BIOLOGY

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 14	15 - 27	28 - 39	40 - 53	54 - 66	67 - 80	81 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 16	17 - 30	31 - 44	45 - 57	58 - 68	69 - 81	82 - 100

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

The range and suitability of the work submitted

Most schools used appropriate investigations of a good standard. Two problems persist however; in some schools the complexity of the investigations are not up to IB standards, while other schools are setting investigations for assessment that give too much guidance.

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

Ethics

In many schools the IB Animal Experimentation Policy (available on the OCC) is adhered to while in others it seems to be disregarded. 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, including humans. Any proposed experimentation involving animals 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 reduce the numbers of animals involved, or to ultimately replace of 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.

These rules equally apply to those student designed investigations that are not intended to be followed through in a practical session. Some teachers and students seem to think that if it is not followed through, they can ignore ethical principles. In these cases the teachers are clearly not counselling their students on what is ethically acceptable.

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

Behavioural experiments or experiments on animal physiology are frequently quoted as examples.

Experiments in these areas are still possible so long as they remain within the normal tolerance limits of the animal. Thus, 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.

It goes without saying that wild animals 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 no longer 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 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.

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.

The approach to experiments on human physiology should be reconsidered by a lot of teachers. Using fellow students for investigations into the effect of exercise on the heart rate can be considered unsafe if the health status of the students 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. Evidence of this practice should be included with the sample.

Some inappropriate examples quoted by moderators include:

- Exposing mud worms to caffeine and heat stress.
- Exposing *Daphnia* to solutions of nicotine, caffeine or ethanol.
- Exposing “volunteer” students to “unhealthy” food, fear and even medication (paracetamol)

Clerical procedure

After three years, earlier versions of the 4/PSOW form are still being used by some teachers. These do not provide space for the moderator and senior moderator marks. The latest versions (available on the OCC) should be used. The 4/IA form and list of the sampled students is often absent.

It is disconcerting to see that there are teachers who do not appear to be consulting the Handbook of Procedures. This is published and updated each year.

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 how the teachers were awarding marks. There are a large number of teachers who 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 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 student 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.

A few teachers are not designing practical programmes with sufficient numbers of hours, others are over-estimating the time spent on an activity. It should also be noted that the Group 4 Project can only count for 10 hours on the 4/PSOW.

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.

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.

Areas of strength

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

The use of ICT in the areas of data logging, graph plotting software and spreadsheets is good, although some schools have efforts to make in the use of data bases and spread sheets.

Areas of weaknesses

Trivial, simplistic investigations that do not generate sufficient data to permit adequate assessment of data processing were too often used for assessment. If there is one significant area of weakness it is in the processing of data. Students 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. Sometimes teachers point out the errors to their students and still give full marks.

Choice of inappropriate labs by the teacher was often a major 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.

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 clearly not being carried out. Moderators have observed different standards of marking between colleagues presenting work in the same sample.

Rules applied by the moderators

In the event of the teacher providing too much guidance to the students 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 Students could have identified their own control variables
Design	It is clear that the students 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 students have used a photocopied data table with headings and units.	c; c; c = 6	p; c; c; = 5 Student could have added uncertainties or relevant qualitative observations
Data Collection & Processing	The students 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 student 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

Too many teachers are still 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. Moderators made the following comments this year.

- Group work presented as individual work - all candidates with same plan, same data values; some candidates readily say in their reports that this was a group effort!
- Teachers using standard labs and saying they are Designed by candidates: for example, the effect of antibiotics on bacteria (standard selection of antibiotics on discs put on agar plates and then measure zone of inhibition).

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 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 and what is a control experiment. Sometimes unrealistic controls are being proposed when a control experiment would be appropriate (e.g. set room temperature to 21.1°C).

The investigations are frequently too simplistic. The range of values of the independent variable was insufficient to establish a trend. The number of repeats was insufficient to permit statistical analysis. 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. Moderators made the following comments:

- Not enough values being used in plans to establish a trend
- Planning very simplistic labs e.g. find the number of people in the school of Chinese heritage with dimples.

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. HOWEVER these standard protocols must be 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. 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. Osmosis is often presented as a Design investigation theme without any modification from a text book method.

The two point discrimination test for touch receptors on the skin is also frequently used. All too often this ends up a repeat of a text book classic when it is possible to give it a different approach e.g. Does skin sensitivity change with different levels of exercise?

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? This needs to be described in the method.

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.

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, for example, 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.

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

Data Collection and Presentation (DCP)

A consistent problem repeated by the majority of moderators 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 can decide not to mark the investigation for DCP or CE. It also can be the product of an investigation set by the teacher, which is more problematic.

It may be that class data is required in order for the student 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 students must present their own data or clearly identify which is their own data in a pooled data table. The students must plan and produce their own data tables. Copying a table from other students will be counted as collusion and the school's IA work will be subject to an enquiry. Teachers who provide the students with a pre-formatted data table can expect their students 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. rates of photosynthesis using the sunken leaf disks, rates of reaction of catalase and osmosis) often create problems. Teachers some are permitting their students to use standard textbook protocols without modification. A little imagination and editing to make the instructions more open-ended could easily solve the problem.

Moderators often 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)
- There were no qualitative observations made
- There are no units in the table (note: decimal units should be used)
- 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 observations. 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 (often the mean is actually calculated and then ignored by the student for graphing)
- There was no statistical treatment of the data when it was possible
- 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 (many teachers marked this as complete and made no comment about it on the student work)
- 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, were not explained.
- A majority are putting a linear line of best fit even when the data is clearly S-shaped or clearly has a non-linear pattern.

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.

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 leading to a weak conclusion and evaluation.

Some students seem to have trouble in analysing their data. There is often confusion over what directly proportional means. Every potential straight line is described this way, even when not true.

Some teachers are using simulations instead of real biological investigations. These may be useful for training data collection and processing as they generate large amounts of data quickly. However they are not suitable for assessment, especially the assessment of this criterion. It is not possible to provide a biological explanation in these cases and evaluation is very superficial.

Overall literature values or the theoretical background were not consulted enough 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. The weaknesses they identify are 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 yet marked over generously.

As stated above in clerical procedure, if the method and the data used by the student are not provided by the teacher then CE cannot be moderated.

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.

ICT coverage

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

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 a tendency to use bar charts for everything amongst the weakest students, perhaps because it is the default setting. 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.

It might be an idea to train the students to plot graphs manually before using a graphing program. In fact, if a student is having technical difficulties in presenting the graph as they wish, and this graph is for assessment, then a hand drawn graph would be suitable alternative. So long as there is some exposure to graphing programs during the practical programme it is sufficient.

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.

On the other hand, under the current criteria the used of databases and simulations alone are, currently, not appropriate for assessment of Design, DCP or CE. If they are used in conjunction with e real hands on investigation this would be an excellent initiative.

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.

Recommendations for the teaching of future candidates

- Share the criteria with the students.
- 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 for your class.
- Give the students experience in identifying independent, dependent and controlled variables.

