May 2015 subject reports

Biology Time Zone 2

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 16	17 – 30	31 – 43	44 – 55	56 – 69	70 – 81	82 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 16	17 – 31	32 – 44	45 – 55	56 – 68	69 – 79	80 - 100

Time zone variants of examination papers

To protect the integrity of the examinations, increasing use is being made of time zone variants of examination papers. By using variants of the same examination paper candidates in one part of the world will not always be taking the same examination paper as candidates in other parts of the world. A rigorous process is applied to ensure that the papers are comparable in terms of difficulty and syllabus coverage, and measures are taken to guarantee that the same grading standards are applied to candidates' scripts for the different versions of the examination papers. For the May 2015 examination session the IB has produced time zone variants of Biology HL/SL papers.

Higher level internal assessment

Component grade boundaries

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 internal assessment

Component grade boundaries

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

The range and suitability of the work submitted

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

The use of ICT in the areas of **1** Data logging, **2** Graph plotting software and **3** Spreadsheets is good.

The use of data logging in investigations are now quite well established. In many schools the students (and teachers) seem to be at ease with their systems and they are being used more often in student-designed investigations. However there are schools where teachers are assessing work done using the manufacturers' worksheets. This is inappropriate, as it is too heavily guided.

Trivial, simplistic investigations that do not generate sufficient data to permit adequate assessment of data processing were sometimes used for assessment; "DNA extraction", "osmosis of gummy bears or worms", "water evaporation of towels". Students are sometimes 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. Occasionally moderators are surprised to find that teachers point out significant errors to their students yet still give full marks.

Choice of inappropriate labs by the teacher was often a cause for differences in the level awarded by the moderator.

Where teachers apply the criteria rigorously and clearly, the moderators make relatively small adjustments to the marks. In schools where the descriptors of the aspects are ignored, the moderation can reduce the marks quite severely.

Some schools have a way to go in the use of databases and simulations to fulfil the ICT requirement. Simulations are also a weakness because what teachers are calling simulations are often just animations.

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.

In some schools, cross moderation between colleagues in biology is not being carried out. Moderators observe quite different standards of marking between colleagues presenting work in the same sample.

Candidate performance against each criterion

Design

Too many teachers are setting general themes with little scope for different investigations. The result is that the whole class of students selects the same variables and investigates the same system. They will have a very negative impact on the new Individual Investigation.

For example, in the same investigation presented by a school, all of the students in the sample had exactly the same research question. They were all investigating the effect of solute concentrations on the osmosis of potato tissue, the same intervals and the same protocol for measuring the dependent variable. All of the students in the sample had produced almost the same Design.

These teachers appear to be boxing the students in to perform the same investigations. This is approach is not appropriate and it need not happen.

For example, if enzyme activity is the theme to be assessed for the criterion Design, there are a whole range of enzymes to choose from, enzymes from different sources, different substrates, different potential inhibitors, different limiting factors and different methods for determining the rates of reaction. When a moderator is confronted with a whole class that is investigating the same enzyme, from the same source, using the same independent variable and using the same method to determine its activity, then it is not surprising that collusion or excessive guidance is suspected. The teacher's moderation will be affected by this. The same problem has been observed in all the classic themes for Design such as transpiration, osmosis, photosynthesis, fermentation, surface area to volume ratio and bacterial growth.

This practice is not restricted to teachers who are new to the IB. There are sometimes moderator comments in the feedback that go back over several sessions. Either the teachers are not receiving this feedback from their coordinators or they are stubbornly ignoring it, all to the cost of their students.

Research questions need to be focused. A research question that lacks focus will have an impact right through the rest of the investigation. For example students who decide to investigate several independent variables at once such as the effect of pH, temperature and substrate concentration on the activity of an enzyme. The names of the species used or the source of material (e.g. sources of enzymes) are often missing. The range or categories of the independent variable should also be given.

The three categories of variables must be clearly identified. It is clear that students need to be taught what the different variables are and what their relationship is. Moderators have observed that there is sometimes confusion over what is a controlled variable, that ensures fair testing, and what is a control experiment that can establish the effect of a variable that is not controlled. Sometimes unrealistic controls are being proposed when a control experiment would be

appropriate (e.g. set room temperature to 21.1°C using the air conditioning controls). It is not certain that some students are aware of the existence of water baths, heat shields or buffer solutions. Several moderators commented on the lack of control of temperature. Some students seem to think that temperature can be controlled by a thermometer. It was also noted that students who were varying the pH as the independent variable, rarely tried to measure the pH that the system was actually working at.

Research questions often state that the aim is to investigate the influence of the independent variable on the rate of change of a dependent variable. Unfortunately the protocol does not explain how this rate is to be calculated.

The investigations are often too simplistic**.** The range of values of the independent variable is insufficient to establish a trend. The number of repeats is insufficient to permit a statistical analysis that will allow a firm conclusion to be drawn. E.g. 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.

Standard protocols will, no doubt, be used by the students when they design their investigations. We are not expecting them to re-invent the wheel. These standard protocols however, must be duly referenced and significantly modified or applied to the student's own investigation. For example, if osmosis is being investigated and the student uses the method of change in mass of tissue to monitor the effect of solutions of different concentrations on a tissue, this is legitimate but if the investigation simply determines 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. Why stick to the traditional potato? Try carrots, yams, cassava, apple, sweet potato.

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

In experiments on seed germination the phenomenon of germination was often confused with that of post germination growth of the seedling.

Planning to use data loggers for the measurement of variables is becoming more common. This is a good thing. However the link between what the probe measures and the dependent variable is often left up to the reader. For example a pressure sensor may be used to measure the effect of catalase on the breakdown of hydrogen peroxide. The fact that a gas (oxygen) is produced by this reaction and that its accumulation in a vessel will cause a pressure change needs to be explained. For the dependent variable to be correctly identified this link needs to be made.

It is good practice for students to follow through their own designs. Some schools seem to have their students design an investigation that remains theoretical. The result is often an unrealistic investigation. Even when a teacher does decide to follow through a student designed investigation the result may be an unrealistic investigation. An example that keeps reappearing is measuring the effect of music genre on heart beat rates. This is almost impossible to control and students ought to be counselled against it from the outset. They might be advised to use a

metronome instead (they should be left to work out for themselves that the volume and the frequency can be controlled).

Students should use decimal / SI units (e.g. °C not °F and cm not inches). Spoonfuls and cupfuls should be discouraged.

Moderators frequently complained about the use of the word “amount” which is often used by the students. It is not always clear whether they are referring to volume, mass or concentration.

Data Collection and Presentation (DCP)

A persistent problem is the presence of trivial investigations that do not generate sufficient quantitative data for adequate processing. This sometimes stems from investigations that are poorly designed by the students themselves. In this case the teacher could have decided not to mark the investigation for DCP or CE. It also could be the product of an investigation set by the teacher, which is more problematic.

It should be understood that the use of pooled data is inappropriate for the assessment of individual investigations assessed for the new IA, as these are supposed to be the student’s own individual effort.

