November 2013 subject reports

Biology

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 29	30 - 41	42 - 54	55 - 67	68 - 80	81 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 29	30 - 42	43 - 54	55 - 68	69 - 80	81 - 100

Higher and 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

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.

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 continue to comment on investigations that were unsafe or unethical. However, this is getting less frequent.

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 the effect of smoking or alcohol on heart rate.

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 still 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.

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

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 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 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.

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 too rare and moderators are still commenting on their absence in designed investigations involving human subjects.

Clerical procedure

The latest versions of the 4PSOW form (available on the OCC) should be used. The 4/IA form and list of students is often absent in the samples received. Only one 4/IA form is required per school.

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. 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.

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 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 or their information is very limited.

Only a few teachers are not designing practical programmes with sufficient numbers of hours, some however are overestimating 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.

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

Trivial, simplistic investigations that do not generate sufficient data to permit adequate assessment of data processing were sometimes used for assessment. 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 teachers point out significant errors to their students and 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 efforts to make 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.

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

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

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 now seems 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.

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

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.

For example, in one 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 caffeine on heart rate. All of the students in the sample have done almost the same Design.

These teachers appear to be boxing the students in to perform the same investigations. This 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 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 novices 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 form 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 enzymes) are often missing.

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. 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 often 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.

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.

The two point discrimination test for touch receptors on the skin continues to be frequently used. All too often this ends up a repeat of a text book classic when it is possible to give it a more original or personal approach eg 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?

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. 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 complain about the use of the word "amount" which is frequently used by the students. It is no always clear if they are referring to volume, mass or concentration.

Data Collection and Presentation (DCP)

A consistent 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 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 could 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.

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

Moderators often had to reduce the marks of the teachers who had missed the following points:

- Data (raw or processed) that is inadequately presented (for example with superficial titles)
- Units missing in the table column headings (note: decimal units should be used)
- No uncertainties given in the column headings of tables of data collected using measuring instruments
- Inconsistent decimal places in tables
- The decimal places did not correspond to the precision of measurements
- The absence of associated qualitative observations where they are valuable. For example an ecological field investigation is incomplete without some kind of description of the site used. This appears to be a common problem.
- 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 when plotting graphs)
- The absence of statistical treatment of the data when it was possible
- When statistical treatment is applied with no consideration of its appropriateness. For example calculating standard deviations when there were only 2 or 3 measurements
- 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 has some other 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 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 under the current criteria, especially the assessment of this criterion.

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. 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.

If the method and the data that have been used by the student are not provided by the teacher, then Conclusion and Evaluation cannot be moderated.

Manipulative skills

The evidence on the 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.

ICT coverage

Many schools seem to have made an effort to equip themselves with the necessary materials to carry out data logging. There are signs that the material 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.

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.

On the other hand, under the current criteria the used of databases and simulations are not appropriate for assessment of Design, DCP or CE.

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 and guidance for the teaching of future candidates:

- Share the criteria with the students and explain them.
- 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.
- 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 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.
- Do not use simulations for assessment. Simulations used in conjunction with hands-on investigations producing “real data” are however to be encouraged.
- Do not use the Group 4 Project for assessment of D, DCP CE or MS. Only use it for Personal Skills. Inappropriate use will be sanctioned.
- 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.
- Complete one 4/IA form signed by all the teachers for your school’s sample and cross moderation between colleagues is essential.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 16	17 - 23	24 - 28	29 - 32	33 - 37	38 - 40

General comments

Of the teachers who responded on the G2 forms, an overwhelming 97% thought that the level of difficulty was appropriate, 56% thought that it was of a similar standard with a slight majority of the others saying that it was a little more difficult than year's paper. 94% thought the clarity of wording was between fair and excellent and 100% thought the same for Presentation. Over 90% of the G2 forms were in English, with the others being in German. There were several comments from the German speaking centres about the accuracy of translation, but those examining in German did not see that there was any significant problem. There did not seem to be any comments at all in Spanish. This was a successful paper with many questions that discriminated effectively between stronger and weaker candidates. There was one problematic question (36) and one typing error (question 40). The spread of marks was very wide but there were some very high scores indicating excellent knowledge and understanding from those candidates.

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

Question 1

The weaker students were lured into answer A, but the vast majority understood the logic behind the question.

Question 10

A few teachers commented that all answers could be correct. Indeed A, C and D could all cause a change. However D is the most likely cause as asked for in the stem.

Question 11

A multi-part question which proved to be a very good discriminator, with just over one third giving the correct answer of D. The crucial expression in the question is 'could result' and many went for A as option I was the most obvious.

Question 18

This was a good discriminator, perhaps showing that some students had avoided classification. More than one third were split between Angiospermophyta and Bryophyta.

Question 19

A significant number did not think that changes in dog breeds was evidence for evolution, answering A instead of B.

Question 23

A discriminating question, testing detailed knowledge of ventilation. D was the correct answer, but a very significant number gave C.

Question 27

There was a comment that the diagram was not clear. However this did not seem to have affected the students who generally gave the correct answer of B.

Question 31

There was a comment that C was not clearly pointing to the intermembrane space. However it is clearly not pointing to the same as B and is sufficiently clear. This proved to be a discriminating question, due to the subject area not the diagram.

Question 32

There was a comment to say that the diagram was a little faint. However the labeling was extremely clear and the vast majority gained the mark.

Question 35

Fewer than half gave the correct answer of D.

Question 36

This raised a few comments on the G2 forms. The correct answer of B was only given by half the number of the candidates who gave the incorrect answer of C. It was decided that the wording was perhaps too subtle and in the end both B and C were deemed worthy of the mark.

Question 40

Thank you to those who spotted the new HGC hormone in place of HCG. Fortunately the candidates were not put off by this with over two thirds gaining the mark.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 11	12 - 16	17 - 20	21 - 23	24 - 27	28 - 30

General comments

The comments on the G2 forms indicate that 72% of the respondents felt the paper was of a similar standard to last year's paper while 12% felt it was easier and 7% felt it was more difficult. As for the paper's level of difficulty, 98% felt it was at the appropriate level of difficulty. The clarity of the wording and the presentation of the paper were found to be suitable to excellent by all respondents.