- Be sure that investigations used for assessment produce quantitative data.
- Encourage the students to make additional 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 with no evidence of analysing them, is insufficient.
- Encourage the students to carry out research into the background literature both before starting an investigation and once the results are complete.
- Do not use simulations or databases alone for assessment.
- **Do not** use the Group 4 Project for assessment of D, DCP CE or MS. Only use it for Personal Skills.
- Make sure that you are using the most up-to-date version of the 4/PSOW form (available from the **Handbook of Procedures** on the OCC).
- Check to be sure that all the parts of the 4PSOW form are completed correctly.
- Include the 4IA statement and the list of sampled students selected by IBCA

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 15	16 - 21	22 - 26	27 - 31	32 - 36	37 - 40

General comments

Of the 57 G2 reports received by the time of grade award, 33 thought that the paper was of a similar standard to that of last year, 2 though it was much more difficult and 2 thought it was a little easier. The remaining 3 thought that it was a little more difficult. However, 51 of the teachers thought that the level of difficulty was appropriate while 5 thought it was too easy and 1 too difficult. 20 respondents thought the clarity of wording was satisfactory, 35 thought it was good and only 2 of the teachers thought that the paper was poor. Regarding the presentation of the paper, 14 believed it was satisfactory and 43 thought it was good. There were many discriminating questions on this paper and a very 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 2

Although many candidates answered this question correctly, some candidates failed to use the image to answer the question.

Question 5

Many candidates had this question wrong and chose answer A instead of D. The most probable reason is they confused the word glycogen for glucagon. This proved to be a good discriminator.

Question 9

This question raised some issues in the G2s about lack of clarity. The phrase gene transfer could have confused the candidates; probably genetic modification would have been a better choice for it.

Question 19

Many candidates failed to see both recombinants, only the first option was detected.

Question 24

The question was poorly phrased. The question asked for the most likely result in a species when what was really expected was the change in the population. This did not seem to put off the candidates, as this proved to be a very easy question and most candidates answered it well.

Question 25

There were some issues in this question regarding the possibility that answer B is also correct. Although many candidates did go for B, D is a better answer as what is asked for is the consequence, not the cause for the greenhouse effect.

Question 26

This question provoked a lot of controversy and proved to be a poorly discriminating question. The question proved to be hard for more able students to answer. Many candidates chose homologous structures. One probable reason is that the answer referred to change in species throughout time but the question was showing the progression in change in different genera. As this question was correct, it was decided not to eliminate it but the grade boundary for 6/7 was carefully considered to ensure fairness.

Question 28

There was a complaint on G2s about the use of the SAN in the question instead of the full name of the sinoatrial node. The guide uses the acronym, so it is fair to use it in the exam. This question showed a bad discrimination factor. Many candidates chose answer B instead of D.

Question 34

There was some concern on the terminology used in the question. The term early pregnancy is not too scientific but a more definite time span might have confused candidates, which is why it was not used. This question proved to be a very good discriminator, so it probably did not distract candidates, as the more able candidates were getting this question right.

Question 39

This question was one of the best discriminators of the exam. Strong candidates answered D correctly while the weaker candidates were choosing A as an answer.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 13	14 - 23	24 - 34	35 - 44	45 - 55	56 - 72

General comments

Thanks go to the 57 centres that returned G2 forms. 49 thought the level of difficulty to be appropriate, 1 too easy and 7 too difficult. 33 thought that it was of a similar standard to last year, with 6 thinking it was easier and 10 more difficult. 52 thought that the clarity of wording was satisfactory or good, and 54 thought the presentation was at least satisfactory.

There were a few comments about the syllabus coverage with particular reference to question 6 in Section B. Some remarked that the question focused on only one area of the syllabus. While paper authors do aim to achieve a balanced coverage of the syllabus, students at HL are expected to have a thorough and in depth knowledge of the syllabus. Students should also be aware that some topics may not be covered on the exam at all.

There were some comments about command terms. Questions may be set using command terms of a level below that stated in the syllabus, for example, within reason, if the command term in the syllabus says 'Explain', then a lower command term e.g. 'Draw or sketch' can be justified, such as for question 8 a).

There were a few comments that the answer boxes were not big enough to give full answers. There were a few places where they could have been slightly larger, but generally they were of sufficient size. If students have to go on to extra sheets then, in almost every case, they are attempting to write too much. If there are two marks for a question, then no more than two marks can be awarded even if an extra page is written. In addition schools should be discouraged from handing out extra sheets as there is almost always more than sufficient space in the original answer booklet. It is critical that if a student's answer continues later in the book that the student provides a label which indicates this to ensure that the additional portion of the answer is not missed.

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

Plants (topic 9 and questions 2 and 8), sex linkage (Q3), linkages between structures within the digestive system (Q5), the ultrastructure of the kidney (Q5) and genetics definitions (Q7).

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

The understanding of the command terms seems to be improving, with evidence (circling, underlining etc.) that the students were reading the questions more carefully. There also seemed to be a better understanding of the higher skills, with an improvement in the 'evaluate' skills.

DNA replication was well known by those students who attempted to answer this question.

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

Question 1

In part a most students managed to give the correct answers for maximum number (between 82-84) of stem cells per ml of blood, though some misread the graph. The maximum number needed to be a whole number. The number of hours (5) needed to release the maximum number of cells was correctly identified by most, though some provided a longer amount of time.

In b most gained either 1 or both marks. Some students described similarities when only the distinctions were required.

In c, weaker answers failed to state whether or not the hypothesis was supported or not. In addition others lost marks by failing to state whether they were referring to the control or the jet-lagged mice.

In d many candidates failed to make the connection between mRNA and translation, with the weakest answers describing a numerical relationship. A number misread the graph in terms of under what conditions the peaks and lowest points occurred.

In e there was a tendency to give descriptive answers, stating figures from the graph, without drawing a comparison using comparative terms. As an example, 'clenbuterol releases 40 stem cells' would not earn a mark, but 'isoprenaline releases more stem cells than clenbuterol' is. Students must use clear comparative terms and be specific in their comparisons when there are multiple treatment groups.

A similar pattern of student answers was seen in f, where many were picking each individual point on the graph, rather than giving an outline as asked. Students need to pay attention to the distinction between a 'describe' and an 'outline'. In f(ii) students muddled the distinction between stem cells being produced and stem cells being released.

The ethical discussions in h were somewhat weak, with most gaining a mark for the death of early-stage embryos. Students appear to be using 'fetus' and 'embryo' interchangeably. Many statements were nebulous, for example referring to 'playing God' without adequately unpacking its meaning. In bioethics, 'playing God' refers to undertaking a controversial action unilaterally without adequate consultation with stakeholders and runs counter to the precautionary principle. In this expanded form, the notion of playing God would make for a good answer to a discuss question. Few mentioned the positive ideas of reduction of suffering.