As in previous sessions moderators have had to reduce the marks of the teachers who had missed the following points:

- Data (raw or processed) that is inadequately presented (e.g. with superficial titles or headings)
- Units missing in the table (note: decimal units should be used)
- No uncertainties given in the tables of data collected using measuring instruments.
- Inconsistent decimal places in tables
- The decimal places that do not correspond to the precision of measurements
- The absence of associated qualitative observations where they are valuable. E.g. an ecological field investigation is incomplete without some kind of description of the site used. This appears to be a common problem still.
- Raw data plotted in graphs that do not actually reveal anything (Note: raw data can be plotted to derive maxima, minima, optima, rates, intercepts or to reveal correlations)
- Raw data plotted when the mean should have been calculated and plotted (often the mean is actually calculated and then ignored by the student for graphing)
- The absence of statistical treatment of the data when it was possible and desirable
- When statistical treatment is applied there is no consideration of its appropriateness. E.g. calculating standard deviations when they had only made 2 or 3 measurements.

- There was no presentation of uncertainties in graphical data either by using trend lines or error bars or uncertainty ranges on the axes.
- The error bars, when used, are not explained.
- Adding a straight line of best fit even when the data is clearly shows a curved distribution.

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 should not be credited. Those using spread sheets such as MSExcel should consider taking screen shots.

Several moderators commented on the lack of qualitative observations to support the measured data.

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, up to now, each criterion is marked on its own merits there will be a knock-on effect through an unfocussed research question to a poorly designed investigation that collects a limited amount of data, permitting limited processing, leading to a weak conclusion and evaluation. Moderators were also concerned about candidates who did not take time to clearly interpret their data. They boldly stated a conclusion leaving it to the reader to verify if the data actually supported it. Weaker candidates also failed to refer back to the original research question.

In the new programme, for IA submitted from 2016, results from simulations will be acceptable, so long as the simulation produces realistic data that can be processed. Simulations are particularly useful if results from a virtual experiment can be compared with those generated by a real one.

Overall, there was not enough consultation of literature values or the theoretical background by the students. When they were consulted 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.

Students 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. Students who have not developed this skill tend to remain superficial in their evaluation. They fail to evaluate the significance of the weaknesses that have been identified. The weaknesses they identify are often hypothetical (“the seeds could have been dead”) without evidence to back it up. For weaker students 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 students and teachers would do well to remember this when they are marking their students.

Suggested modifications were sometimes superficial and unrealistic, yet marked over-generously.

If the method and the data that have been used by the student are not provided in the sample, then Conclusion and Evaluation cannot be moderated. It is clear that those students evaluating their own experimental designs tend to do a better job than those following a worksheet or a method given by the teacher.

Manipulative skills

The evidence on the 4/PSOW forms indicates that the students are being exposed to a sufficient range of investigations. This ensures that the manipulative skills can be assessed correctly. However, a large number of moderators notice that some schools are attributing 6/6 for the whole sample for this criterion. There is no discrimination between the candidates yet the moderated marks suggest that that the students in the class do not all have the same capacity for experimental work.

Non-moderated criteria will no longer be present in the new programme with IA submission from 2016.

ICT coverage

Many schools seem to have made an effort to equip themselves with the necessary apparatus to carry out data logging. There are signs that the equipment is being used frequently and in student designed investigations.

Graph plotting using software was perhaps the easiest and most widespread for schools to apply. However the signs are that the students still need to be taught the correct conventions of graphing. There is still a tendency to use bar charts for everything amongst the weakest students, perhaps because it is the default setting of MSExcel. Bar charts are appropriate for data in categories but not for continuous variables where there are enough data points to establish a trend. Legends (keys) are not always necessary and students do not seem to know how to de-select them. When they are needed the students often have difficulty labelling them appropriately – students often present the different curves as “series 1” and “series 2” When the students used scatter plot, a trend line was not always used when it was appropriate. Note: joining the points dot-to-dot may be appropriate where the trend cannot be predicted. This can happen for series of measurements taken in field work, or any investigation where there insufficient data to justify a trend line**.**

It might be an idea to train the students to plot graphs manually before using a graphing program. Sketching a graph of the data before using a graphing program can be very helpful and save a lot of time.

The use of spread sheets 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.

The Group 4 Project

It needs to be repeated for a very few schools now, 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. Once again it is evident that some teachers are awarding full marks 6/6 to all their students without any discrimination.

Recommendations for the teaching of future candidates

- Read the feedback on your sample from the previous session. This is available from your IB Coordinator.
- Share the criteria with the students and explain them.
- Consult the Online Curriculum Centre (OCC) for teacher support material (TSM)
- Apply the internal assessment criteria rigorously and give a breakdown of the marks awarded.
- Give the students experience in identifying independent, dependent and controlled variables.
- Ensure that the open-ended theme that you set has enough scope to provide a variety of research questions for the whole class.
- Guide students away from repeating classic investigations or working on the same research question when they design their own individual investigations.
- Counsel the students on the safety issues, ethics and feasibility of the investigations they design.
- Be sure that investigations used for assessment produce sufficient quantitative data.
- Encourage the students to make additional qualitative observations about their experiment. It is good practice for them to keep a log book.
- Ensure that the investigations have the potential to generate sufficient data for substantial processing.
- Teach the students that plotting graphs of raw data is insufficient if nothing can be derived from them.
- Encourage the students to carry out research into the background literature both before starting an investigation and once the results are complete.
- 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.
- Complete one 4/IA form signed by all the teachers for your school’s sample and cross moderation between colleagues is essential.
- Familiarise yourself with the new programme’s requirements for practical work and internal assessment.

Recommendations for IB procedures, instructions and forms

Clerical procedure

- The latest versions of the 4/PSOW form (available on the OCC) should be used. The 4/IA form and list of students is sometimes absent in the samples received. Only one 4/IA form is required per school.
- Moderators are reporting that the electronic version of the 4/PSOW that can be downloaded from IB is frequently incorrectly filled in. The criteria for the sampled work might be flagged using a cross but the actual marks are not filled in.
- Teachers are regularly including the “complete”, “partial” and “not at all” breakdown of their marks. When this is combined with comments and feedback to the candidates it makes it very clear how the teachers were awarding marks. Unfortunately a growing trend has been observed of clean copies with no comments on at all but 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 students will reap the benefits. It is a lot easier for a moderator to support a teacher’s marks when there are clear, readable notes accompanying the sample. Although some teachers are having problems applying recommendations given in the feedback, there are encouraging signs that many are responding to the feedback
- 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 adequate summaries of oral instructions for the investigations in the moderation sample. Most schools complied with this requirement but moderators are reporting that not all do this. or that they are so cursory that they are not much use at all.
- Only a few teachers are failing to design practical programmes with sufficient numbers of hours. Some, however, have been observed to grossly inflate the time spent on an activity.
- Atypical candidates should be replaced in the sample. These would include students whose work is incomplete or transfer students where a substantial part of their work has been marked by another teacher.
- When the only marks appearing on the 4/PSOW form are the two marks required for the internal assessment, it causes concern amongst the moderators. There is no indication that the students were marked a number of times using the criteria. One wonders how these students 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 4/PSOW form. This should be verified before it is sent.
- Some schools are sending photocopies of the student’s work. Usually these are of good quality. The problem is that graphs and diagrams using colour can be confusing. The originals must be sent and a photocopy kept back.