Teachers were also asked to comment on the suitability of examination papers in terms of accessibility for candidates with learning support and/or assessment access requirements as well as whether there was cultural, religious, ethnic or gender bias. Of the 32 respondents to this section, 98% felt the questions were accessible to all.

Many questions on the exam performed well with a good discrimination index indicating that stronger candidates had answered correctly with weaker candidates tending to choose the distracters rather than the correct answer. There were also some very easy questions that were answered correctly by the vast majority of candidates which supported the observation on some G2s that this paper was easier than last year's paper. There were no problematic questions. The spread of marks was wide but very low marks were not seen and there were some very high scores indicating excellent knowledge and understanding from those candidates.

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

Some questions performed in a predictable way, so no comments need to be made about them. The comments are related to questions where candidates did very well or very poorly or that aroused comments on the G2 forms.

Question 1

This question was a good discriminator. While the majority correctly chose D, a very large minority incorrectly chose A, not understanding what the overlap of error bars meant.

Question 2

There was a comment on the G2s that the term 'corkscrew' used to describe the structure of flagella was confusing. This is a standard way of describing the appearance of a flagellum. Candidates did seem to know the function of the flagella and pili as the most commonly chose distracter was D, which differed from the correct answer C by the description of shape of these structures.

Question 3

This question was the easiest on the paper with the almost all candidates correctly identifying B as the property of cells providing evidence for the cell theory.

Question 7

Although this question was one that was common to HL, the SL candidates found it to be much more difficult. Perhaps this has to do with the fact that more HL candidates also do Chemistry than SL candidates. It was a very good discriminator with almost all of those getting it incorrect choosing B, showing confusion between the structures of glucose and ribose.

Question 8

For some reason, this straightforward question on the function of lipids was left blank more frequently than others. It was a good discriminator.

Question 9

There were comments on the G2s that there was more than one possible answer to this question. While it may be true that in some specific cases the various distracters may be correct, the most correct answer is D as the substrate will decrease in all enzyme reactions, causing the enzyme activity to gradually decrease.

Question 10

This question had the highest discrimination index on the paper with the better candidates correctly choosing A and almost all other candidates incorrectly selecting C. The top candidates realized that light is used in the light dependent reactions so looked for the

products of this stage, while the weaker candidates were considering the final products of photosynthesis.

Question 11-13

The genetics questions were well answered by the vast majority of candidates.

Question 14

This question was a good discriminator with the majority of those getting this wrong incorrectly choosing D. Almost all were able to determine that the type of inheritance was recessive but the weaker candidates were not able to see whether it was X- or Y-linked.

Question 15

This question was a good discriminator with the majority of those getting this wrong incorrectly choosing D. Almost all understood that fragments of DNA moved in an electric field (B and D) during electrophoresis but the weaker candidates did not know what was the basis for their separation, which is size.

Question 16

This question on gene transfer was also a good discriminator as the stronger candidates correctly choose B, indicating that they knew both enzymes involved in the steps indicated while the weaker candidates were split between C and D showing that they knew one, but not both of the enzymes.

Question 18

This was a very easy question with almost all candidates able to correctly distinguish between autotrophs and heterotrophs.

Question 21

It seems as if candidates were poorly prepared to answer a question on plant phyla as the majority got this wrong. The distribution of answers seemed to indicate that many were guessing as all responses were seen in high proportions.

Question 22

There were a few comments on the G2 forms that this question on overall population change was confusing and that it was mathematical in nature. However, the candidates did not seem to find it confusing. It is from assessment statement 5.3.1.

Question 23

This question on amylase was very easy with almost all candidates choosing the correct response.

Question 26

This proved to be a poor discriminator since all answers were seen in fairly high percentages. Many candidates found this confusing, perhaps from not fully understanding that the question was asking for substances dissolved in plasma, not transported in plasma. Erythrocytes are cellular so not dissolved in solution and heat is not dissolved either.

Question 27

This question was a good discriminator. Many of those getting this incorrect chose C, showing confusion as to which ion was diffusing into the neuron.

Question 28

There were two comments on G2s about the nature of this diagram of the female reproductive system while others said the diagrams were clear and labelled so that parts were easily identified. Those not getting the correct answer B tended to choose D instead, confusing the vagina and cervix.

Question 29

This question proved to be a very good discriminator with stronger candidates correctly choosing A and the weaker candidates split fairly evenly between the three other distracters.

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 - 45	46 - 56	57 - 72

General comments

Thanks go to the 34 centres that returned G2 forms. 31 thought the level of difficulty to be appropriate, and the other 3 too difficult. 21 thought that the paper was of a similar standard to last year's, with 3 thinking it was easier and 6 more difficult. 22 thought that the clarity of wording was very good or excellent, 10 thought that it was satisfactory or good with 2 thinking it was poor. 26 thought the presentation was very good or excellent and with the others being split between satisfactory and good.

There were a few comments implying that the introduction to Question 1 (e) was far too wordy. The candidates seemed to find it quite straightforward, and there was good evidence (underlining etc.) that most had read it carefully.

Some teachers commented on the amount of SL material on the paper, especially Question 3. The fact that it is from the core syllabus, does not mean that it is any less challenging for HL students. Topics 2 (Cells) and 5 (Ecology and Evolution) do not have any HL extension. The students are expected to have a thorough knowledge of the complete syllabus.

Most candidates managed to answer within the correct boxes, with fewer additional sheets used.

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

Precision of answers to Genetics questions (Q2), photosynthesis (Q4), the kidney (Q5). Calculations in general

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

The understanding of the command terms continues to improve, 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. The general level of diagrams (6a and 7a) has continued to rise.

Construction of a food web from information given (3a), the fact that valine replaces glutamate in sickle cell anaemia.