Question 2

It was obvious to the examiners that many centres had not taught Topic 9 (Plants) as this was left blank by whole centres. I was the Palisade mesophyll/ cell – the arrow was clearly between chloroplasts. Mesophyll on its own was not accepted as this is too vague. It is accepted that the arrow from II was ambiguous, and stoma or guard cell was accepted, with the corresponding correct function in b. There was confusion as to the distinction between the function of the stoma and the function of the guard cell.

Question 3

The words 'hemophiliac' and 'female carrier' should have been enough to remind the students of sex linkage. Many did not know that hemophilia was sex-linked The candidates were allowed an 'error carried forward' mark if they had completed the Punnett square correctly but with the incorrect parents.

The blood clotting process was not at all well known. Many interchanged fibrin and fibrinogen in terms of function and properties.

Question 4

Many students were confused by the large schematic diagram, and did not understand the word 'process' in part a. They were not able to state that X is combustion/burning and that Y was photosynthesis.

Due to the fact that 'decomposition' was in the stem, 'decomposers' was not allowed in part b. Saprotrophs/bacteria or fungi were accepted.

The hole in the ozone layer seemed to be well known in the South American centres. Unfortunately this has nothing to do with the answer expected in part c about the enhanced greenhouse effect! Few seemed to distinguish between the short wavelength/high frequency UV rays from the Sun and the long wavelength/low frequency IR rays reflecting back through the thickening atmosphere.

Question 5

The examiners do realise that they are not testing artistic ability. However all diagrams should be large enough and clear enough to show the connections between the parts. In addition, as the papers are now scanned, the lines should be bold, as should the labelling arrows. Marks were lost for not clearly showing that the oesophagus connected to the stomach, the stomach connected to the small intestine and the small intestine to the large. The location of the connection between the large and small intestine was not well known. The pancreas seemed to float around without any duct leading to the small intestine as did the liver and gall bladder. The liver was often drawn too small.

Most students were quite knowledgeable about lactose intolerance though there were a lot of misspelled words as well as incorrectly applied terms.

The knowledge of the workings of the kidney seemed to be very school-specific, with whole schools seeming to know little more than there is some filtering at the start and urine is produced in the end. Well-prepared candidates produced some impeccable answers.

Question 6

The production of semen and spermatogenesis were confused by many candidates. Better candidates were able to give a very impressive account of the process, though many focused too much on spermatogenesis rather than on the other components of semen.

In spite of the fact that the structure and function of the placenta seem to have been on several papers in the last few years, they were not very well-known at all. Most gained some function marks for gas exchange and transfer of nutrients and waste, but the structure was not well known.

Most knew something of the hormonal control of birth. However weaker candidates started at conception and seemed intent on explaining the whole process.

Question 7

This was the most popular question by far. It also tended to be the best answered. Most candidates were attempting to describe chromosome, gene, allele and genome, rather than defining as asked. The definitions in the syllabus were expected or very close alternatives.

Better-prepared candidates scored well on part b, being able to competently compare the genetic material in prokaryotes and eukaryotes. Weak answers were caused by missing the

word ‘genetic material’ and just compared the two, scoring very few marks. A large number inappropriately defined naked DNA as being DNA that is not enclosed within a nucleus rather than DNA that is not associated with histones.

The explanation of DNA replication was well known by all but the least well prepared candidates. Many gave answers of textbook quality. It should be mentioned that if diagrams are included they should be clear and well labelled.

Question 8

The syllabus statement for 8.2.7 does say ‘explain’ as a command term for absorption spectrum. Draw is a lower level skill, and students should be able to draw the typical absorption spectrum. The x-axis is commonly not understood conceptually. If the axis is ‘wavelength’, then red should be shown as longer wavelength than blue. This was commonly reversed. The y-axis was often insufficiently labelled as absorption. Absorbance or percent absorption was required.

Most of the better students who attempted this question explained photophosphorylation very well. Students who had done poorly on the rest of the paper avoided this question.

As mentioned before, some centres seem to have regarded the plant topic as optional, so the function of phloem was not well known. Many did not demonstrate awareness that sugars are translocated as sucrose, not glucose.

Recommendations and guidance for the teaching of future candidates

- Encourage students to avoid needlessly extending their answers outside the allocated space. If there is a legitimate need to write outside the box, encourage students to provide an annotation that clearly indicates that the answer continues.
- Diagrams should be large, bold with clear labels. Connections must be unambiguous and correct. Structures need to be drawn as distinct.
- Remind the students that the enhanced greenhouse effect and the hole in the ozone layer are separate problems.
- Review the concepts behind the electromagnetic spectrum that are relevant to biology.
- Emphasize the distinction between an outline and a description.
- Encourage the use of comparative terms for compare answers.
- When asked to ‘evaluate’ an hypothesis, students should indicate whether the data supports or falsifies an hypothesis.
- Watch your timing so that all parts of the syllabus can be addressed equally. Botany tended to be the least well understood area of the syllabus.
- Encourage the careful use of language and biology specific terminology.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 13	14 - 19	20 - 25	26 - 31	32 - 40

General comments

Of the 56 respondents to the G2s, 51 considered that the questions were of an appropriate level. Only 4 though the exam was too difficult and 1 that it was too easy. 36 found this paper was of a similar standard to last year, 5 a little more difficult and only 2 much more difficult. 5 respondents thought it was a little easier than last year and only 1 that it was much easier. Regarding the suitability of the question paper in terms of clarity of wording, 18 found it satisfactory and 39 good. In terms of presentation, 41 though it was good, 15 satisfactory and 1 poor. Some respondents complained about the bad content coverage. The IB takes real care to ensure that the proportion of marks in the questions asked, corresponds to the number of hours the topic is taught for. There are limitations to the amount of questions that can be asked; therefore some areas of topics are not tested in each paper. The allocation of 6 marks in the last question is to test the ability of the candidates in long response answers, giving them a chance to show their in-depth knowledge of the option.

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

Candidates had problems with precision in their answers: poorly worded answers, lacking appropriate terminology and poor writing skills were often seen. Students were able to identify the relationships in the charts and graphs, but had difficulty taking it to the next level in using the information to predict a relation or effect.

The most difficulties were found in questions D3 (cladograms), D2c (comparison of convergent and divergent evolution) and, because of mark scheme demands, G2b (deciduous forest). Sometimes candidates knew the answers but their expressions were so awkward that no marks could be awarded (in E2aii cones are sensitive to red, blue or green, not to all three). In E3 candidates did not write the evolution of altruism, they only described an example of altruism. In F2 cell wall structure of bacteria, sewage treatment, differences between *Chlamydia* and *Streptococcus* and the use of viral vectors in gene therapy were not well known. In G2c candidates mentioned the estimation of "a population", but what is really estimated is its density, frequency, abundance or cover. In H2c the location of trypsin in the digestive system was incorrect.

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

Interpretation of graphical questions was well attempted and most students did well at analyzing data. Most read the graphs or tables carefully and were able to give the information required. Some candidates demonstrated good data analysis and summarizing skills (1st question).

Some good higher level knowledge was demonstrated by some candidates on options E2ab-3, G3 and H2-3. The questions that scored the best were on conservation of fish stocks and role of bile in lipid digestion.