New features of the Internal Assessment that need to be considered:

It may sound obvious but from now on in the new programme the new criteria need to be applied. These can be found in the latest biology subject guide available on the OCC. The nature of the science investigations has not changed, so teachers should recognize many of the same skills being expected of the candidates. Nevertheless the mode of application has changed significantly. There are no separate aspects to the criteria and the mark range for some criteria has been extended. The marking is arranged by bands, which may take a little getting used to. Example investigations on the Teacher Support Material should help here.

There are number of new features that teachers should be aware of:

- The purpose of the investigation needs to be expressed clearly in the report and there needs to be clear evidence of personal engagement (see next point).
- The investigation cannot be a simple repeat of a classic investigation or one that is listed as part of the skills. However, it is possible to adapt and extend from a prescribed investigation.
- The assessment of manipulative skills may no longer be part of the internal assessment but evidence of the consideration of safety, ethics and environmental impact is expected for the Exploration criterion. Evidence that consent forms have been used will be expected where human volunteers are used.
- Given that 10 hours are allocated to the Individual Investigation, a significant amount of data should be collected. This will impact on Personal Engagement, Exploration, Analysis and Evaluation.
- Citations as footnotes are preferable for specific facts such as literature values. Correct format of citations/bibliography is necessary. URLs alone are insufficient. This will contribute to the Communication criterion
- Page length is limited to 6-12 pages. In addition format, e.g. font size and sizes of images and graphs will contribute to the Communication criterion. Text and graphs should be large enough to read clearly.
- As well as suggested improvements to modify the investigation, suggested extensions to the study are expected for the Evaluation criterion. As with the improvements they need to be realistic and precise.

Further comments

General comments

Most schools used appropriate investigations of a good standard. A serious problem persists however in some schools that are setting investigations for assessment that give too much guidance or insufficient latitude.

From the 2016 IA submission, the Individual Investigation, the internally assessed component of the new program, will require an individual approach. Students cannot work in groups or work on the same investigation on this assignment. More details on the preparation for the new internal assessment criteria will be found at the end of the report.

In most schools the criteria are being applied rigorously but in a few schools the teachers seem to be ignoring the descriptors of the different aspects. In these cases the work had to be marked down.

Ethics

Moderators continued to comment on investigations that were unsafe or unethical.

In many schools the IB Animal Experimentation Policy (available of the OCC) is adhered to while in a few it seems to be disregarded. These schools should review the investigations carried out in light of this policy and ensure that all experiments are considered from an ethical point of view.

The IB does not wish to inhibit investigations but it does want to stimulate a responsible attitude towards experimentation on animals. Any proposed experimentation involving animals, including humans, should result in a discussion between teacher and student based on its ethical implications and how to refine the experiment to alleviate any harm or distress to the animal; to reduce the number of animals involved, or to ultimately replace the use of animals by using cells, plants or computer simulations. Any call for human volunteers in experiments must be accompanied by a consent form. Investigations on human subjects must not place the volunteers at risk. Moderators are reporting investigations that are quite inappropriate, for example using the death rate of fish as a dependent variable. This should not happen if the teacher is properly supervising the students.

Exposing animals to conditions normally experienced in their natural environments is permissible. It is good practice to include a discussion with the students on the tolerance limits of the animal and how these could be established. There are plenty of sites on the web that will help here. Exposing them to caffeine, alcohol or energy drinks is not appropriate. Exposing them to conditions outside their normal environmental tolerance limits is not appropriate.

It goes without saying that wild animals (e.g. invertebrates) should be returned to their natural environment soon after the investigation. Animals obtained by a supplier should be kept under safe and healthy conditions.

Situations that deliberately demand the euthenising of animals are not appropriate. Thus, fruit fly genetics must be replaced by, for example, rapid *Brassica* plants, *Sordaria* mould, maize cobs or simulations, such as the virtual fly lab (though this would mean that as a simulation it could not be assessed using the current IA criteria).

Dissections are a special case in biology. The guidelines are quite clear on this. The practice of dissections because they are a traditional part of biology course is not an adequate reason for including them. Including them, however, in order to study form and function in the distribution of organ-systems, organs and tissues is valid. Much of this can be done using simulations or dissections of organs purchased in butchers shops. Nevertheless, this kind of investigation would be inappropriate for assessment as it rarely produces quantitative data.

Fieldwork often involves the sampling of animal populations. This should take place with the minimum of disruption to the environment. The animals should be sampled using techniques

that do not cause injury and which limit their stress. The animals should be returned, with due care and attention, to the places where they were collected.

Teachers should carefully consider the approach to experiments on human physiology. Using fellow students or other people for investigations into the effect of exercise on the heart rate can be considered unsafe if the health status of the volunteers is not determined first. Some schools are already expecting their students to use a proforma for the signed consent of the participants in experiments. This is good practice but it is still uncommon and moderators are still commenting on the absence of consent in designed investigations involving human subjects.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 10	11 – 16	17 – 23	24 – 27	28 – 32	33 – 36	37 - 40

General comments

Most of the 212 teachers writing G2s believed the difficulty of the examination was appropriate (92%), only a few believed it was too difficult (5.5%) and the rest too easy. Compared to last year, most believed it was of similar standard (52%) while some believed it was a little easier (13%) and some a little more difficult (23%). Only a few believed it was much more difficult (3.5%). The suitability of the paper with regard to clarity and presentation in general was very good. Most teachers were happy with the paper as they said the clarity of wording was excellent (8.5%), very good (36%) or good (36%) and fair (15.5%) while only a few believed it was poor (3%). The presentation of the paper was also very good (41%), good (28%), excellent (20%) or fair (8.5%). Most teachers agreed that the examination paper was accessible in terms of accessibility and cultural/religious/ethic bias.

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

In general the questions seemed easy for most candidates. Here are a few comments on the questions that arose queries or problems.

Question 3: There is a comment in the G2s about the fact that there are some prokaryotic organisms that do have internal-bound compartments. This is true, but most prokaryotes do not have these compartments, and this is only an exception. In Biology there are many exceptions to the rule. In a multiple choice question one expects the best suited answer, in this case, all the other answers were incorrect, so the fact that prokaryotes do not have membrane bound

compartments was the most suitable answer. In all, the question turned out to be an easy question and a good discriminator.

Question 6: Some proteins synthesized in the free ribosomes will be used in the nucleus (for example polymerases), but these are only a few, most of them are used in the cytoplasm, therefore C is the best answer.

Question 7: Although there have been comments on the difficulty of this question, it really turned out to be very easy and most candidates got it right.

Question 8: Although the fact that Y-chromosomes contain genes not present in the X chromosome is not part of the guide, in 4.3.5 and 4.3.6 candidates are expected to explain how the sex chromosomes determine sex, therefore they should be able to answer the question correctly. All the other answers are obviously wrong, so could easily be discarded.

Question 9: This question turned out to be an easy question, although some candidates confused the answer with the translation process.

Question 10: This question was complex, because the events were not really in a sequence, therefore confusing candidates. Although A was a popular answer, the ribosome's subunits join after the tRNA joins the methionine, therefore this is not the correct answer.

Question 12: The answers to the question do not reflect a measurement of a rate of reaction, as time is not included. As none of the answers include the time, it is implied in the question.

Question 13: This question was too easy for most candidates.

Question 14: Some candidates wrongly believed that triose phosphates are produced in both photosynthesis and respiration; while others also got the wrong idea that electrons pass through ATP synthase. This question was a very good discriminator.

Question 15: this question had too much data to analyse for a multiple-choice question. Capable candidates however were able to answer this question well.