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

Question 1

This was a data analysis question based around diabetes. Most gained the mark for the correct ethnic groups in (a), however, part (b) proved surprisingly difficult, with less than half of the candidates correctly calculating 19 cases (per 100, 000). In (c) most gained the mark for the (much) greater incidence of Type II amongst 10-19 yr olds, but only the better candidates spotted the similarity between the incidences of Type I in both age groups. In the first part of (d) the better candidates could find at least one good comparison between the ethnic groups. The answer 'due to different diets' was a common vague answer in (d)(ii). More precision was expected e.g. greater fat/carbohydrate intake.

Most were able to state that the relationship was negative/inverse in (e), with weaker candidates trying to describe it using numbers from the graph. Stronger candidates correctly calculated the 45% decrease in part (f). There was no mark for the workings, but the numbers should have been taken from the right hand axis. Most were able to gain at least one mark for the discussion of reversibility in (g). Similarly in (h) most were able to link increased insulin concentration with more glucose absorption and in (i) most gained a mark, although the fact that the plasma lipids lowered the activity of the enzyme was not well spotted.

Question 2 (genetics)

The fact that there was a trisomy 13 as a result of non-disjunction eluded the majority, who seemed to register that pair 21 was OK, therefore nothing else could be wrong. Many lost a mark for not explaining why it was a male. Better prepared candidates were able to explain haemophilia and polygenic inheritance. For some candidates it seemed to be the first time that they had encountered them.

Question 3 (ecology)

In (a) most were able to gain both marks for the food web, but only about half were able to deduce that the arctic cod was a secondary consumer. In part (b) most knew about the 10% passing to the next trophic level in a food chain, but did not apply this to the ecosystem – i.e. that it has to be continually replaced. The concept of 'nutrients' was poorly understood by many.

Question 4 (Photosynthesis)

A line above and including all the peaks was required for (a)(i). Most candidates were familiar with the terms absorption and action spectra, but could not explain the relationship between the two in 4(a)(ii). In part (b) most knew that an electron became excited, but how or why this came about was not well explained.

Section B

Question 5 (water)

a. Most knew something about the properties of water, with very weak candidates simply saying that we cannot live without it. Some confused high (specific) heat capacity and high (latent) heat of vaporisation.

b. Varied from textbook perfect to those unfamiliar with the word angiosperm who left it blank.

c. Similarly in part (c) the functioning of the kidney did not seem to have been taught in some centres, with some weaker candidates not knowing much more than the fact that it is where urine is produced.

Question 6 (bacteria and infection)

a. Although the general level of diagrams has been improving, there were still a few poorly labelled ones, especially not distinguishing clearly between the cell wall and the plasma membrane. There were many pili and flagella seemingly floating in space, and many with eukaryotic structures. Most correctly drew the bacillus shape correctly.

b. Well prepared candidates gave a very clear and precise account of transcription. However some still remain confused between transcription, translation and replication, so described the wrong process. One common error was to say that helicase instead of RNA polymerase separated the strands. At the end, many forgot that they were explaining the process in prokaryotes and described the mRNA leaving the nucleus.

c. Most knew that the stimulation of the immune system involved macrophages, and T and B cells, but only the better candidates could explain the process clearly.

Question 7 (Membranes, Enzymes and Nerves)

a. Most were able to score some marks for a reasonable diagram.

b. Some weaker candidates were confused by the link between parts a and b and thought that they had to describe membrane enzymes. A description of the induced fit model of enzyme action was required. The markers were amazed at the lack of detail in the answers, with many not mentioning active site, substrate or ES complex.

c. Many candidates gave a full account of the synaptic transmission. Weaker candidates knew that calcium ions were somehow involved, but little more.

Question 8 (Mainly proteins)

a. Most were able to gain some marks on hydrolysis and condensation. Very few diagrams/ structures were completely correct.

b. The processes inside the mitochondria were well known by the better prepared candidates, who were able to explain in detail. Several candidates just tried to draw a diagram of the Krebs cycle without any annotation, hoping that the examiners would find some marks. A well annotated diagram can achieve full marks, but it must be clear. Many risked losing the quality marks by describing glycolysis in great detail, thus giving the impression that they were simply writing down everything they knew instead of answering the question.

c. Most knew that Sickle Cell Anaemia is due to a mutation, but only the better ones were able to correctly state that it was a single base substitution. Few correctly described that the mutation was in (one of) the polypeptide chain of Haemoglobin(A), with many vague statements attributing it to erythrocyte instead. Nearly every candidate remembered that glutamic acid was replaced by valine. Unfortunately this was the only mark gained by many.

Recommendations and guidance for the teaching of future candidates

- Make sure that key works are incorporated into the answers- for example remembering to use the expressions ‘active site’ and ‘substrate’ in enzyme answers.
- Make sure that all candidates have access to the syllabus and are familiar with the command terms included with each syllabus statement.
- Candidates should not try to spot questions. The candidates must be familiar with the entire syllabus. If you are going to go beyond the syllabus, make sure that you have covered everything else first.
- All answers should fit in the boxes provided – try to avoid repeating the stem of the question in the answer as this can occupy two lines of the box without the possibility of any marks.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 12	13 - 18	19 - 25	26 - 33	34 - 40	41 - 50

General comments

There was evidence of good preparation across a wide range of topics. Some candidates reached very high overall scores, well above 40. Unfortunately, Spanish scripts generally showed a much lower level of achievement than English scripts. This difference was due to a lack of knowledge.

Thanks go to the 45 centres that returned G2 forms. 43 thought the level of difficulty to be appropriate, 1 too difficult and 1 too easy. 29 thought that the paper was of a similar standard to last year’s, with 5 thinking it was easier and 7 more difficult. 29 thought that the clarity of wording was very good or excellent, 16 thought that it was satisfactory or good. 30 thought the presentation was very good or excellent and with all but 1 of the others being split between satisfactory and good. 1 thought it poor.

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

Section A

On the data analysis questions, candidates often quoted or described the data instead of considering what the data meant. This problem was especially evident in the responses to questions that required discussion, comments, or evaluation of data. Additional areas of weakness were calculating a percentage, reading a graph with Y axis labels on left side and right sides, using data from different graphs to evaluate a hypothesis, explaining vesicle transport of material within a cell (A.S. 2.4.7), showing the antiparallel features and 5’-3’

bonding in a DNA diagram (A.S. 3.3.3 and 3.3.5), and applying knowledge about human karyotypes (A.S. 4.2.4 -4.2.7).