There was in general an accurate understanding of command words, with fewer candidates misunderstanding the questions.

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

Option D

Question 1

b) The lack of sufficient explanation in the question, 'mean beak size' for each species or for the two species together, led to a wide variety of answers that scored poorly. Many also quoted values for individual years which did not describe a 'trend.'

c) Factors contributing to different beak size between species were stated (different food sources) instead of reasoning which factors cause that a given species change its size.

Question 2

a) i) Most answers contained 'methane', ammonia being the other substance stated but frequently only one correct substance was seen, therefore no mark was scored. In aii) many candidates scored the mark, although very few used the appropriate scientific vocabulary expected.

b) Generally well answered with poorer ones being vague and not saying the change was an increase. Human evolution is sometimes weakly covered (Hominids changed "from organic, natural foods to meat").

c) Again, generally well answered but marks quite often lost because a full comparison was not given and if it was, comparison always mentioned speciation and not evolution of adaptations. Very few mentioned cross-breeding.

Question 3

Many answers had content that did not match well with the markscheme, making this the hardest question in the exam, as very few candidates scored full marks. Often vague statements were given, not distinguishing between the fundamental differences between cladogram and traditional methods of classification. There was no clear idea about what/how/why cladograms were done, and the differences were between them and traditional classification. Many candidates believe that cladograms are the source of data, not their presentation.

Option E:

Question 1

a) and b) Generally well answered, although some candidates interpreted that +8 was faster than -12 and in many cases answered 2, as it is the velocity at which there was a greater percentage of larvae swimming.

c) and d) The majority of answers scored one of the two marks available as only single ideas were given. Answers tended to lack clarity in what was being compared

especially. Weaker candidates talked about positive/negative directions, not really understanding about the current flow.

Question 2

a) Good answers.

b) Several answers described the pupil reflex arc/pathway which was sometimes sufficient to gain one mark.

c) Few answers related to coma victims, dismissing almost half of the possible marking points but leaving sufficient possibilities to score well. Many candidates considered that if no pupil reflex is present, brain death is sure. Some stated the role of brain stem. Vegetative state was confounded with brain death. Several candidates repeated part of the information given in the previous question.

Question 3

Many answers did not relate the evolution of altruistic behaviour with the genetic aspect. Very few answers made reference to the alleles. The specific behavioural aspects of vampire bats, mole rats and honey bees especially were well known but often failed to expand further.

Option F: Few candidates chose option F, thus there was not a representative trend.

Question 1

a) and b) Well answered in general although many candidates failed to calculate the difference in cadmium ion uptake.

c) Little use of the data available. Only 2 of the mark scheme choices seen in answers.

d) Mostly well answered.

Question 2

a) Whilst knowledge of the differences in wall thickness was evident, further comparative detail was not. The definition mostly gained a mark.

b) Poorly answered, showing little appreciation of the different roles played in sewage treatment by bacteria. Many candidates answering in Spanish seemed to ignore this topic, although the question is nearly an exact statement in the guide.

c) Somewhat surprisingly poorly answered with *Streptococcus,* often stated as a cause of food poisoning.

Question 3

Answers failed to include enough of the range of risks needed for a high score.

Option G:

Question 1

a) Decent answers but confused by part iii.

b) Many failed to get a second mark possibly as they already filled up the available space with the lengthy terms 'no/single/multiple large herbivore species', weak candidates especially.

c) Same single scores and reason as above. Not easy to write a succinct answer without using wordy terms from the question.

Question 2

a) A good number of answers compared the two photos and made no reference to 'before the fire', which was not strictly needed.

b) The three aspects required were very rarely seen in answers. "Deciduous" trees was not accepted as it appears in the question.

c) Similarly here, a question that could produce an essay for the answer. Answers generally referred to the fact that a single large herbivore appeared to be better for plant community due to higher and abundance. The rest of the answer tended to lack the clarity for the other marking points. Also some candidates took the question to mean a single plant species/population (understandably) therefore not evaluating what would happen when multiple large herbivores are present.

d) There were some very good answers including examples of all 3 requirements but most candidates wrote vaguely about pollution and avoiding humans. Some answers about natural reserves were also too vague, about "good nutrition and absence of predators".

Question 3

Many candidates made a list of measures rather than their 'discussion'. Answers tended to score well compared to other options, although in the future no mark shall be given if a full discussion is not given.

Option H:

Question 1

Mostly well answered. Some answers to b. may involve a wrong value from the graph (for highlanders with CMS) yet giving the 'right' answer. In d. the exclusion of relevant data relating to the symptom was not rewarded.

Question 2

a) i) Very few identified the muscle correctly. There was some complaint about the fact that what was tested was a longitudinal section of the villus instead of a transverse section as stated in the guide. The complaint is reasonable, nevertheless, the candidates should have known the order in which the muscle layers appear and could have inferred the answer to the question. As a matter of fact, the more able candidates answered this question correctly.

ii) Several answers related to having protein channels which was not credited with a mark but most scored at least one.

b) Many good answers were seen but also a large number which did not refer to bile salts being present, so losing marks.

c) Again, some good scores but a large number of candidates lost marks because of imprecise answers such as not mentioning the pancreas as the trypsin source and often incorrectly saying it was activated by HCl in the stomach.

Question 3

Many quality answers with marks being lost due to insufficient or erroneous details or incomplete accounts, lacking details of the type of urine produced.

Recommendations and guidance for the teaching of future candidates

- It is important that students make themselves familiar with establishing relationships between causes and consequences. They should be able to reason better why a phenomenon occurs; which are the causing factors and how a process develops. Candidates need to give more lucid and concise responses to many data analysis questions. Emphasize careful reading of graph axis and keys so that correct conclusions can be drawn to answer the question.
- Candidates should practise exercises on interpretation and operation with numerical data and learn some formula which are important in the syllabus.
- Concentrate on teaching/learning two options well, rather than more options superficially.
- The command terms are the clue to the style of answer required, so these need to be demonstrated and reinforced over the teaching period, especially the command term "compare." In a comparison, they must make sure they compare two or more data.
- More practice on exam style questions to make sure that candidates understand what the question is asking for. Practise past paper data analysis questions using the corresponding published mark schemes.
- Students should know how much to offer for a 1 mark, 2 mark, 4 mark question etc. Students could be given a mark scheme and asked to mark each other's practice papers as part of a revision exercise to understand what an examiner is looking for.
- Many candidates run out of space for their answers – it is not a requirement to write full sentences in paper 3, nor is it necessary (or wise) to rewrite the stem of the question. Pertinent phrases that make the point are often better. Try to get candidates to avoid restating the words in the question because they will gain no marks.
- Biological mathematical skills appear to be weak in many candidates. To avoid losing a mark for lack of units, stress that candidates should always write units, even if not really required: e.g. Calculate the % difference = 4%. Similarly, explain to candidates why occasionally arbitrary units are used in expressing data.
- Some candidates demonstrate a lack of appropriate higher level knowledge; they should pay more attention to syllabus statements and definitions which indicate the level of detail required for some answers, particularly the longer 6 mark questions.
- All recommendations in previous subject reports continue to apply.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 12	13 - 16	17 - 20	21 - 23	24 - 26	27 - 30

General comments

Of the 68 G2s received by grade award, 39 considered it similar in difficulty to last year's paper while 4 found it a little harder. The remaining 14 G2 forms suggested that it was a little easier and 6 much easier. G2 forms gave a generally favourable response to this paper, with 61 reporting that it was appropriate in terms of level of difficulty, with the remainder considering it too easy. More than 96% felt that this year's paper had good or satisfactory syllabus coverage, clarity of wording and presentation. Only 1 respondent though the clarity of wording was poor.