Question 16: although the diagram of the food web was probably not the best, the question was clear to most candidates.

Question 17: for some candidates it was difficult to interpret whether the question was testing changes in individuals or in populations, therefore getting the wrong answer.

Question 18: This was a good discriminator. Many of the weaker candidates fail to realise that overpopulation also promotes natural selection.

Question 20: Some candidates were tricked and answered that the conversion of P_{fr} into P_r causes a long-day dicotyledonous plant to grow in height.

Question 22: This was one of the easiest questions in the paper.

Question 23: Although this question looked difficult, it was the easiest question on the paper.

Question 24: In section 10.2.6 the candidates are asked to identify which of the offspring are recombinants in a dihybrid cross involving linked genes. Nevertheless, most candidates were unable to answer this question.

Question 25: Many candidates were tricked to answer that alleles from the same gene are assorted independently. While the alleles migrate to each pole, it is the collection of different genes that are assorted independently.

Question 26: this was an easy question for most candidates.

Question 27: Although the resistance to pests is often referred to as an example of the use of genetic modification in plants, this was a very easy question and most candidates chose plant resistance to herbicides.

Question 28: this question was too easy.

Question 29: there was a complaint on the G2s about the placing of this question. Considering it was based on statistics of stomach cancer, placing it in the digestion system topic seems reasonable.

Question 30: this question was a good discriminator and good candidates clearly understood that fusing tumour cells and B lymphocytes serves the purpose of producing monoclonal antibodies.

Question 31: Candidates found this question very easy.

Question 32: Most candidates correctly recognised that the function of the coronary arteries is to supply the heart muscle with oxygen and nutrients. Some candidates wrongly believed that they carry blood away from the heart.

Question 33: an easy question.

Question 34: Many candidates wrongly believed that arterioles move in the body instead of suffering vasodilation. Nevertheless, most candidates had the right answer, proving this question to be too easy.

Question 36: This question was not too clear because the axis in the graph do not say this is showing a vaccination process, therefore confusing candidates.

Question 39: the diagram was not enlarged because it would have become pixelated. Nevertheless it is clear enough that the shown cell is the interstitial cell.

Question 40: the acrosome reaction is in the guide in section 11.4.9 so candidates should have known that it is the cortical granules and not the acrosome that fuse with the membrane.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 7	8 – 12	13 – 18	19 – 21	22 – 24	25 – 27	28 - 30

General comments

Most of the teachers answering the G2 report believed the difficulty of the examination was appropriate (93%), only a few believed it was too difficult (2.5%) and the rest too easy (4%). Compared to last year, most believed it was of similar standard (66%) while some believed it was a little easier (15%) or much easier (1.5%) and some a little more difficult (10%) or much more difficult (2.5%). Only a few believed it was much more difficult (3.5%). The suitability of the paper in regards to clarity and presentation in general was very good. Most teachers were happy with the paper as they said the clarity of wording was excellent (11%), very good (42%) or good (33%) and fair (11%) while only a few believed it was poor (1%). The presentation of the paper was also very good (43%), good (27%), excellent (23%) or fair (6%). Most teachers agreed that the examination paper was accessible in terms of accessibility and cultural/religious/ethic bias.

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

In general the questions seemed easy for most candidates. Here are a few comments on the questions that posed problems.

Question 4: the guide clearly states that the cell wall is an extracellular structure; therefore candidates could not have confused the intracellular space with it.

Question 6: There is a comment in the G2s about the fact that there are some prokaryotic organisms that do have internal-bound compartments. This is true, but most prokaryotes do not have these compartments, and this is only an exception. In Biology there are many exceptions to the rule. In a multiple choice question one expects the best suited answer, in this case, all the other answers were incorrect, so the fact that prokaryotes do not have membrane bound compartments was the most suitable answer. In all, the question turned out to be an easy question and a good discriminator.

Question 9: although the question could have confused candidates by adding the charges in the amino and carboxyl termini, this was not an unfair question. The fact that the R group was fully shown should not have confused them.

Question 10: the activity of an enzyme is reflected in its rate of reaction.

Question 11: The answers to the question do not reflect a measurement of a rate of reaction, as time is not included. As none of the answers include the time, it is implied in the question.

Question 13: This was one of the easiest questions in the paper.

Question 14: Although this question looked difficult, it was one of the easiest question on the paper.

Question 16: Although the resistance to pests is often referred to as an example of the use of genetic modification in plants, this was a very easy question and most candidates chose plant resistance to herbicides.

Question 17: a better wording for this question would have been to say in the correct answer that in species organisms can potentially breed (as in many cases they do not).

Question 18: In assessment statement 4.2.3 candidates are expected to study crossing over.

Question 19: some candidates wrongly believed that the process of photosynthesis produces heat.

Question 20: this question had too much data to analyse for a multiple-choice question. Capable candidates however were able to answer this question well.

Question 21: the wording of this question could have been better, but it did turn out to be the easiest question in the paper.

Question 23: for some candidates it was difficult to interpret whether the question was testing changes in individuals or in populations, therefore getting the wrong answer.

Question 24: this question was too easy.

Question 25: there was a complaint on the G2s about the placing of this question. Considering it was based on statistics of stomach cancer, placing it in the digestion system topic seems reasonable.

Question 26: Candidates found this question very easy.

Question 27: Most candidates correctly recognised that the function of the coronary arteries is to supply the heart muscle with oxygen and nutrients. Some candidates wrongly believed that they carry blood away from the heart.

Question 28: Due to the fact that the diagram was not clear enough to distinguish a bronchiole from an alveolus, the answers C and D were taken to be correct.

Question 29: an easy question.

Question 30: Many candidates wrongly believed that arterioles move in the body instead of suffering vasodilation. Nevertheless, most candidates had the right answer, proving this question to be too easy.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 8	9 – 16	17 – 24	25 – 35	36 – 46	47 – 57	58 – 72

General comments

The number of teachers completing G2 comment forms was 224. The greatest fraction of respondents found that the paper was of appropriate level of difficulty (92.7%). Slightly more than half of respondents thought that the paper was of a similar standard to last year's paper while approximately one quarter thought that it was more difficult. About three quarters of the respondents thought that the clarity of the wording was good, very good or excellent. Even more thought that the presentation of the paper was good, very good or excellent. The general consensus of the respondents was that there were no significant concerns about the paper with respect to content that might represent a gender, ethnic or religious bias.

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

Students showed significant conceptual misunderstanding with respect to the principal of dominance and recessiveness. A large number of candidates inferred that dominant traits will always have selective advantage and that dominant traits will always be the most common phenotype.

Demonstrating detailed knowledge of the mechanisms of spermatogenesis is an area students had difficulty with, particularly with the accurate use of terminology.

Students were largely unsuccessful in demonstrating detailed knowledge of a specific example of a genetically modified crop especially in terms of up to date information about the advantages and disadvantages of a specific crop.

Discussing the cardiac cycle in terms of contraction rather than in terms of the sequential flow of blood through various chambers and vessels proved to be difficult.

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

Good quality heart diagrams were common.

Detailed knowledge of kidney function was common.

Constructing a diagram showing the relationship between the rate of photosynthesis and light intensity was well done.

Knowledge of the structure and function of nucleosomes was common.

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

Question 1

1 a. Nearly all students noted the positive trend.