Section B

The carbon cycle (A.S. 5.2.1) was either drawn well or very badly. Candidates don't seem to fully understand the concept of rate. When describing how to measure the rate of photosynthesis (A.S. 3.8.7), most answers neglected any reference to time. Outlining the role of hormones in menstrual cycle (A.S. 6.6.2) and explaining the principles of synaptic transmission (A.S. 6.5.6) challenged some candidates who could not provide enough accurate details. However, a few candidates provided marvellous complete answers to these topics which exceeded the marks available.

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

Section A

Many candidates could distinguish between type I and type II diabetes (A.S. 6.5.12). Recognition of negative/inverse relationship in graphs was widespread. The labels of the different cell parts (A.S. 2.3.2 and 2.3.2) were usually answered well. Everyone seemed to know about the role of helicase in DNA replication (A.S. 3.4.1). Using given information to draw a Punnett grid (A.S. 4.3.2 and 4.3.11) which showed correct genotypes and phenotypes seemed easy for many.

Section B

Many candidates displayed accurate detailed knowledge about the structure and function of the ventilation system (A.S. 6.4.4 and 6.4.5). Drawings of membrane structure (A.S. 2.4.1 and 2.4.2) were often of high quality.

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

Section A

Question 1

a. Distinction between type I and type II diabetes was easy for most; best answers included information on beta cells and insensitivity of cell receptors to insulin; some linked halves of different marking points for no credit e.g. type I early onset while type II with diet (lifestyle changes) instead of type II early onset while type II adult onset or type I treated with insulin while type II with diet (lifestyle changes).

b. Usually correct, based on a generous markscheme; no mark for inverse proportion.

c. Many candidates could not calculate the percentage decrease in enzyme activity.

d. One of two marks was often awarded; the question asks for the effect of lipids on enzyme activity but some wrongly answered how enzyme activity affects lipid. Some thought the effect of lipids on the enzyme was irreversible because of enzyme denaturation. Virtually no candidate answered marking points c or d which showed a lack of critical thinking regarding experimental design.

e. The increase was wrongly calculated by many candidates who often said '400' but there was more success on this calculation than on 1c.

f. There was a major tendency to quote or describe the data instead of commenting on the data. For example, candidates said that when insulin concentration increased, glucose absorption in muscle also increased instead of saying that increased insulin concentration caused/resulted in increased glucose absorption.

g. Some candidates misinterpreted the second graph as showing the body's response to insulin with a high lipid diet. Again, candidates failed to consider experimental design so the fourth marking point was never awarded.

Question 2

a (i) Knowledge of basic cell structures usually earned at least one of two marks. Some confused nucleus with nucleolus or mentioned other incorrect organelles.

a (ii) This was a discriminating question as most answers lacked detail; 'energy production' was too vague (should have been 'ATP production') and 'cell respiration' was incomplete (should have been aerobic cell respiration).

b. Sometimes X and Y were incorrect or ignored. A few gave 'endoplasmic reticulum' without specifying 'rough'. Many only mentioned transport by vesicles. Another problem was the use of 'vacuoles' instead of vesicles or the wrong direction for vesicle movement.

Question 3

a. The DNA diagram provided many ways to earn three marks. Complementary base pairing was an easy mark. Roughly 20% of the candidates failed to draw two strands. Most candidates did not show the anti-parallel nature of DNA and very few had the correct linkage at the pentagon corners.

b. It seems that every candidate knew about helicase and stated its function correctly. Thus, few zero answers appeared. DNA polymerase was also mentioned by many, but without the correct function. A few candidates confused replication with translation.

Question 4

a (i) A broad range of inaccurate answers were given e.g. karyotyping, polymerase chain reaction, or just no response at all.

a (ii) This question proved to be difficult because three components (pairs, size, structure/banding) were needed for the one mark. Many candidates forgot that chromosomes are placed in pairs in a karyotype. Some just mentioned 'karyotyping'. In this case, candidates should realize that just repeating a term (karyotyping) from the question stem will not get them credit.

a (iii) Few mentioned metaphase; interphase, which was commonly given, lost the mark. Several answers suggested meiosis.

b. A 'male' (based on recognition of the Y chromosome) was an easy mark for most. After that, the three copies of chromosome 13/trisomy 13 was not always linked to non-disjunction. Many candidates seemed preoccupied with chromosome 21 and whether or not Down syndrome was present thereby overlooking trisomy in chromosome 13.

c i) A Punnett grid usually given with correct genotypes and correct genotypes of sister with normal pigmentation. Confused answers gave pedigree charts or introduced sex linkage.

c ii) Often the correct percentage or ratio was given. In some cases, this occurred despite an incorrect Punnett grid in 4c(i).

Section B

There was a fairly even distribution of choice for questions 5, 6, and 7.

Question 5

a. Many candidates spent considerable time drawing beautiful trees, rabbits, and factories but labels on the arrows that connected the various components of the carbon cycle. Some candidates never showed CO_2/carbon in the air.

b. Many candidates could name production of O_2, uptake of CO_2, and an increase in biomass as methods to measure the rate of photosynthesis. This meant an easy three marks. Gaining marks beyond that became very difficult. The primary reason was that when candidates gave details about the method, they failed to mention rate, as in a unit of time for the measurement e.g. bubbles of O_2 released per minute. The equation for photosynthesis was rarely given by any candidate.

c. The mechanism of ventilation in humans was generally explained well. Some accounts were flawed when specific intercostals muscles contracting or relaxing were not identified. More serious problems occurred when candidates mixed up ventilation with gas exchange at the level of alveoli or dwelled on cell respiration.