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 to questions that aroused comment from teachers on G2 forms.

Question 6

Although many candidates answered this question correctly, some candidates failed to use the image to answer the question.

Question 8

The wording of this question seemed to be confusing to some candidates. Possibly not familiar with the term mesh, some candidates went for options B and C as an answer instead of A.

Question 12

Many candidates had this question wrong and chose answer A instead of D. The most probable reason is they confused the word glycogen for glucagon. This proved to be a good discriminator.

Question 21

There were some concerns in the G2s about the lack of clarity in this question. It was thought that candidates could have believed that interaction with the environment was also implied. Most candidates did however choose the correct answer, proving it to be an easy question.

Question 23

The question was poorly phrased. The question asked for the most likely result in a species when what really expected was the change in the population. This did not seem to put off the candidates however, as this proved to be a very easy question and most candidates answered it correctly.

Question 24

This question provoked a lot of controversy and proved to be a poorly discriminating question. The question proved to be hard for more able students to answer. Many candidates chose homologous structures. One probable reason is that the answer referred to change in species throughout time but the question was showing the progression in change in different genera. As this question was correct, it was decided not to eliminate it but the grade boundary for 6/7 was carefully considered to ensure fairness.

Question 27

This question was tricky and did not discriminate well for the more able candidates. Many candidates chose option B instead of A. Although usually type II diabetic patients do not require insulin injections, they may do. The more correct answer is A.

Question 28

There was some concern about the terminology used in the question. This question proved to be a very good discriminator, so it probably did not distract candidates, as the most able candidates were getting this question right.

Question 30

Many candidates did not answer this question, it is possible that they did not have time to finish the exam.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 12	13 - 20	21 - 27	28 - 33	34 - 40	41 - 50

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

Section A

Comprehension of the data in question 1, especially the second graph, challenged candidates. This led to mixed results in the answers for the various parts of question 1. In struggling to interpret the data, some candidates failed to properly respond to the various command terms (distinguish, evaluate, explain, compare and discuss) which framed the questions. Just as unseen data will always appear on the exams, candidates can always expect to see command terms leading the questions. Proper use of command terms should be an easier part of the academic skill set expected among HL or SL candidates at exam time.

Questions 2, 3 and 4 were set to cover other parts of core material in the syllabus. Gaps in knowledge were seen in sub-topics 4.3 (theoretical genetics), 5.1 (communities and ecosystems) and 5.5 (classification).

Section B

In question 5, many candidates were unfamiliar with extracellular components (A.S. 2.3.6).

Relatively few students attempted question 6, which might suggest limited knowledge of sub-topics 3.1 (chemical elements and water) and 3.2 (carbohydrates, lipids and proteins). However, those who answered this question knew the material fairly well. Overall, the various parts of question 7 produced a broad range of results from exceptional to poor. The question featured sub-topics 6.4 (gas exchange), 3.7 (cell respiration) and 3.6 (enzymes).

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

Section A

In question 2(a), most students knew digestive system structure and function (A.S. 6.1.4 and 6.1.5). At least one of two marks was usually achieved in question 2(b)(i) sub-topic 6.2 (The transport system) and 2(b)(ii) sub-topic 6.3 (defence against infectious disease).

Section B

Maybe because it has been a common question on past exams, there was clear improvement in the quality and content of the membrane drawings (A.S. 2.4.1) for question 5(a). Drawings were generally large with clear reasonable images, precise accurate labelling, and neatly done.

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

Section A

Question 1

a) i) Answered well; most candidates were within the range of 82 to 84.

   ii) Candidates were not as successful as in i); those who missed the answer of 4/5 hours seemed to overlook the time as “hours of light” on the horizontal axis for the control mice.

b) Weaker candidates wrote two separate descriptions of the graphs rather than citing specific differences between them, as required by the command term “distinguish.” It should not be left to the examiner to identify the differences. In such questions, specific items to be distinguished would best be written, one after the other, and linked with words like *whereas*, *however* or *than*. For example, “the highest release of stem cells per ml blood was 80 for the control *whereas* only 60 for the jet lag mice’ or “more stem cells are formed in the control *than* in the jet lag mice.”

c) Candidates did not provide specific references to the data when evaluating the hypothesis.

d) This question nicely applied course content to research data. Many candidates only stated that **“**if the amount of mRNA is high, more protein is produced.” Though the correlation is accurate, candidates were not awarded the mark. Since the question was an “explain,” it required further reasoning to be complete. Examples such as “because mRNA is translated to protein” or “because mRNA is involved in protein synthesis” would have been adequate.

e) This question was difficult because it involved analyzing a graph to "compare" the effects of two different chemicals and a control on the production of mRNA and the release of stem cells. Once again, weaker candidates only gave descriptions of data on the graph instead of making actual comparisons. A statement such as "isoprenaline produces a *low* amount of mRNA for CXCL12" communicates less information than "isoprenaline produces the *least* amount of mRNA for CXCL12." Such a subtle improvement can lead to the awarding of a mark.

f) Many knew that stem cell research could lead to improved treatment or cures for disease; also, that it resulted in the death of early-stage embryos. Vague answers such as "playing God" were not accepted or inaccurate ideas such as stem cells are collected from a zygote or early fetus. This was a 'discuss' question on the ethical issues of stem cell research (A.S. 2.1.10) and mention of a specific ethical conflict or specific pro or con positions led to a mark.

Question 2

a) i), ii), iii) Candidates knew the role and location of the stomach. Marks were lost when candidates mixed up the identity and role of the small and large intestine (A.S. 6.1.4, 6.1.5).

b) i) This was similar to past exam questions about structure and function of veins (A.S. 6.2.5). An easy mark, gained by most candidates, was that valves in veins prevent backflow of blood. Thin walls allowing muscle pressure to move blood or wide lumens to accommodate slow moving blood were cited less often. There was also glaring confusion with capillaries such as "veins have thin walls for diffusion of oxygen molecules" or "veins have walls of one cell thickness so exchanges can occur."

ii) This question required an outline of how some cells can ingest pathogens in the blood and in body tissues (A.S. 6.3.4). "Outline" meant only a brief account or summary, with or without a diagram. Quite a few candidates scored the maximum of two marks. They knew that phagocytes can detect/recognize/identify foreign protein or pathogens which can then be engulfed through phagocytosis. Unfortunately, more than a few candidates thought that antibodies engulf pathogens.