1 b. Most students noted that while the Arctic showed a decline, Antarctica showed an increase. Weaker answers involved a descriptive account or failed to notice a second difference between the Arctic and Antarctic data. Noting that the rate of change for the Arctic was greater was more commonly included in answers than detecting that the data was more variable for Antarctica.

1 c. Most candidates noted that the data for Antarctica was supportive evidence of global warming. Weaker answers failed to state that the data was equivocal; strong candidates suggested global warming could lead to climate change with different outcomes in different locations.

1 d. Some respondents on the G2 forms raised concerns about the presentation of the data but most students earned these marks. A broad range of answers were accepted.

1 e. A number of candidates failed to link sea ice changes to population size changes. Better answers differentiated between colony 2 being stable and colony 3 having a growing ice season.

1 f. Many answered that penguin population changes could be used as indicators of the effects of global warming. Few extended the discussion to refer to historical data or limits to generalizing effects on penguins to other species.

Question 2

2a. Most candidates answered this question correctly.

2b. If candidates had difficulty with this question it was due to communication issues. Some referred to the bands as genes and others found it difficult to clearly express their rationale for identifying Male 1 as the father.

Question 3

3a. Most students earned these marks. A small number demonstrated knowledge of the properties of cells but seemed to be unfamiliar with the cell theory itself.

3 b i. A number failed to state a correct function. The pilus plays a role in adhering to surfaces and in bacterial conjugation. A number annotated the picture with the name of the structure without stating a function.

3 b ii. About half of candidates correctly answered this question. A number were making order of magnitude errors such as writing 150 000x and 1500x. Some were unfamiliar with the interpretation of the metric prefix.

3 c i. most were able to explain the function of helicase

3 c ii. Students need clarification on the mechanism of action of DNA polymerase III. Complementary base pairing occurs without a catalyst. The enzyme catalyzes bond formation in the 5' to 3' direction.

3 c iii. The mechanism of action for primase was rarely accurately explained with only the best prepared candidates recognizing that it occurs on both strands.

3 c iv. Similar to primase, the mechanism of action of ligase was very rarely accurately described, most limiting it to bond formation between Okazaki fragments, not acknowledging that ligase has a role on the leading strand as well.

Question 4

4 a. A surprising number failed to define this term correctly.

4 b. Most candidates earned at least some marks on this question. A number of candidates could not correctly identify gametes. Some made errors in counting the numbers of different phenotypes in the grid leading to incorrect ratios. Only a few candidates failed to identify the phenotypes;

4 c. In the best answers, candidates avoided statements involving dominant and recessive traits in the discussion but a surprising number argued that dominant traits always have a selective advantage and that dominant traits will always be more common. Many wrote that natural selection could alter phenotypic ratios but did not fully relate their answers to this. Few candidates earned the full four marks.

Question 5

5 a. It was common for four marks to be awarded. Students knew this topic well.

5 b. Many candidates appeared to be giving memorized responses from past mark schemes without recognizing the subtleties of what the question demanded. Better prepared candidates used language carefully. Some muddled the discussion by referring to mitosis.

5 c. Candidates struggled to use terminology correctly. The greatest confusion occurs in discussing the beginning stages of spermatogenesis.

Question 6

6 a. Common problems in student diagrams included: errors in representing the relative size of chambers, errors in representing the relative thickness of walls, failing to show connections of vessels to the correct chambers and representing those connections. Lastly drawing valves with care including their correct orientation.

6 b. It was rare for students to discuss simultaneous contractions within the cardiac cycle. Most framed their answers as a sequential flow of blood.

6 c. Students appear to know this topic well as many full mark answers were awarded.

Question 7

7 a. Students appear to have a general understanding of mechanisms but make a number of errors in terms of the location of events such as where the proton gradient builds up.

7b. This was well answered by most students. Many did not draw the curve intersecting the horizontal axis at a value above zero. Many constructed a diagram of the curve but provided text below the curve in a paragraph rather than annotating the curve itself with explanations of what was occurring at various levels of light intensity.

7 c. The best answers outlined the biology of the example well though a very large number dealt in hypothetical or speculative costs and benefits of genetic modification.

Question 8

8a. Students tended to perform well on this question though it was rare for students to demonstrate detailed knowledge of the mechanism of active transport in terms of ion exchange.

8 b. Students found it easier to list the conditions required for germination rather than outlining the conditions required.

8 c. Many students earned marks by outlining the stages of mitosis though a number were not clear on when spindle fibres form and when they attach, commonly indicating that this occurs in metaphase. Some students muddled the mechanisms of meiosis and mitosis. The distinctions between cytokinesis in plant and animal cells does not seem to be well understood. The events that occur in the different stages of interphase appears to be less well known.

Recommendations and guidance for the teaching of future candidates

- Students should be encouraged to take care with word choice, for example in referring to bands in a DNA profile as genes. Formative assessment that focuses on the correct use of terminology is recommended. This could take the form of giving students annotated diagrams or having them watch animations and then requiring them to provide a descriptive account of what they have viewed.
- Students should be given practice solving magnification questions using metric prefixes. One recommended strategy is to ask students to start by converting the quantity immediately to scientific notation or decimal notation before performing

mathematical operations.

- Students need to review the mechanism of action of the enzymes primase and DNA polymerase III. Many good quality animations exist to demonstrate these mechanisms.
- Teachers need to take care to clarify the concept of gene linkage. Working with paper-based models or other manipulatives to demonstrate crossing over and meiosis can help solidify student understanding.
- Students need practice with drawings and should be provided with formative assessment opportunities in this area. Teachers should point out that correct proportions of structures in drawings is expected such as in the relative size of the heart chambers. Clear connections, if they exist in the organism, need to be represented in drawings such as in the connection of blood vessels to chambers. The correct orientation of structures in drawings is also important to emphasize such as in the orientation of valves within the heart vessels.
- Interpretation of the command term 'annotate' needs to be reinforced. A number of students labeled the pilus rather than annotating the diagram with the function and a number drew the photosynthetic rate / light intensity curve but did not annotate the various parts of the graph.
- The distinction between cytokinesis in plant and animal cells should be emphasized.
- A number of genetically modified crops have been produced for some time now including Bt corn and genetically modified canola and soy crops. Genuine concerns as well as specific accurate examples of benefits exist. Students should be encouraged to avoid hypothetical or speculative examples of benefits and costs.
- Students should be encouraged to consult the number of marks allocated to a question in order to determine the number of distinct ideas required such as in question 1 b. This question could be used as practice as it has three distinct things for students to note while most students just responded with a single difference between the two data sets.
- Students need clarification of the concepts of adaptation, allele frequency and dominance and recessivness. Teachers should develop an example of a dominant trait that does not confer an advantage such as Huntington's disease to explain that not all dominant traits provide an advantage. Six fingers as an example is a dominant trait that is not the most common phenotype.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 6	7 – 13	14 – 18	19 – 25	26 – 31	32 – 38	39 - 50

General comments

Thank you to the 168 teachers who returned G2 feedback forms. An overwhelming majority, 96% thought that the paper was of appropriate difficulty, with the other 4% thinking it too easy.

72% thought that the paper was of a similar standard to last year's, with the remainder having a slight bias towards a little more difficult. 87% thought that the clarity of wording was at least good, with 11% describing it as fair. The presentation was rated by 64% as very good to excellent. Very few students answered more than one question in Section B.

