November 2014 subject reports

Biology

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 29	30 - 42	43 - 54	55 - 66	67 - 78	79 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 16	17 - 33	34 - 46	47 - 57	58 - 70	71 - 81	82 - 100

Higher level internal assessment

Component grade boundaries

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

Standard level internal assessment

Component grade boundaries

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

General comments

Most schools use appropriate investigations of a good standard. A problem persists however in some schools that are setting themes for investigations for assessment that give insufficient latitude.

From the 2016 the IA submission will be the Individual Investigation, the internally assessed component of the new programme. It will require an individual approach. Students cannot work in groups or work on the same investigation on this assignment.

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 has to be marked down.

Ethics

Moderators continue to comment on investigations that are unsafe or unethical. Currently the schools receive a warning to conform to the IB code of ethical practice. However this is about to change.

For the IA submitted from 2016, the new internal assessment criteria have a provision for ethical practice, safety and environmental impact. Therefore in future, inappropriate practice by the candidate should directly affect the mark awarded by the teacher.

In many schools the IB Animal Experimentation Policy (available from 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. In particular, informed consent forms are not being used during investigations into human physiology.

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 and between students and their peers, 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 sampling of a wound to obtain bacteria to test for antibiotic resistance. This should not happen if the teacher is properly supervising the students.

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. Exposing them to conditions outside their normal environmental tolerance limits is not appropriate.

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

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

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

Fieldwork often involves the sampling of animal populations. This should take place with the minimum of disruption to the environment. The animals should be sampled using techniques that do not cause injury and which limit their stress. The animals should be returned, with due care and attention, to the places where they were collected.

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

Recommendations for IB procedures, instructions and forms

Clerical procedure

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

A new format of PSOW will be used from the 2016 session onwards.

Moderators are reporting that the electronic version of the 4/PSOW that can be downloaded from the IB is frequently incorrectly filled in. The criteria for the sampled work might be flagged using a cross but the actual marks are not filled in.

Teachers are regularly including the “complete”, “partial” and “not at all” breakdown of their marks. When this is combined with comments and feedback to the candidates it makes it very clear how the teachers were awarding marks. 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. Work with no comments or breakdown of the marks will possibly not get the feedback that it deserves.

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 comply with this requirement but moderators are reporting that not all do this.

A few teachers are failing to design practical programmes with sufficient numbers of hours. Some, however, have been observed to overestimate the time spent on an activity. Some schemes of work provide inadequate programme coverage, the commonest problem being missing options.

For the 4/PSOW to be submitted in 2016 the scheme of work will still have a required number of hours and coverage of ICT applications but additionally there are several required investigations that must feature on it.

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, so that they receive the necessary feedback to improve their performance.

The new programme requires that a single piece of work, the Individual Investigation, is submitted and marked for each of the criteria by the teacher. However it is strongly recommended that the teachers use the new criteria when they are marking their students for regular assignments during the course. This way the students will learn what is expected of them.

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.

For a few schools the length of the reports is extraordinary, one was over 54 pages long.

For the IA submitted from 2016, the new Individual Investigations are required to fit on 6 to 12 pages.

The range and suitability of the work submitted

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. Some teachers are also missing these points and marking over generously. Occasionally moderators are surprised to find that a teacher points out significant errors to their students yet still gives 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 not adhered to when marking, the moderation can reduce the marks quite severely.

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

Literature sources are sometimes 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. Furthermore SL and HL criteria are the same and they should be assessed in the same way.

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 may 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 may have added uncertainties or relevant qualitative observations

Criterion	Problem	Teacher awards	Maximum moderator can award
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 to 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 in which candidates appear 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. However there are schools where teachers are assessing work carried out using the manufacturers' worksheets. This is inappropriate, as it is too heavily guided.

Candidate performance against each criterion

Design

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

For example, in the same investigation presented by a school, all of the students in the sample had exactly the same research question. They were all investigating the effect of temperature on the activity of catalase using the same range of temperatures, the same intervals and the same protocol for measuring the dependent variable. All of the students in the sample had produced almost the same Design.

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

For example, if enzyme activity is the theme to be assessed for the Design criterion, there is 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 if collusion or excessive guidance is suspected. The teacher's

moderation will be affected by this. The same problem has been observed in all the classic themes for Design such as transpiration, osmosis, photosynthesis, fermentation, surface area to volume ratio and bacterial growth.