Question 3

a) Widespread weakness was seen as many candidates could not identify which organisms belonged to which phyla (A.S. 5.5.3, 5.5.4). One correctly matched organism was often mixed with one that didn't belong, resulting in no mark.

b) i) Unrealistic food chains were given; for example, daisy→ant→snail. Arrows showing energy flow did not always lead from producer to primary consumer etc. or were shown leading in both directions. Finally, the food chain had to include a producer, a primary consumer and a secondary consumer.

(ii) Although the food chain in 3(b)(i) had to begin with either daisy or fern, the initial source of energy should have been (sun)light. Either plant was unacceptable for the mark.

Question 4

Each of part of question 4 required knowledge of genotype (A.S. 4.3.1), using a pedigree chart (A.S. 4.3.12), reference to gender as described by sex chromosomes (A.S. 4.3.5) and inheritance of a sex-linked condition (A.S. 4.3.8). Many candidates

gained all marks or no marks. Credit was lost because candidates mixed up the terms of genotype and phenotype. Also, incorrect usage of allele notation sometimes discredited some answers. Correct usage appears in the Teacher's notes (A.S. 4.3.8).

a) i) needed the genotype X^HY; no credit was awarded to a word description such as normal male;

ii) again the genotype is needed but easier to get than in i) since in X^HX^h it's not necessary to know if h is dominant or recessive; iii) description of the boy's phenotype was needed e.g. normal or not affected or no hemophilia.

b) Almost no candidate could answer this question to the extent of gaining the mark. Though genetically modifying sheep to produce clotting factors was sometimes known, candidates failed to mention how the clotting factors became available to humans. That the clotting factors could be harvested from the sheep milk was a necessary piece of additional information. Surprisingly, some extremely weak candidates gave accurate thorough answers to this question (A.S.4.4.9).

Section B

Question 5

a) Candidates knew their hydrophilic heads and hydrophobic tails! Overall performance on this question was good. As noted earlier, improvement was seen in the quality of the drawings. However, some details needed to be more exact: peripheral/extrinsic protein should have appeared on the membrane surface, not fully embedded and flush with the surface; channel proteins, by definition, required a channel or pore.

b) Candidates who knew about extracellular components (A.S. 2.3.6) tended to know enough to gain the maximum 4 marks. There was greater familiarity with cell walls and their role in plants than glycoproteins and their role in animals.

c) Explanations of passive and active transport (A.S. 2.4.5, 2.4.6) involved many ideas that candidates seemed to know. Responses were generally well organized. Easy marks were gained for knowing which type of transport required ATP and for knowing details about different concentration gradients. Candidates did stumble when they confused protein pumps needed in active transport for protein channels used in facilitated diffusion. Some candidates also forgot that osmosis involves the movement of water molecules, not just "particles," from lower to higher solute concentration gradients across semi-permeable membranes. Instead of explaining osmosis in terms of solute concentration, other candidates correctly wrote about movement of water molecules from higher to lower water potential.

Question 6

a) Stating a role for sulphur, calcium, phosphorus, and iron (A.S. 3.1.1) allowed candidates to easily gain four marks. Sulphur was slightly problematic because its structural role in amino acids or proteins or enzymes is somewhat abstract.

b) The question required an outline of condensation and hydrolysis with reference to fatty acids, glycerol and triglycerides (A.S. 3.2.5). This was often done quite well. Some answers were accompanied by carefully annotated diagrams.

c) This part had the poorest achievement among candidates. The polarity of water molecules with hydrogen bonding as the basis for many of its properties (A.S. 3.1.4, 3.1.5, 3.1.6) was either overlooked or inadequately explained. The concept of water providing a stable environment over a broad temperature range also challenged candidate understanding. However, as always, some candidates were totally competent in their answers which even integrated accurate reference to specific heat. Ideas about water as a solvent and transport medium, water as a medium for metabolic reactions and how cohesion properties in water relate to transpiration were scattered among candidate answers.

d) As candidates distinguished between ventilation, gas exchange and cell respiration (A.S. 6.4.1), certain ideas keep reappearing and others were infrequently expressed. Among the former were inhalation and exhalation; movement of carbon dioxide and oxygen; and release of energy from organic molecules. Less common were involvement of muscle activity for ventilation; exchange between alveoli and blood or between blood and cells; and that cell respiration occurs in mitochondria. “Ventilation is moving air into the lungs” was not enough for a mark, nor was “cell respiration is release of energy from food” which was too general.

Question 7

b) With this question on aerobic respiration (A.S. 3.7.2, 3.7.3), many candidates easily earned four of the six available marks. These were that aerobic respiration requires oxygen, produces carbon dioxide, produces water and produces a large yield of energy/ATP. Additional marks were earned with commentary on glycolysis, since it produces the pyruvates that are eventually broken down aerobically.

c) Factors that affect enzyme activity (A.S. 3.6.1-3.6.4) is another topic that has appeared repeatedly on past IB exams. Furthermore, the topic is often visited during IA investigations. Details on how changes in temperature and pH affect enzyme activity formed the heart of most answers. Denaturation of enzyme structure that alters the active site was usually included in those answers. The effect of substrate concentration on enzyme activity was less common. Higher quality answers mentioned collisions between enzyme and substrate and linked enzyme activity to the frequency of collisions at different temperatures or substrate concentrations. Many written passages were supported with annotated graphs that also earned marks. However, some candidates confused the graph for enzyme activity vs temperature with the graph of enzyme activity vs. substrate concentration. They show a plateau in the temperature curve and declared that the plateau represented denaturation of the enzyme at that temperature.

Recommendations and guidance for the teaching of future candidates

Teachers and students should realize that careful systematic effort is made to balance each IB exam paper for syllabus content. However, because of the breath of the syllabus, it is not possible to test every topic of the core on each SLP2. Therefore teachers must help candidates thoroughly learn all topics on the syllabus to insure readiness for the exam. To quote Louis Pasteur’s “chance favours the prepared mind.”

A former chief examiner when asked “how do I prepare my students to succeed on the data-analysis questions?” replied that candidates need to be continually confronted with as many types of data as possible. Using periodicals or on-line resources, try to build a collection of different types of graphs and other pieces of data for candidates to interpret as individuals or as groups. Use the material as often as possible. Perhaps for extra credit, candidates could help

locate data for eventual use in the classroom. Finally, unseen data will always appear on SLP2. If the data seems difficult, students can always come back to it after answering other questions they know, in order to save some time.

Using former IB exam questions, teachers should have their students practise writing responses to different command terms and writing responses that directly answer the question. (One way to think about the command term “distinguish” is to consider it as a “compare” with only differences given). Relevant accurate detailed information will always win marks. In Section B essays, all parts (a, b, and c) of one question must be answered. Students are not allowed to choose different parts from different questions. Attention should always be paid to the number of marks available in any question. It usually means that at least that number of distinct thoughts must be provided if high achievement is to be reached. However, if a question is worth only 1 mark, a page of explanation is not necessary.