Question 6

a. Growth curves often showed an S shape but, in some cases, the curve folded over itself. (Some even drew a log-linear plot.) Labelling was generally poor. Surprisingly, errors/omissions were seen in the X and Y labels. Although the plateau phase was usually clearly labelled, the exponential/log growth stage and the transitional phase were often vague. Many candidates did not earn full marks.

b. As consequences of overproduction of offspring, many answers only mentioned competition, limited resources, and survival problems. A common incorrect answer was 'competition between species'. The spread of disease in a population, the accumulation of waste products to toxic levels, and exceeding the carrying capacity were infrequently mentioned. An increase in predators was not awarded a mark. Some answers digressed in the direction of evolution without gaining marks.

c. The role of hormones in the menstrual cycle was badly answered by many. The role of FSH was known but only partial knowledge of LH, estrogen, and progesterone was seen. Regarding estrogen and progesterone, candidates generally knew they are involved in the maintenance of the lining of the uterus but that was all. Often, the various hormones were stated but without any description of their effect.

Question 7

a. There were many clear diagrams showing the molecular structure of a membrane. A labelled phospholipid bilayer always seemed to be shown. 'Intrinsic and extrinsic proteins' are terms still used by candidates. The marking criteria for glycoprotein and cholesterol discriminated against some who included them. Cholesterol molecules were sometimes incorrectly placed next to the phosphate heads rather than being embedded in the bilayer and appearing smaller than the hydrophobic tails. Overall, however, candidates earned maximum credit for this question.

b. The topic of enzymes has been visited many times on exams and is usually studied in depth. Though the question was narrowed to an outline of enzyme-substrate specificity, many

candidates were able to get three of the six available marks. Specificity of enzyme shape to substrate, the lock and key model and the binding of enzyme active site to substrate were the marking points frequently awarded. Sometimes irrelevant information was given, as when enzyme activity under different environmental conditions was described.

c. Unfortunately, candidates who showed thorough understanding of the principles of synaptic transmission were few and far between. Insufficient accurate detailed information was a common problem, along with an incorrect sequence of events. Other answers were laden with generalities, vagueness, or confusion. Many candidates scored poorly on this question.

Recommendations for the teaching of future candidates

Candidates should:

- try to study all topics at an equal and reasonable depth;
- draw clearly labelled diagrams. For example, it isn't enough to assume the sketch of an organism will be immediately identified; annotations are important;
- practise drawing the required diagrams/figures; because of the guide, they are all known;
- think through the graphs they draw, shape is one thing, but the labels with units are crucial as well;
- should read questions very carefully before answering them; when a question is not easy to understand at first sight, it should be left to the end;
- restrict answers to that which has been specifically asked and not waste time on information which will gain no marks; answer the question asked

Teachers should:

- try to teach all topics at an equal and reasonable depth;
- insist on more detailed answers for biological processes and stress the use of biological terms;
- help candidates to practise how to extract information from various forms of data such as graphs;
- provide candidates with more data-based problems, where different skills are called upon;
- provide 'hands on experiences' for investigation (laboratory or field); some candidates learn more effectively by actual experiment than traditional teaching;
- administer mock exams to candidates; special attention should be given to the marks scored for each question; candidates should know from previous practice that each mark awarded will correspond to a different concept

Higher 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 - 25	26 - 30	31 - 40

General comments

Comments were received about the English (91%) and the German (9%) versions of this paper. Nearly 88% of the 34 teachers responding on G2 forms felt that the level of difficulty of this paper was appropriate. The other 12% thought that that it had been too difficult. When comparing the paper to last year's, most teachers thought the standard similar although some found it a little more difficult. Half of the teachers felt that the clarity of the wording was very good, the others ranking it either poor (8%), fair or good (23%), or excellent (19%). About the presentation of the paper, the proportions were 3% poor, 12% fair, 23.5% good, 38% very good, and 23.5% excellent.

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

Although most candidates show an ability to read and/or describe data properly, they have more difficulty in areas requiring a finer reference to data and in questions requiring the skills of objective 3 command terms, such as 'explain', 'discuss', 'evaluate' and 'deduce'. Evaluation of hypotheses is often limited, if any, to the evidence supporting them, with no mention of what may not support them or what may limit their scope. Writing complete and accurate definitions proved to be difficult for many candidates. Many candidates were unable to express their answers clearly, using appropriate terminology, neglecting to include details that could have refined their answers. Many limited themselves to the repetition of what they learnt from manuals, with a range of ability to do so. The areas of difficulty for the different options were:

- Option D: Hardy-Weinberg calculations, explanation of the biochemical evidence of common origins of organisms;
- Option E: identification of parts of the brain and distinction between rods and cones with sufficient details;•Option F: features of pandemics, use of acid for food preservation, role of reverse transcriptase;
- Option G: description of primary succession;
- Option H: identification of parts of the ileum (microscopic image), role of membrane-bound enzymes in digestion.

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

Most candidates seemed to know which two options they were prepared for and answered them thoroughly. A large number of candidates displayed a comprehensive knowledge of factual information, demonstrated mainly by their answers to the last question in each option for which many gained all the available marks, especially in options E, G and H. Candidates generally did well at retrieving information from graphs, displaying units and performing basic calculations.

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

Option D - Evolution

Question 1

Many candidates had some difficulty in reading the graph properly, especially in locating where divergence points occurred, but could nevertheless outline the trends. They had difficulty in explaining the difference between the rate and the number of SDs and to suggest how some SDs not found in chimpanzees occurred. Nearly all candidates were able to design a satisfactory cladogram.

Question 2

The majority could name balanced polymorphism properly. Most knew that they had to apply the Hardy-Weinberg equation to find the percentage of heterozygotes in the population, but many had difficulties in determining the value of p and/or 2pq. Many found it hard to distinguish between allele frequency and gene pool using appropriate terminology. The conditions of application for the Hardy-Weinberg law were well known by the majority of candidates.

Question 3

Candidates had more difficulty with this question than with questions requiring longer answers in the other options, but many nevertheless provided good answers and managed to gain all the marks; those who were less successful confused biochemical evidence with origins of life.