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

Calculation of magnification (2b), Immunity (4), Synapses (7c), Therapeutic cloning (6c)

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

Cell Theory (2a), Ecology (3)

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

Section A

Question 1 (Data Analysis)

Some G2 comments seemed to think that Question 1 was too long, containing too many marks for one concept. Others felt that it was too biased towards geography due to the map analysis. Really the map reading required should have been within the capabilities of all students. Perhaps a geography student may have been at some advantage, but it could be argued that sometimes a chemistry student is advantaged in other years.

a) Nearly all students identified Toledo correctly.
b) Good candidates were able to analyse the data, quoting specific districts. Weaker ones did not mention any districts or tried to make the data fit the association.
c) Better students were able to compare the trends correctly and easily scored all three marks. Weaker students wrote about Toledo and then Corazol, hoping that the examiner would make the comparison for them. Very weak students just quoted numbers without considering trends. There were some G2 comments that it was difficult to make out the lines. However the students seemed to have no trouble, and some well organised students drew over it to highlight the correct line.
d) In part (i) an answer in terms of reducing the number of mosquitos or an increase in education about mosquitos was looked for. Simply 'the mosquito population went down', was not deemed good enough; it needed a because…… or due to….. Similarly in part (ii) 'fewer mosquitoes' was too weak. Vaccines are nowadays near to becoming a reality, but certainly did not exist between 1995-1999. Similarly cures for malaria, and an increase in the number with sickle cell forest were discounted.
e) Nearly everyone gave broadleaf forest and broadleaf hill forest.
f) Most correctly stated Toledo with the correct reason.
g) This proved to be a testing question, and as several pointed out, would have benefitted from a larger answer box as it was worth 4 marks. Many gained the mark for pointing

out that if farming does provide the habitat for mosquitoes, then replacing would be beneficial, and that no part of mixed hill forest has high incidence, so that could work. Few got beyond these and discussed biodiversity and adaptation.

Question 2 (Cells)

Most gained both marks for their knowledge of cell theory in part a. Students who read the rubric correctly in b scored well. However approximately half of the students read 'label' instead of 'function'. A disappointing number had no idea how to calculate the magnification (15000X) and some answers showed no concept of scale, with answers such as 0.15 X or $5x10^{-7}$ X

Question 3 (Feeding relationships)

Most gained at least 1 mark for their description of a food chain. Most students were able to pick a suitable food chain from the web given. However a significant number seemed to ignore the web given and draw one from memory. There were a few with the arrows reversed and not starting with a producer. The naming of the trophic levels is given in 5.1.7, and these are expected. In c most were able to give a valid reason.

Question 4 (Immunity)

A disturbing number could not give a definition for pathogen in part a. (6.3.1). In b, some teachers seem to have over-taught antibody production including the HL components, with the result that the students were giving very confused answers and missing out the basics. There were a few G2 comments that the command term for part b should have been 'describe' rather than explain. The reasons why antibiotics are effective against bacteria and not viruses was quite well understood, by those students who had covered it.

Section B

Question 5 (Genetic code, transport and energy). The least popular Section B question.

a) Many mentioned codons and anticodons, but few explained what they are. Most gained marks from stating that one gene codes for one polypeptide, and that polypeptides can be linked or modified to form proteins.
b) Many were confused by the differences between channel proteins (passive) and protein pumps (active).
c) There were several comments about how the students could gain 8 marks on a question about ATP. It was obvious that some students had studied option C, but this should not really have given them an advantage. In fact the students found this question much easier than the teachers thought, scoring well in this section.

Question 6 (Cell Division, Animal cloning and therapeutic cloning)

a) Most had an idea that four haploid cells formed from one diploid and were able to outline the stages of meiosis.
b) The technique of cloning was not well understood, with many mixing it up with IVF. The origins of the differentiated cells and the ova were often confused.

c) Therapeutic cloning was not well understood, and again confused with IVF. Many answers conjured up ideas of human clones kept in laboratory cupboards from which organs could be harvested when needed. The answers seemed to be centre specific, with students from centres where it was discussed in detail scoring well. There were several comments about the fact that it was allocated 8 marks for ethical issues, whereas the other two parts were only awarded 5 each. It is an extremely important topic, which may have far reaching consequences for the students in the future.

Question 7 (Heart and Synapses)

There were some G2 comments that the whole of this question could be answered with only SL knowledge. This is true. However part c proved difficult for all but the top students

a) The diagrams of the heart were of very varied quality. A diagram was asked for, i.e. the chambers and correctly positioned blood vessels, not an artistic impression with the blood vessels mysteriously floating outside the heart. Very few showed the atria with thinner walls than the ventricles.
b) Perhaps it is the fault of descriptions of the heart action in terms of how a blood cell would pass through the heart, but very few were able to explain that both atria contract at the same time etc. Weaker candidates seemed to think that the blood just flowed through the heart, instead of explain the movement in terms of muscle contraction.
c) The question writer was obviously trying to show the connection between the heart and nerves with the opening sentence. Unfortunately weaker students did not read beyond the first line and did not realise that the question was about synapses. There were many irrelevant essays about nerve impulse propagation and also the action of the SAN and AVN. Well prepared candidates could explain concisely the train of events triggered by the arrival of the nerve impulse at the presynaptic knob. The word ‘message’ was questioned by several teachers. It was presumably used to imply that it does not pass across the synapse as an impulse.

Recommendations and guidance for the teaching of future candidates

Make sure that the students understand the command terms – Explain, compare etc.

Practise drawing simple line diagrams. Small, unclear diagrams will not gain any marks.

If you run out of space and continue in an answer booklet, then SAY SO and write “continued on page…” at the end of the answer box. At SL there is room to continue on the lined pages in the answer book, so the extra answer books are not required.

If you seem to need more space to answer and your handwriting is of normal size, then you are writing too much. Additionally, in Section B you will lose quality marks for a ‘blanket answer’ that contains a lot of irrelevant material.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 6	7 – 13	14 – 18	19 – 22	23 – 27	28 – 31	32 - 40

General comments

Comments were received about the English (95.8%), French (0.4%), Spanish (3.4%) and German (0.4%) versions of this paper, corresponding to a similar proportion of the candidates who sat it. Nearly 95% of the 232 teachers responding on G2 forms felt that the level of difficulty of this paper was appropriate. The others thought almost equally that it was either too easy or too difficult. When comparing the paper to last year's, 67% of teachers thought the standard similar. Less than half of the teachers (41%) felt that the clarity of the wording was very good, the others ranking it either poor (0.9%), fair or good (47%), or excellent (10%). The proportions were similar about the presentation of the paper, with a little more finding it excellent. All these figures show a slight decrease in satisfaction compared to last year's paper.

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

Answers in the different options have revealed a few areas of the programme which appeared difficult for candidates. In option D, candidates had difficulty distinguishing between genetics and allele frequency in a population when outlining how the Hardy-Weinberg equation is derived. In option E, the actions of the ANS were not clear for some candidates. The use of viral vectors in gene therapy and the consequence of releasing raw sewage into rivers were weaker areas in option F. For option G, the discussions about ecological relationships and *in situ* conservation were poor, perhaps because some candidates did not realize that these questions were different from past papers, although using similar key words; some were not able to calculate, at least partly, the Simpson diversity index. In option H, many candidates had difficulty recognizing a tight junction, although required by the syllabus; basic knowledge was stated instead of a discussion on the incidence of coronary heart disease.