Help candidates to improve their writing skills. Clarity and thorough development of ideas are most important. Any examiner should not have to complete the thought for the candidate, or read between the lines in order to award a mark. This does not imply that candidates should ramble in their answers. On the contrary, concise writing should be emphasized and candidates should be discouraged from writing extra pages during the exam, unless absolutely necessary. Also, because scripts are scanned for e-marking, candidates must write their responses within the answer boxes that are provided so that nothing will be lost during scanning. Finally, it is obvious that illegible handwriting may mean that potential marks may not be awarded. In this session, at least a few scripts were almost impossible to read. Remember an examiner cannot mark if the examiner cannot read what has been written. During the school year, consider helping those candidates with poor handwriting in an effort to fix that problem.

If that does not help, speak to the IB coordinator for alternative solutions since poor handwriting may affect the outcome of all IB exams, not just biology.

Candidates should learn real world examples for key processes (e.g. stem cell therapy, food chains) to avoid broad generalizations. Names of organisms should be learned at the level of genus or species.

In genetics, make sure students know how to describe Punnett square data in words, and that they clearly understand the meaning of recessive, dominant, genotype and phenotype.

The SL syllabus has a limited number of assessment statements that begin with the command term “draw” or “label.” Teachers should expect that their students will encounter such questions in various places on the exam. These can be studied and practised *in advance*.

High standards should be set in terms of accuracy and completeness. Realistic shape, relative proportion and juxtaposition of structures should always be expected. Drawings or diagrams should be big with clear and complete labelling. Annotate all cycles. Include direction arrows, particularly in energy flow diagrams.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 14	15 - 19	20 - 23	24 - 28	29 - 36

General comments

The comments on the G2 forms indicated that almost all of the 66 respondents felt the paper was similar to or a little easier than last year's paper. As for the paper's level of suitability, 64 felt it was at the appropriate level of difficulty with the remaining respondents thinking it too difficult. The clarity of the wording was found to be suitable or good by all of the respondents as was the presentation of the paper. Teachers' comments are all considered at the Grade Award Meeting and all teachers are encouraged to fill out the G2 Form at the end of each examination session. The actual percentage of teachers who do this was higher than in previous years but still very small.

Options A and G were the most commonly chosen options. Options D and E were fairly frequently chosen. Very few chose Option C or F.

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

One area of difficulty continues to be interpreting the command terms and thus knowing what precisely is required to answer accurately. 'Evaluate', 'explain' and 'compare' were often problematic. Many candidates did not answer 'compare' questions correctly; they described the two items and hoped for marks that way. Also, when answering a question in which they were asked to 'discuss' an idea, candidates need to remember to include both positive as well as negative possibilities. There seems to be an emphasis on the negative factors only.

In data analysis questions, candidates did not explain or evaluate data when asked to; instead they often described the data which did not gain marks. Definitions were often poorly stated, even where they are clearly given in the syllabus.

Topics which proved difficult were: end-product inhibition, cultural and genetic evolution, allele frequency, germ line and somatic therapy and CFCs and its effect on ozone.

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

Some candidates produced very good scripts and it was obvious they had been given sufficient time and instruction to cover the two options thoroughly. They were able to analyze the data in Question 1 as well as indicate their level of subject knowledge in the following questions.

In general, candidates tended to do well on extracting data from graphs and doing simple calculations in the data analysis questions.

Although some candidates were able to score well, the answers still often lacked clarity and were not concise. Few candidates confidently stated solid, concise, clear answers. Topics that

were answered well by the majority of candidates included how sound is perceived by the ear and use of sugar in food preservation.

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

Option A

This was a very popular option and candidates tended to do fairly well on it.

Question 1

a) Almost all candidates read the graphs correctly to obtain the correct difference between overweight men and women.

b) Many did not give the correct range for the BMI corresponding to overweight status, giving incorrect upper limits.

c) Many candidates were able to get one mark for indicating that more women exercise than men but only some were able to get a second mark.

d) Candidates struggled with this question, primarily as they did not use the data to evaluate the hypothesis given. Instead of looking at how the data either supports or does not support the hypothesis, they talked in general about factors that could influence being overweight. One comment on the G2 forms indicated that it was hard to find 3 points for an answer to this when in fact the mark scheme provided 6 ways of getting the points.

Question 2

a) (i) Many candidates were able to gain the mark for indicating that fibre does not provide energy.

(ii) Many were able not able to read the nutrient label correctly and see that monounsaturated fats provided the most energy. They incorrectly indicated that proteins did as there were more grams of protein. They did not consider that fats contain more energy than proteins.

b) There were often vague descriptions of the differences between saturated and unsaturated fats. Many indicated that there were double bonds but did not indicate that these were between carbon atoms. Some were confusing double and single bonds with hydrogen bonds.

Question 3

a) This proved difficult as many candidates did not consider ethnic groups but gave countries instead. Often statements such as in the US the main dietary source of energy comes from meat were seen. Many scientific articles have been written about nutrition based on ethnic background.

b) Many candidates were able to get a mark for indicating that supplementing common foods would prevent deficiency diseases or provide nutrients lacking in the diet. However, the fact that ‘common foods’ were the ones the supplemented and the benefit of that were usually overlooked.

Option B

Question 1

a) Many candidates did not indicate that VO_2 max was a rate, instead indicating it was a volume or amount.

b) Almost all candidates were able to get the mark for reading the correct values from the graph.

c) Many candidates found it difficult to use the data to describe the relationship between intensity of exercise and source of energy. Better candidates were able to score two or three marks.

d) Most candidates struggled with this section and did not relate their answers to oxygen availability for aerobic and anaerobic exercise.

Question 2

a) There were some comments on the G2s regarding the fact that it was not clear where the arrow II was pointing. The mark scheme made provision for this.

b) Most were able to get a mark for a sprain being caused by overstretching or a partial tear of a ligament. The better candidates were able to get a second mark as well.

c) Comparisons of the hip and knee joint were poorly made. Candidates could not clearly articulate how the movement was different even though they seemed to realize they were. Very few indicated that both were freely movable joints.

Question 3

a) Many candidates were able to give a correct definition of fitness.

b) Many candidates were able to indicate that both tidal volume and ventilation rate increased during exercise but the explanations were often not clear. Still, many were able to get the twp marks.

c) Many knew what erythropoietin was used for and why so were able to get one mark but few actually evaluated its use.

Option C

This option was selected by few schools.

Question 1

a) Candidates were able to correctly use the graph to find the amount of ATP produced by oxidative phosphorylation.

b) Most saw that there was a much larger increase in lactate than in oxygen content during rattling.

c) Many candidates did poorly on this question which required them to use the data to deduce the role of anaerobic respiration in provision of ATP for rattling. Deduce is a command term that candidates find difficult. It requires them to use the data to reach a conclusion.