Option E - Neurobiology and behaviour

Question 4

Most identified ‘occasional’ as the stage showing the least difference between the two types of twins. The comparison of results was a bit more difficult, although most gained some marks; many did not understand that these were concordance rates rather than percentages of use. Some candidates stated numerical values only instead of stating the relationship between values in their comparisons, gaining no mark. The analysis was sometimes laborious, but most could see the differences between the two types of twins as a supporting evidence for genetic factors; statements about evidence for environmental factors were scarce.

Question 5

Many candidates labelled the two brain areas correctly, but others provided one or two incorrect answers; the majority identified Y as either the *medulla oblongata* or the pons and gained the mark, providing that their answer to X was correct. Most had fMRI, but some missed the ‘f’ and did not gain the mark. Most gained marks for the rods and cones, but some marks were not awarded because of imprecise or too vague answers; some candidates answered about colour vision instead of intensity of light. Answers for controlling experiments involving human behaviour were very diverse, but some gained marks for mentioning variations between humans and/or ethics.

Question 6

Most gained many if not all marks for this question on exaggerated traits, using peacocks as an example. Although some answers were clearly organized, others were a bit confusing or repetitive, nevertheless gaining some marks. Some addressed sexual dimorphism only.

Option F - Microbes and biotechnology

Question 7

Many got the correct day and cumulative number of cases, but were weaker for the calculation. The progression outline was more difficult, and answers didn't relate to the time line. Reasons for the long delay were mixed and not always logical. Extracting features of pandemics from the data was laborious, but most candidates gained some marks as they referred to a couple of points of knowledge.

Question 8

Many knew that acids inhibit the growth of microorganisms, but they were confused about the mechanism, often referring to dehydration and not mentioning the effect on enzyme activity. Many knew the names of the organisms involved in wine production and nitrogen fixation, but the answers stating *yeast* were considered too vague. Definitions of chemoheterotrophs were often incomplete.

Question 9

Most answers were good, but some lacked specificity; answers were often based on gene engineering procedures and did not consider how reverse transcriptase works for viruses; few explained many usages.

Option G - Ecology and conservation

Question 10

Most figured out the correct answer, but many were slightly out of range (10°C). Spawning biomass was a different story: many were out of range and many also read the units incorrectly (e.g. 150/1000 tonnes instead of 150000 tonnes). Although most gained marks, outlining the trends was difficult for many, and evaluating the evidence for possible extinction was worse. For both questions, candidates had difficulty to relate to the time line; many were using the temperature (dependent variable) as a reference instead of the years (independent variable). Factors influencing the spawning biomass seemed random, some getting the correct answer.

Question 11

Many had correct definitions for biomass, but some referred to weight or amount instead of mass and others didn't include the area component. Whereas most stated *primary succession* correctly, describing the ecological changes occurring was difficult and resulted in a diversity of answers for which a few marks were gained.

Question 12

Most candidates gained many if not all marks, but many answers were repetitive and not very clear.

Option H - Further human physiology

Question 13

Most candidates could provide the values, but fewer could calculate the percentage increase correctly. Most could deduce the effects of the supplement to gain the two marks, but many candidates didn't realize that supplements applied to high cholesterol diets only or failed to mention that cholesterol applied to liver tissue. This had consequences on their evaluation of usage of supplements to treat CHD; many considered only the evidence provided by the cholesterol concentrations supporting the hypothesis.

Question 14

There were good answers, but many answered "microvilli" and/or couldn't label the longitudinal muscles. Most gained all marks about the transport mechanisms, but many seemed to not have understood the question and discussed movement through the digestive tract. Outlining the role of membrane-bound enzymes was difficult, and the marks were gained mainly for examples only.

Question 15

This was probably the best answered question in the paper. Many candidates gained all marks for ADH; there were nevertheless some answers lacking the details required by some marking points and a number of confused and incomplete answers.

Recommendations for the teaching of future candidates

- The knowledge of some candidates is not appropriate to HL expectations; they should pay more attention to syllabus statements and definitions which indicate the level of detail required for some answers. Some candidates performed quite poorly, especially in German and Spanish, due to a lack of information and knowledge.
- More attention should be drawn by candidates to follow instructions and to understand what is required for a specific question. Candidates need guidance and practice in how to consider the depth of their answers according to the mark allocations and the command terms. If a question is worth six marks, at least six statements must be made. The sequence of the statements should be carefully considered, as well as using examples to illustrate an idea. Throughout the two-year programme, candidates should have plenty of opportunity for writing extended response answers and, with the revised syllabus, incorporating knowledge into the analysis of a situation.
- Candidates should have covered the full content for two options and attempt to answer only those two (one in the new syllabus). It is apparent that some candidates are answering to an option simply because the data analysis looks easier, but they gain no marks on the content portion of the option.
- Candidates should practise past examination papers during the two years of the programme, along with the application of markschemes to evaluate their own work and those of other candidates.
- Candidates should be encouraged to use subject-specific vocabulary in their answers. Accurate definitions should be learnt, but candidates should also be prepared to apply them.
- Candidates should practise recognizing the magnitude of images and the structures relating to that magnitude. Many would not have mistakenly written microvilli if they had recognized that the image was that of an optic microscope.
- Candidates need more practice with data analysis, paying attention to accuracy when reading data. Varied presentations of data should be used as they require considerable practice to master their interpretation. Data from previous examination papers, as well as data from all sources, can develop the required experience for interpretation. Candidates need to practise extracting data from graphs, using them to deduce trends, and analyzing them to provide evidence for and against a hypothesis and to interpret causality between variables. Some theoretical knowledge should be integrated in their arguments.
- Units should always be given with an answer to a calculation or when quoting data from a graph, whether they are required or not in the question.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 9	10 - 13	14 - 17	18 - 22	23 - 26	27 - 36

General Comments

The comments on the G2 forms indicate that 62% of the respondents felt the paper was of a similar standard to last year's paper while 6% felt it was easier and 22% felt it was more difficult. As for the paper's level of difficulty, 88% felt it was at the appropriate level of difficulty. The clarity of the wording was an issue for 18% of respondents and individual queries are addressed in the sections that follow. The presentation of the paper was found to be suitable or good by all respondents.