For all options, candidates generally seemed to have some difficulty to go "beyond the data": they often restated numerical values without showing that they understood their relative importance in relation to the nature of the experiment and in comparison to other pieces of data. This was particularly difficult in questions requiring higher objective level skills, such as compare, distinguish, discuss, evaluate, etc. In fact, higher objective level questions in general remain more difficult for candidates; it seems that the meaning of command terms, as defined in the subject guide, are often ignored. Some candidates also seem to have difficulty writing focused answers, using appropriate terminology and details. Although a number of candidates

did well in comparisons and distinctions, many others have difficulty in approaching them logically and methodically, pairing similar elements and showing differences and similarities with appropriate wording or display.

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

Candidates generally showed a good degree of knowledge in all options. Except for a few questions, they seemed well prepared for lower objective level questions; they also incorporated some knowledge in their answers to higher objective level questions, although other elements were also required for the latter. Most candidates have read graphs accurately and were generally able to see trends in data.

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

Option D - Evolution

Question 1

The majority of candidates could state the relationship between brain mass and maximum life span and could identify the group with the widest range of brain mass. Whereas some candidates could quickly establish all the key elements for the comparison, others provided incomplete complex answers. Many discussed brain mass and life span in terms of human evolution instead of using the data about all species on the graph.

Question 2

The majority of candidates could label the cladogram correctly, although a certain number did it backwards. Most candidates were able to make an acceptable comparison of allopatric and sympatric speciation. Many candidates presented a good discussion about the use of species definition, but many others could not express their ideas clearly enough or only had a vague idea.

Question 3

There were some excellent answers on the derivation of the Hardy-Weinberg equation while others were confused between the general description of alleles and the use of the Punnett grid, not understanding the relevance of the frequency of the alleles in the population. Nearly all candidates could write at least three assumptions for its use.

Option E - Neurobiology and behaviour

Question 1

The vast majority of candidates stated the percentages correctly, but there were some answers out of range and some others in which candidates inverted the values. Most described the

trends in antennation correctly, but some only stated values without saying that they were decreasing or increasing or described minor changes for each interval without mentioning the general trend. Similar answers were presented for the differences between walking and grooming. The evaluation of the hypothesis was more difficult for many who failed to mention that the effect was more noticeable at the beginning of the observation period or did not read that the components of social behaviour were antennation and begging.

Question 2

Most candidates outlined the foraging behaviour of the bluegill correctly. The vast majority stated the psychoactive drugs correctly. Most candidates provided correct examples and descriptions of learned behaviour, although some names (i.e. bird) and/or its importance were too vague; some also confused innate and learned behavior.

Question 3

There were many very well organized answers with an excellent comparison between the SNS and PNS and their roles, but there were nevertheless some that were incomplete.

Option F - Microbes and biotechnology

Question 1

Most candidates had no problem stating "state 7". Candidates provided a great variety of reasons for the distribution differences, but not so many suggested two valid ones. Most candidates could compare and analyze the data, although some provided confusing answers. Most could suggest the best location for a bee farm with reasons.

Question 2

There was a range of answers about using viral vectors: although some provided clear and complete answers, many did not use appropriate terminology or were incomplete; others showed only a vague understanding of the process or confused it with other processes related to biotechnology. The other parts of the question were very well answered by most.

Question 3

Most candidates provided good, but often only partial answers about the release of raw sewage into rivers; many omitted to mention the saprotrophic and/or pathogenic nature of bacteria present in sewage and to make references to specific substances such as phosphates, nitrates and ammonia.

Option G - Ecology and conservation

Question 1

Most candidates were able to identify "site 1" and the trends in data, although some got lost in details for the latter. The other parts of the question caused problems for most, showing that many candidates had not understood the relationship described in the stem, that the mats were

formed of decomposing *Cladophora* and *E. coli*. Suggestions were generally very vague and most candidates did not distinguish between conditions that would apply to a lake, such as changes in temperature and pH, and those in laboratory conditions, such as changing light intensity of CO_2 concentrations. There were many wild guesses about the relationship between the two species, namely parasitism or mutualism without any justification for either.

Question 2

Although some candidates had no trouble at all in calculating the Simpson diversity index, too many could not relate to the parameters of the equation, thus not being able to calculate the numerator and/or denominator The majority seemed to understand the significance of the increase in the index, although some confused the previous year with the current year; few were able to mention stability or succession in their answers. "Tundra" was correctly identified by most from the climograph. Most knew what in situ conservation is but could not engage in an appropriate discussion.

Question 3

This question caused some difficulty as, although many candidates correctly named a method and described it, most could not mention limitations of the named method or even had difficulty describing it properly. The described challenges were often too vague and not focusing on conserving world fish stocks; many simply listed problems without going any further (e.g. net mesh size, fishing in breeding seasons, fish migration, etc.).

Option H - Further human physiology

Question 1

Most read the value from the table with no difficulty and showed an understanding of the causes of asthma. Many candidates had difficulty relating their comment about exercise provoking asthma to a high percentage in all categories, simply listing values that they assumed to be high without actually commenting that it was high. Too many candidates simply gave many values or non-qualified statements instead of analyzing the relationship, therefore having difficulty in explaining the disadvantages of becoming obese.

Question 2

Most candidates were able to identify microvilli but fewer identified the tight junction, not relating to structures that would be visible with an electronic microscope, as stated in the syllabus. Many correctly compared the composition of gastric and pancreatic juices correctly although there are still some who simply listed properties in random order instead of pairing them as it should be in a comparison. Discussions about the impact of smoking were generally very vague and limited to elements of knowledge, without mentioning correlations between smoking and CHD; many did not mention nicotine and its effects and used poor terminology.

Question 3

Many of the answers were excellent and most candidates provided complete answers. Some went into far too much detail on some aspects, including the control of glucose levels, but nevertheless included enough material for their answer to be complete.

Recommendations and guidance for the teaching of future candidates

Teachers should be aware that the revised syllabus (first examinations in 2016) will focus on understandings, applications and skills and should therefore prepare candidates accordingly. The format of Paper 3 will be different, assessing applications and skills for the entire syllabus in part A, and the option coverage in part B. Memorizing material from manuals may no longer be sufficient in some cases, as focus will shift on the application of understandings. The following points apply to the present syllabus, but will nevertheless continue to be valuable in the future.

Although the syllabus will be different, teachers should get candidates to practise from past exams in order to correct their own work with the IB markscheme to help them become more familiar with the requirements, according to the number of marks being given and the command term used. This should be done for each topic throughout the course. All kinds of data should also be presented to candidates, either as class discussions or homework. This includes images from optic and electronic microscopes to which candidates should be able to relate elements of the same magnitude. Candidates should practice considering all pieces of data. Memorizing answers from previous papers should be discouraged as new questions are usually worded slightly differently and require answers to be adapted accordingly, not to mention changes in the syllabus. Candidates could therefore be given exercises or homework to practise applying their knowledge to new situations.

Candidates should be exposed to the appropriate meaning, as written in the subject guide, of command terms throughout their course, especially objective level 3 command terms. Candidates should be aware that describing data and stating values is usually not sufficient for a comparison or other types of level 3 questions.

