriate.

Syllabus coverage was judged to be good by 56%, clarity of wording was thought to be good by 64% and 79% thought this of the presentation of the paper. Only a very small percentage of teachers felt that the syllabus coverage and paper presentation were poor.

There were no clear differences in the degree of difficulty presented by the different options. As in previous years, options A and D seemed to be the most popular, closely followed by E and G. Options B and C were answered by fewer candidates, whilst F was by far the least popular option in terms of the number of candidates who answered it.

The standard of performance showed a wide spread, with some very low and a few very high marks being achieved. It is a little disappointing to think that those candidates who scored very low marks had perhaps benefited little from the course. Pleasingly, the majority of candidates followed the rubric of the paper and only attempted the required two options, but it is still surprising that many candidates made use of continuation sheets, in some cases using several pages. They need to understand that the space allocated for an answer is a good guide to the length of answer required, and should try to make their responses precise and to the point. Quality rather than quantity should be the aim for all candidates. For some, application of skills is still as much of a problem as the levels of knowledge and understanding, with candidates failing to gain marks for a number of different reasons.

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

A large number of candidates had difficulty in handling data from the graphs and charts. They tend to repeat data or simply describe patterns, with no real attempt at analysis or processing of the information. The majority appeared to not know how to calculate percentage change, which was required in several of the options. Generally, questions which asked for mathematical manipulation of data were frequently answered incorrectly.

Candidates also struggled with the data-response questions which displayed more complex graphical information, using multiple axes and scales (options D and F) or split bars (option G). Surprisingly, many candidates failed to produce good answers to the straightforward *define* questions, and predictably it was the more demanding *discuss* questions that proved to be the best differentiators between the stronger and weaker candidates

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

Many candidates did seem to have a reasonable knowledge of the concepts in the syllabus, and many were able to draw on their existing knowledge to evaluate the data presented to them. The data analysis question in options A, B and E appears to have been answered more easily than the other options. The level of subject knowledge was good for many centres, but disappointing from others. This emphasises the importance of careful preparation of the candidates, and also perhaps of the choice of options studied.

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

Option A: Human nutrition and health

Question 1

- a) Most candidates correctly identified the food source that had changed least in percentage of total energy intake.
- b) The majority of candidates made the required comparisons of changes in energy contribution, gaining full marks, but some did not compare urban with rural populations.
- c) Most candidates could suggest coronary heart disease as a possible health concern, but there were some vague points made about the lower fibre intake, with few accurate answers about increased constipation or bowel cancer.

Question 2

- a) This was a difficult question for many candidates, and the knowledge of hormonal control of appetite by candidates in some centres was sketchy. Candidates need to be able to refer to hormones produced by the empty stomach, or hormones produced by the pancreas/small intestine after eating or by adipose tissue in response to fat storage. Many gave vague, muddled responses, which lacked scientific terminology, and the part of the brain which is involved was frequently named incorrectly. Few maximum marks were awarded here,
- b) The consequences of anorexia nervosa are generally well known, with the majority of answers gaining the two marks.

Question 3

- a) A reasonable number of candidates were able to describe a relevant study to determine the recommended daily intake of vitamin C, but few gave sufficient detail to achieve full marks.
- b) Most candidates were able to quote numerical values for vitamin C dosage, and many showed an awareness of issues such as large dosing and rebound malnutrition. Few answers made the point that vitamin C is an essential vitamin which cannot be synthesised by the body or stored. There were many irrelevant references to ways of consuming vitamin C.

Option B: Physiology of exercise**Question 1**

- a) Most candidates gave the required response time.
- b) A correct calculation of the percentage difference in response time was rare. Most were calculating the difference only.
- c) Many candidates did achieve the two marks, but there some who appeared to find it difficult to extract information from the data.
- d) Candidates often seemed unable to use the data given in the question, and many were writing about the effects of exercise on human learning.

Question 2

- a) Very few candidates could define the terms asked for in this question.
- b) It was common for answers to this part to mention the heart and circulatory system, rather than the pulmonary system.

Question 3

- a) There were few correct definitions for fitness.
- b) Many candidates gained one mark for the idea of the type of activity which the muscle fibres could carry out, but there were few correct details given about the physiology of the two types ie amount of oxygen required, type of respiration.
- c) This part was poorly answered by most candidates, with few able to present a balanced argument worthy of credit. Vague, generalised points were common.

Option C: Cells and energy**Question 1**

- a) (i) The information shown in the graph was not easy for candidates to interpret, but the majority achieved the correct answer, with appropriate units.
(ii) The expected answer of 3mM was rarely given by candidates.
- b) Few answers referred to the peak in activity for each level of pyruvate, or the fact that activity is maintained at 14 mU per mg protein at 12mM of pyruvate.
- c) Most candidates' answers concentrated on the point that enzyme activity increases as substrate concentration increases, but there were few other details given as explanation. Rarely the concept of saturation was mentioned.

Question 2

- a) This was answered well by the majority of candidates, although some struggled to distinguish the different membranes in the diagram.
- b) Many candidates did not relate structure to function, and so did not give the appropriate activity associated with each structure described.

Question 3

- a) Not all candidates could name a correct enzyme, many giving inappropriate examples not involved with photosynthesis.
- b) Candidates need to be precise in their answers to this type of question, and not give vague statements about enzymes changing shape, rather than the active site changing shape to fit the substrate. There are still many candidates who think that the substrate changes.
- c) This was a good opportunity for the better candidates to show their knowledge and understanding of the topic, and there were some excellent answers. Few could give an example.