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 is still very small with only 50 respondents (out of a possible 1919) at the time the Grade Award meeting was held.

As in previous sessions, Option A was the most commonly chosen option with options D, E and G also frequently chosen. Very few chose Option F.

The areas of the programme which proved difficult for candidates

Topics which proved difficult were:

- ATP production in muscles during different intensities of exercise
- Chemiosmosis in mitochondria
- Decision making in the central nervous system
- Role of saprotrophic bacteria in sewage treatment (which was also listed as an issue in Nov 2012)
- Formation of methane form biomass
- Primary succession

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

It was good to note that very few candidates attempted more than the two required options and few used extra sheets of paper, meaning most answered the questions in the spaces allocated. Many candidates produced good scripts and it was obvious they had been given sufficient time and instruction to cover the options thoroughly. They were able to both analyze the data in Question 1 as well as indicate their level of subject knowledge in Questions 2 and 3.

One area of difficulty continues to be the interpretation of the command verbs and thus knowing what precisely is required to answer accurately. 'Discuss' and 'explain' were often problematic on this particular paper.

Some questions that were thought to be easy produced lower scoring results than expected as responses lacked accuracy. Definitions and details need to be learnt.

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

Option A – Human nutrition and health

This was the most popular option on this paper and candidates tended to score highly on this, except for the data analysis question.

Question 1

a (i) Candidates had no problem with the use of the bar chart to state which group had the lowest frequency of kidney failure, with most getting this mark.

(ii) Most also used the bar chart to find the correct value of 11.5% although some seemed to misunderstand the question, giving two answers. This ambiguity seemed to be caused by the use of the word 'both' in the question. This led some candidates to give both 24.5% (for percentage with kidney failure) as well as 11.5% (for greater than normal albumin levels). As long as the 11.5% was clearly in the answer, the mark was awarded.

b. The responses to this question were often awkward and it seemed that some did not understand the data in this stacked bar chart so they did not make valid comparisons between the levels of albumin in the ethnic groups. Few were able to get the full 3 marks.

c. Almost all candidates found this question difficult and very few correct replies were seen. Many related their responses to perceived social inequities, not the data provided.

Question 2

a (i) Most candidates received a mark for stating that non-essential amino acids can be synthesized by the body.

(ii) The answers to this question on consequences of anorexia nervosa were surprisingly vague and many were not able to give two good replies for the mark.

b. This question on phenylketonuria was either very well done, with many getting 2 or the full 3 marks, or not scoring any marks.

Question 3

a. Although candidates did not note that fatty acids share a common structure but differ in the total number of carbon atoms in the chain, many were still able to get the full 3 marks for this question. Candidates showed a good understanding of saturated and unsaturated fatty acids as well as what cis and trans referred to. Some candidates were carelessly referring to hydrogen bonds and thus losing marks.

b. Many candidates received 2 but seldom 3 marks for evaluating the benefit of reducing cholesterol in the diet. Most did not seem aware that cholesterol can be synthesized by the liver or that factors other than diet can affect levels of cholesterol.

Option B – Physiology of exercise

Question 4

a. Most candidates correctly indicated that the maximal heart rate decreases with age.

b. Many also earned 2 marks for noting that the VO_2 max decreases with age in both groups of women but that (at any age) VO_2 max was higher in the endurance-trained compared with the sedentary women.

c. This question was discriminating as only the better candidates were able to predict that exercise reduces maximal heart rate because stroke volume increases.

d. Many correctly noted that the beneficial effects of exercise were indicated for the whole age range tested but that it was less effective after age 60 years, as indicated by the data on VO2 max and maximal heart rate.

Question 5

a. It was surprising the large number of candidates who could not correctly identify the humerus and cartilage in the diagram of the elbow joint.

b. Many candidates also did not get marks for this section as they could not clearly state the function of the bone or of cartilage. Insertion/anchorage for attachment of muscle / acts as lever; seldom give marks for I; often vague such as 'gives structure to arm'

c. Most were correctly able to state an injury at the joint, commonly stating dislocation, torn ligament or sprain as examples.

Question 6

a i) Some candidates received marks for noting that fast and slow fibres differed in the type of cell respiration used or the type of exercise they were used in. Very few referred to differences in blood supply, myoglobin levels, or stamina.

ii) Most candidates struggled to outline the methods of ATP production used in muscle fibres during different intensities of exercise.

b. A generous mark scheme allowed many candidates to gain full marks for discussing the ethics of using anabolic steroids, although few mentioned harmful mental effects.

Option C – Cells and energy

Question 7

a. Most could read the graph correctly to earn 1 mark. Some were outside the allotted range so candidates do need to be careful and use a ruler for data analysis questions.

b. Many candidates were able to get one mark for stating that as the concentration of both peptides increased the remaining activity decreased. Few were able to get the second mark as they found it difficult to describe what the graph was showing.

c. Most were able to correctly identify peptide 1 as the most effective inhibitor because only low concentrations were needed to inhibit enzyme activity.

d. Very few candidates were able to get any marks for this question,

Question 8

a. This was an easy question on proteins with most candidates getting full marks for both (i) and (ii)

b. This question was very discriminating as only a few got this correct; it appeared that candidates either scored all 3 marks for correctly labelling what was happening in chemiosmosis, or none. There were some comments on the G2 forms that this diagram was a little unclear. It was felt that this was a very clear diagram, however, it was a bit tricky to decide what substances the arrows were referring to. The use of the word 'molecules' in the stem seemed to have confused some as label II was for protons(H^+).

Question 9

a. Most candidates correctly identified the stroma of the chloroplast as the site of the light-independent reactions.

b. Many candidates could get 3 marks for the explaining the relationship between structure and function in the chloroplast.

Option D – Evolution

Question 10

This question proved very challenging for most candidates, particularly sections (c) and (d).

a. Many were able to correctly answer both (i) and (ii) although again some candidates answered outside the range due to not reading the graph carefully.

b. Again, many candidates were able to get 2 marks here for outlining the trends shown in the graph.

c. This question proved very difficult and few candidates received marks. The better candidates noted that this period was of shorter duration than the others. Few noted that these SDs occurred between the divergence of gorillas and the divergence of the chimpanzees or that some SDs may have been lost or deleted.

d. This question was also difficult and few candidates could suggest that SDs might be found in gorillas and humans but not chimpanzees perhaps because the same SDs occurred (independently) in both humans and gorillas or that there had been a deletion of the SD in chimpanzees.