Question 2

a) Many candidates could correctly label the two parts of the chloroplast indicated.

b) Many scored two of the three marks on relating chloroplast structure to function.

c) Candidates seemed to either have a clear understanding of oxidation and reduction with regards to loss and gain of oxygen, hydrogen and electrons, thus gaining the two marks, or to have no idea at all.

Question 3

a) Many candidates could name two fibrous proteins although some incorrectly named globular proteins such as hemoglobin or non-protein substances.

b) Descriptions of the induced fit model of enzyme activity were usually incomplete with many simply outlining the lock and key hypothesis.

c) Control of metabolic pathways by end-product inhibition was weakly done. Many were able to get one mark for stating that the end-product inhibited an enzyme at the beginning of the pathway and some got a second mark for indicating that there was an allosteric site for the inhibitor to bind with but very few got a third marking point.

Option D

Question 1

Many candidates were able to score 2-4 marks on this data analysis question without seeming to really understand the data. They did not understand the idea of relative beak size compared to the long-term mean.

a) Almost all indicated correctly the year of the greatest change in relative beak size.

b) Many candidates did not compare trends but instead gave almost year by year descriptions for the two species, thus not gaining the marks.

c) Many were able to get one mark for possible reasons for the trends in relative beak size but very few received the second mark.

Question 2

a) Candidates either gave two types of environments where organic molecules could have been synthesized before the first living organisms existed or gave none.

b) Very few candidates indicated the role of prokaryotes in the development of an oxygen-rich atmosphere on Earth.

c) Good candidates were able to get three of the four marks available for a discussion of gradualism and punctuated equilibrium. Again, many candidates were only able to get one or two marks for actually describing the two rather than discussing them which requires a range of arguments for or against an idea such as the fact the fossil record does not support gradualism and mass extinctions support punctuated equilibrium.

Question 3

a) Many poor definitions of allele frequency were seen. Candidates did not seem to understand that this referred to a particular gene.

b) Candidates did not seem to have a clear enough idea of what cultural evolution and genetic evolution were to be able to compare them adequately. Despite this, many were able to score one or two marks but seldom three.

Option E

Question 1

a) Many correctly identified the maximum new swimming velocity as 12cms^{-1} although some candidates read the wrong axis and gave the maximum percentage of larvae instead.

b) Almost were able to correctly do the calculation required.

c) Many candidates were able to get the two marks by indicating that larvae swam against and with the current at all velocities of water flow but that the number swimming against the current decreased as velocity increased.

d) Many candidates were able to get one mark but few obtained two. It appeared as if candidates did not really have a clear idea of what net velocity indicated so were not really able to use the data to see if it supported the hypothesis.

Question 2

a) Most candidates were able to identify the sensory and motor neurones indicated.

b) This question proved difficult for many candidates. Many incorrectly described a reflex arc rather than outlining how sensory receptors detect stimuli.

c) This section on sound perception was very well done by the majority of candidates with many receiving full marks.

Question 3

a) Many were not able to explain the difference between innate and learned behaviour clearly.

b) The outlines given by candidates on the role of inheritance and learning on development of birdsong were often not clear.

c) Many candidates were able to obtain one mark for indicating an example of the effect cocaine had on mood or behaviour. Few were able to state the build up of dopamine in synapses or continuous neurotransmitter presence due to cocaine.

Option F

Question 1

a) Most candidates were able to correctly describe the pattern of cadmium ion update shown in the graph.

b) Most candidates were able to correctly do the calculation.

c) Many were able to get the two marks here, for information deduced from the graph rather than a discussion, which was seldom seen.

Question 2

a) Many candidates were correctly able to indicate that denitrification was indicated by the arrow between nitrate and nitrogen on the diagram.

b) Many candidates were able to indicate where the various types of Archaea were found although some lost marks by being too general.

c) Many candidates also obtained the two marks for explaining the use of high sugar concentration to preserve food.

Question 3

In general, candidates did poorly on all sections of this question.

a) There were poor responses to the question asking candidates to distinguish between somatic and germ line therapy. Many were very unclear as to what these were.

b) Again, very few gave clear answers on the use of viral vectors in gene therapy. Some received a mark for indicating a valid example such as SCID.

c) Some candidates were able to gain one or two marks out of three on this question as they knew that reverse transcriptase was used to produce DNA for gene transfer such as in the production of human insulin. Most struggled to explain how the enzyme was used.

Option G

Question 1

a) (i) The majority of candidates correctly calculated the difference required although some correctly identified 27.9 – 13.9 and then did not follow through to give the correct answer.

(ii) Many obtained the one mark for identifying the trend.

(iii) Many were able to suggest a possible reason for the differences indicated and thus gain one mark.

b) Many gained one mark for correctly indicating that Konza always had a higher species diversity than Kruger but few got a second mark.

c) Many candidates gained one mark for stating that both species abundance and diversity were higher when a single herbivore species was present. Few were given the second mark although some did correctly note that there was not enough data to evaluate the hypothesis as there was no data on multiple herbivore species in Konza, only Kruger.

Question 2

a) Almost all candidates were able to list abiotic factors that affected plant distribution.

b) While there were many possible examples of secondary succession, many indicated colonization of lava after a volcano erupted which is an example of primary succession.

c) Candidates were familiar with fundamental and realized niches and thus gained one mark but few could distinguish clearly between them and gain two marks.

d) Most candidates were able to gain one mark for indicating that organisms may fit into more than one trophic level but few obtained a second mark for discussing such ideas

as organisms alter diet with stage in their life cycle or that there are seasonal changes in trophic levels.

Question 3

a) There were surprisingly poor responses by the majority of candidates to this question on effects of chlorofluorocarbons (CFCs) on the ozone layer. Many candidates were confusing this with the global warming.

b) Many candidates were able to get one or two marks for discussing reasons for conservation of biodiversity seen in the Amazon rainforest. Some candidates were listing reasons rather than discussing them, however.

Recommendations and guidance for the teaching of future candidates

- Continue to use the action verbs in homework, tests and exams to make candidates familiar with the question stems so that they understand what is required of them when they are asked to 'describe', 'compare', 'evaluate' or 'explain'. 'Discuss' is a command term that is particularly poorly approached by candidates.
- Practise and expect good exam technique during in-school tests and exams. There is no need to repeat the stem or question, as candidates will not get extra marks and this uses up the space needed to answer the question. This is especially important as e-marking comes into effect.
- Many answered all sections on continuation sheets; this is poor examination technique, as they have no idea of the length of answer required or of the marks available. The number of lines given in the exam paper is an indication of the length of response expected. If extra sheets must be used, this should be indicated at the appropriate point on the script.
- Allow sufficient time for the teaching of the options. Teachers should choose the options according to their own strengths so that the candidates benefit by the knowledge and enthusiasm of the teacher.
- Practise interpreting data in different formats. Use past papers throughout the 2-year programme to develop this skill.
- Use past examination papers and mark schemes as well as the CD Question Bank to provide suitable questions so that candidates are familiar with the examination format.
- Where the syllabus asks for an unspecified example, teachers need to ensure that this is covered.
- All teachers need to attend workshops periodically.