Option D: Evolution**Question 1**

- a) Many candidates could not accurately calculate percentage increase in valve length, and some misread the scale and numbers.
- b) The majority of candidates answered this part poorly. It was a suggest question but few had the idea of less fossil evidence from earlier times, or that modern classification methods recognise more species.
- c) A common mistake was to try and explain the data rather than to evaluate it as asked. Most answers focused on the relationship between sea temperature and size.

Question 2

- a) This was relatively straightforward for most candidates, although many seemed unsure about the mixture of materials available for synthesis of simple organic molecules.
- b) Many candidates gave good answers to this question, gaining three marks, but some gave vague muddled responses, which were not credit worthy.

Question 3

- a) The majority of candidates were able to gain two marks here, but this is a question which is frequently asked in this option.
- b) Very few candidates produced comprehensive answers, and most responses were descriptive rather than discussing the problems of the incomplete fossil record. There were few attempts to suggest why there are inconsistencies, though some did hint at the problem of little data.

Option E: Neurobiology and behaviour**Question 1**

- a) As in other options many candidates were simply working out the difference rather than percentage increase.
- b) Most candidates were able to achieve two marks for this part.
- c) The majority of answers did not make the association between the odour and food when identifying the type of behaviour. Simply stating the name of the behaviour was not sufficient.

- d) There were many vague, unscientific answers given, and hardly any reference to bees passing on their genes to the next generation.

Question 2

- a) Most candidates could correctly label the diagram, although some muddled the rod and cone.
- b) The arrow was frequently drawn in the wrong direction, or not drawn at all.
- c) This type of question often presents difficulties for candidates, because they do not know how to give a correct comparison type answer. This is poor examination technique. Also, many were giving details of structure and not function.

Question 3

- a) Most candidates were able to give the required examples to this part.
- b) This was a discuss question, but few candidates gave a balanced response. Hardly any gave a definition of addiction, and very few mentioned the genetic factors involved in any depth. Most got the association of dopamine with pleasure pathways.

Option F: Microbes and biotechnology

This was not a popular option, so it is difficult to give more than brief comments about the various sections.

Question 1

- a) Many candidates answered this correctly.
- b) Often poorly done, those who gained a mark here were stating that it was an inverse relationship, but did not expand their answer further.
- c) Few could offer any correct suggestion about the bacteria used.
- d) Attempted answers tended to be vague and irrelevant. Many candidates who did try to answer appeared to not fully understand the question.

Question 2

- a) Most candidates attempted this section, but answers were mainly confused, indicating a lack of clear understanding of the gene therapy process. Few gave an appropriate example.
- b) Candidates did not present clear arguments for this part, giving vague, rambling comments.

Question 3

- a) Many candidates did not attempt this section. Those that did generally gave good answers, although a few did not address the way in which different preservatives work.
- b) Most could name and outline treatment for an appropriate organism causing food poisoning.

Option G: Ecology and conservation**Question 1**

- a) Many candidates found this question difficult, as they could not read this type of graph correctly, and answers indicated that they had not fully read the information provided at the beginning of the question.
- b) The majority of candidates gave the correct density of trees.
- c) Most gained one mark by stating that there were fewer small trees furthest from the main road. Few referred to the different diameters of small trees.
- d) Many answers were repeating those given for part (a), and most candidates did manage to achieve a mark.
- e) This was generally poorly answered, as candidates did not appear to have understood the information given, and so did not realise that different sizes in the graph were all for small trees. Most did not refer to the absence of tree cutting in the National Park, with the result that there would be more large trees in that area.

Question 2

- a) Few candidates answered this well. Most mentioned competition with native species, but not many gave specific examples.
- b) Most could name a major biome, although descriptions of temperature and vegetation were often very vague.

Question 3

- a) Candidates did not always give the full definition of total dry organic matter.
- b) The majority of answers indicated a lack of knowledge on this area, with many not including the need to weigh samples before and after drying.
- c) Many candidates gained one or two marks here, but some gave vague responses. It was a good differentiator for the stronger candidates.

Recommendations and guidance for the teaching of future candidates

- Candidates should be taught the mathematical skills necessary to manipulate data, such as percentage change calculations, not just using past papers but also through the practical programme so that they become familiar with using the techniques on their own data collected during experiments.
- Teachers should draw candidate's attention to the different types of action verbs used in questions and what they mean, using past papers as examples. One effective way to do this is to give candidates exemplar material to mark (using the mark schemes) and then debrief with them in order to highlight what is required for a good answer. These exercises can be done in groups or individually.
- Teachers should ensure candidates have experience in analysing a variety of graphs, including those with multiple-scales. This skill interfaces well with internally assessed experimental work.
- Teachers should draw candidates' attention to the key definitions relevant to their option, and encourage familiarity with them in preparation for the examination.

- Teachers should give candidates opportunities to write more extended answers in internal tests, so candidates gain experience expressing their knowledge and understanding of more difficult concepts and also writing balanced viewpoints to questions that task them to *discuss* or *evaluate*. Teachers can also share mark schemes with candidates to help them appreciate which points are credit worthy.
- Teachers should remind candidates to read the data response questions very carefully and thoroughly, as they often contain important information that can help them with their answers. Candidates should be made aware that whilst their own knowledge and understanding is often asked for, sometimes key points may be found within the text provided.
- Teachers should remind candidates to illustrate their answers with appropriate examples, whether or not these are asked for directly in the question.
- The *structure relating to function* theme is something that teachers should revisit throughout the course. If teaching the evolution option, it might be useful to draw candidates' attention to some common misunderstandings of the concept such as natural selection operating for the good of the species rather than on an individual.