Question 11

a. This question proved easy for candidates with most earning 2 marks.

b. Likewise, this section on properties of RNA also often was given full marks.

c. Many candidates were able to get 2 marks for discussing the endosymbiotic theory. The only point that was not seen was the point that this theory cannot be falsified or repeated.

Question 12

a. Only about half the candidates gave a definition of allele frequency that earned the mark. Candidates should not use 'frequency' in their definition.

b. Two marks were commonly earned on this question comparing allopatric and sympatric speciation but seldom 3. All marking points were seen but the difference in geographical area was most frequently cited.

Option E – Neurobiology and behaviour

This option was also very popular.

Question 13

a. Most candidates received this mark for noting the positive correlation shown in the graph.

b. This was poorly answered overall, with more than 1 mark seldom being awarded for noting that hippocampus volumes are larger in adults than in young birds. Many looked at hippocampus to brain volume ratios while the question asks only about hippocampus volume.

c. Most candidates correctly answered both parts (i) and (ii).

d. The evaluations done were mainly quite superficial yet many were able to get two marks for this question.

Question 14

a. Although this seemed like an easy question, comments on the G2 forms indicated that the wording of the question was such that it was not clear what was required under 'characteristics'. In retrospect, candidates did do poorly on this as many earned only one mark for correctly identifying the different light intensities detected by rods and cones. A surprising number could not identify the fovea as the location of the cones. The connection to the optic nerve was answered correctly only by the better candidates. Perhaps the use of the optic nerve was confusing and bipolar neuron would have been clearer.

b. This is a question that occurred frequently. Outlining how sound is perceived by the ear was well done by the majority of candidates, with full marks often awarded.

Question 15

a. Most were awarded 2 marks for correctly identifying two inhibitory psychoactive drugs.

b. This proved to be a very discriminating question as very few could explain how decision making takes place in the central nervous system. Even the best candidates only received 1 or 2 marks, often for mentioning inhibitory and excitatory neurotransmitters and the interaction between excitatory and inhibitory presynaptic membranes. Very few mentioned that the sum of the effects of the inhibitory and excitatory neurons determines whether the impulse is passed on.

Option F- Microbes and biotechnology

This was once again the least popular of the SL options, with no comments on the G2 forms about this section. Those that did do this option, found the data analysis challenging.

Question 16

a. Many correctly read the graph for the 1 mark.

b. Only a few of the better candidates were able to estimate that 100 was the factor by which luminescence increased during the given time frame. The scale on the Y axis seemed to confuse candidates.

c. Few candidates were able to score more than 1 for noting that there was low luminescence in the mutant strain while high luminescence in the parental strain (after 8 hours).

d. Again, candidates struggled with this question and did not seem to understand the data sufficiently to evaluate the hypothesis given.

e. Most identified the peptidoglycan cell wall as the shared characteristic of Eubacteria not seen in Archaea or eukaryotes.

Question 17

a. Many candidates were able to 2 marks for stating the habitats of methanogens and halophiles.

b. As was stated in the N12 Examiners' Report, candidates did not do well in this question on the treatment of sewage. One mark for saprotrophic bacteria feed on/break down organic matter (found in sewage) was common but seldom was a second mark awarded.

c. This proved to be a discriminating question as 1 mark may have been given but seldom 2 marks and not 3.

Question 18

a. Candidates found it relatively easy to get 2 marks for explaining the use of acids for food conservation.

b. *Azotobacter* was the organism most commonly indicated as involved in nitrogen fixation. Candidates needed to know the correct genus name; 'yeast' was not awarded a mark for wine production.

Option G – Ecology and conservation

This was also a very popular option and produced the most comments on the G2 forms, mainly concerning the graph used for the data response question. Between the short stem and the 3-D graph, there was a lot of information that candidates had available to them. Perhaps it took them longer to engage with this type of graph as they are seldom exposed to 3-D graphs.

Question 19

a. Almost all correctly identified species 4 as the most common in plant community 1.

b. Most also received the mark for indicating that species 45 had a broad realized niche as it is present in many communities

c. While most gained the mark for (i), few candidates received the mark for (ii). Candidates seemed to overlook the idea of woodlands near Lake Victoria but instead seemed to think the plants were in the lake and have too much water.

d. This question was very discriminating as in general candidates had a difficult time explaining the trends. Some did note that the pattern seemed to be linked to abiotic factors such as water availability.

Question 20

a. Definitions need to be learnt so that candidates can give a clear concise reply.

b. Many candidates correctly identified the ecological change occurring as primary succession for 1 mark in (i) but the outline of those ecological changes was very poorly done overall so that few marks were awarded in (ii). Maximum of 2 marks was common.

Question 21

a. Almost all indicated that ozone absorbs and thus protects against UV radiation.

b (i) Candidates had a difficult time stating precisely what N and n stand for in the Simpson Diversity Index.

(ii) This question on reasons for conserving rainforests has been answered frequently and candidates were often able to get the full 3 marks for giving a reason that was ethical, ecological, economic or aesthetic in nature.

Recommendations for the teaching of future candidates

- Teach students how to use tables when comparing or distinguishing between two things so that they make a point by point comparison. Too many candidates are still describing one and then the other item with no comparison being made.
- Ensure definitions are given and understood. Candidates need to use biology specific vocabulary clearly.
- Stress that the examiner can only mark what the candidate has written and cannot assume anything about knowledge or understanding.
- 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'.
- Practise interpreting data in different formats. Use scientific journal articles and past paper data analysis questions throughout the two-year programme to develop this skill. Encourage candidates to look deeper into the data to identify features they may not see at first glance.
- 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.
- There is no need to repeat the question in an answer. There is not enough space to do this and is poor exam technique.