Candidates should be able to transfer the skills learned from the practical programme to an examination context in order to design valid and reliable experiments in which the independent, dependent and controlled variables are clearly identified. This will become more important in part A of paper 3 starting from the 2016 examinations.

Candidates must practise using appropriate terminology throughout their course. Writing style must be developed to focus directly on what is required and to include all the necessary detail for statements to be complete. Importance or magnitude of values must be written, even when it seems obvious: the candidates must communicate their understanding and assume that the reader will read only what is written. The best answers are usually short, but include all the information and fit in the provided box.

As examination strategies, highlighting key words in stem of data based questions and body of other questions helps drawing attention on the focus of questions. Taking some time to lay down answer elements on rough paper helps structuring answers and including the necessary information.

Most candidates write within the prescribed boxes and make a sensible use of extra answer booklets. To ease the marking process and prevent errors from occurring, all candidates should nevertheless be reminded that examiners view only relevant scanned areas of the papers on screen at a time. It is therefore important that their answers are written clearly enough to be fully legible following the scanning process and that they fit within the provided box; extra booklets may be used sensibly to continue when it is necessary – there should be a clear indication that the answer continues in an extra booklet in this case.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 5	6 – 10	11 – 14	15 – 18	19 – 23	24 – 27	28 - 36

General comments

Over 97% of the 168 teachers responding on G2 forms felt that the level of difficulty of this paper was appropriate. Nearly 70% of teachers thought the standard similar to May 2014.

Over 80% of the teachers felt that the clarity of the wording was good to excellent. The proportions were similar about the presentation of the paper, with a little more finding it excellent.

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

The least favored option was Option F Microbes and biotechnology. This option together with Option B seemed the most difficult though there were some good responses.

Each option contained a longer question on topics such as biomagnification, ventilation, endosymbiotic theory and enzyme inhibition. These questions seemed fairly straightforward but caused trouble for quite a few candidates.

Some of the data analysis gave difficulty, especially where there was more than one graph which required the students to shift between them for the answers.

Questions requiring calculations of the data seemed hard for the candidates.

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

Options A and G were popular, and allowed a lot of candidates the opportunity to gain full marks, or close to full marks. Option D on Evolution was also well answered in many cases. The paper discriminated well with the more difficult and 4 mark questions being well answered by the stronger candidates.

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

Option A – Human nutrition and health

The data for Option A was a table recording body mass and offspring birth mass for mothers fed diets with different ratios of protein and carbohydrate.

1. (c) required the candidates to distinguish between LDL and HDL cholesterol. Many candidates failed to refer to the data in their answers so failed to score any marks.

1. (e) the candidates were required to evaluate an HP diet for pregnant humans. Most candidates restated the data and gave no reasons for recommendations. As this was a 3 mark question it proved costly for many candidates. The question did discriminate well.

Questions 2 and 3 were well answered with better candidates gaining near perfect marks.

Option B – Physiology of exercise

Option B data was a graph showing power decrease and ATP concentration in exercising muscles. Overall the candidates performed well with part (d) giving some difficulty where students were asked to deduce which was a white muscle fibre.

5. (a) Only the better students could outline the function of myosin and actin in muscle contraction.

6. (b) Most candidates knew about the need for exchange of oxygen and carbon dioxide but only the stronger candidates could fully explain the processes changing ventilation rate.

Option C – Cells and energy

The data for Option C was a bar chart showing oxygen consumption in zebrafish embryos in the first 48 hours after fertilization. The data was fairly well answered with part (c) where the candidates were asked to suggest reasons for the changes in the graph causing most difficulty

8. (a) Only the better candidates could give a satisfactory outline of both the primary and secondary structure of protein.

9. (a) and (b) seemed fairly straightforward questions on enzymes but few candidates failed to score full marks. Comparing competitive and non-competitive enzyme inhibition requires contrasting statements of similarities or differences, not two unrelated descriptions.

Option D - Evolution

Option D data was a scatter graph showing the relationship between brain mass and life span for various groups of mammals. The question was fairly well answered, though, being a log graph, may have confused some candidates.

Most candidates scored some points in questions 11 and 12 with the top candidates achieving full marks.

Option E - Neurobiology and behaviour

Option E data consisted of four graphs describing how the behaviour of honey bees changed when fed with alcohol. The candidates had a lot of information provided in the data and this did cause considerable confusion particularly among weaker candidates.

13. (c) The question confused weaker candidates as they were unsure what distinctions had to be made.

13. (d) The candidates tended to look at trends in the data and did not realise that they simply had to look at the first points in the graph to show that ethanol had effected the behaviour of the bees.

14. (a) Most candidates knew thermoreceptors detected temperature but were uncertain about chemoreceptors in smell.

14. (b) Many candidates failed to realise that the action verb “annotate” requires more than a simple label.

15. (a) Comparison of the effects of cocaine and THC were generally poor. Candidates wrote all they knew about cocaine then all they knew about THC without providing contrasting statements. Many failed to score more that the fact that one was excitatory and one was inhibitory.

15. (b) Many repeated THC and cocaine despite being asked for one other example.

Option F - Microbes and biotechnology

Option F data was two pie charts comparing the amount of quorum sensing proteins in bacteria that produce cholera and those that do not. The questions were quite difficult in their language and this confused many students as there were negatives in both questions and responses.

17. (a) Surprisingly few students could outline how a defective gene can be replaced by viral vectors.

17. (b) Most could state the use of Saccharomyces in food production but far fewer the use of Aspergillus.

18. (b) Some students gave comprehensive explanations of the production of methane from biomass. Most students scored at least one point.

Option G - Ecology and conservation

Option G data was a scatter graph showing the relationship between the area of the foot and the force required to detach limpets. The data was on the whole well answered.

20. (a) Very few candidates could calculate the Simpson diversity index although the formula was provided. Few students knew the significance of a change in the index from year to year although allowances were made for wrong answers in the first part of the question.

21. (a) There were some good examples given of biological control of invasive species but also many vague and non-relevant examples.

21. (b) Explaining biomagnification discriminated well with all but the very weakest candidates scoring at least one mark and only the stronger candidates scoring full marks.

Recommendations and guidance for the teaching of future candidates

Once again candidates should be reminded how command terms give an indication of what is required in an answer. In particular, they should know that questions asking them to distinguish or compare require contrasting statements, not two separate descriptions where the examiner has to hunt for the answers to the question. As an example, in the question where candidates were asked to distinguish between human milk and artificial milk, many candidates correctly said that human milk contains antibodies but did not provide the contrasting statement that artificial milk does not. This causes the candidate to lose marks for examination technique, not for their biology knowledge. Candidates should also be reminded that comparisons contain similarities, not only differences.

Candidates should be continually reminded to think about their response and whether or not it answers the question providing sufficient information for the available marks. For example, candidates see words such as actin and myosin in a question and this triggers a response that involves writing all they know about muscles and muscle contraction without addressing the question. Practice with previous exams is recommended with an in depth analysis of the mark scheme. In particular candidates should know how to analyse the question and know what is being asked. There are too many cases where strong students are losing marks due to poor examination technique.

Candidates should be reminded to write within the allocated space and on the lines provided. If they find the space insufficient they should complete their answer on the additional pages, not as a continuation outside the allocated area or in the paper margins.