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

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

The three categories of variables must be clearly identified. It is clear that students need to be taught what the different variables are and what their relationship is. Moderators have observed that there is sometimes confusion over what is a controlled variable, that ensures fair testing, and what is a control experiment that can establish the effect of a variable that is not controlled. Sometimes unrealistic controls are being proposed when a control experiment would be appropriate (e.g. set room temperature to 21.1°C). It is not certain that some students are aware of the existence of water baths, heat shields or buffer solutions.

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

The investigations are often too simplistic. The range of values of the independent variable is insufficient to establish a trend. The number of repeats is insufficient to permit a statistical analysis that will allow a firm conclusion to be drawn. E.g. testing the effect of pH on an enzyme using an acidic environment, a neutral environment and a basic environment will not establish an optimal pH. Overall, too many candidates are using too few replicates, even in teacher directions, so they do not have sufficient data to use statistical tools correctly. This small number of repeats seems more common now.

For the IA submitted from 2016, the new internal assessment criteria will expect Individual Investigations that have collected sufficient data so that the student can demonstrate their powers of analysis, interpretation and evaluation. Thus trivial investigations that do not collect sufficient data will impact on several of the new criteria.

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 e.g. Does skin sensitivity change with different levels of exercise?

For the IA submitted from 2016, the new internal assessment criteria will expect Individual Investigations that are purposeful, where the student has reflected on what they are setting out to test. A simple repeat of a text book classic or one of the skill areas required in the programme will not be appropriate. Nor will investigations where all the students are repeating the same theme with the same independent and dependent variables.

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 now common practice. 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 not always clear whether they are referring to volume, mass or concentration.

Data Collection and Presentation (DCP)

A persistent problem is the presence of trivial investigations that do not generate sufficient quantitative data for adequate processing. This sometimes stems from investigations that are poorly designed by the students themselves. In this case the teacher 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 may 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.

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

- Data (raw or processed) that is inadequately presented (e.g. with superficial titles or headings).
- Units missing in the table (note: decimal units should be used).
- No uncertainties given in the tables of data collected using measuring instruments.
- Inconsistent decimal places in tables.
- The decimal places that do not correspond to the precision of measurements.
- The absence of associated qualitative observations where they are valuable. E.g. an ecological field investigation is incomplete without some kind of description of the site used. This still 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 for graphing).
- The absence of 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 or using t-test for data that employs counts.
- When there is no presentation of uncertainties in graphical data either by using trend lines or error bars or uncertainty ranges on the axes.
- When error bars are used but are not explained.
- Adding a straight line of best fit even when the data is clearly shows a curved distribution.

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

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

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

Teachers and students seem to need guidance on the appropriate approach to 'outliers'. Outliers can be identified when they do not fit in the general trend of a scatter plot. Of course to identify them there needs to be sufficient data. In the analysis of the data, outliers can only be removed if there is good reason to do so e.g. an **observed** anomaly in the material used or the manipulation of the equipment that was recorded. Professional scientists record such events in their log books as they carry out their experimental runs. Removing outliers because they do not "fit" the trend is just cherry picking the data and it is inappropriate practice.

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 an

unfocused research question to a poorly designed investigation that collects a limited amount of data, permitting limited processing, 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.

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

Overall, there was not enough consultation of literature values or the theoretical background by the students. When they are consulted, the sources are often not correctly cited. For guidance on the correct way to cite a reference, the guidelines in the Extended Essay Guide 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 often 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' work as 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 in the sample, then Conclusion and Evaluation cannot be moderated.

Manipulative skills

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

Criteria MS and PS for which marks are submitted by the school but are not then suitable for moderation will no longer be present in the new programme with IA submission from 2016.

ICT coverage

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

Graph plotting using software is perhaps the easiest and most widespread for schools to apply. However 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 use scatter plot, a trend line is not always used where appropriate. Note: joining the points dot-to-dot may be appropriate when the trend cannot be predicted. This can happen for series of measurements taken in field work or when there is too little data.

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

The use of spread sheets for data processing is less apparent in the sampled investigations. When spread sheet tables are inserted into document files, the conventions of presenting tabulated data are 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.

These ICT applications will still need to be part of the Scheme of Work for the new programme with IA submission from 2016.

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 PS 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.

The Group 4 Project will remain a requirement for the new programme but it will no longer be assessed. A reflective statement on their participation in the Group 4 Project will be expected from the candidates.

Recommendations for the teaching of future candidates

- Read the feedback on your sample from the previous session. This is available from your IB Coordinator.
- Share the criteria with the students and explain them.
- Consult the Online Curriculum Centre (OCC) for teacher support material (TSM). New material appropriate for the new programme is now available.
- 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. Though they may be a required part of

the teaching programme, they are not appropriate for the new assessed Individual Investigation.

- Counsel the students on the safety issues, ethics and feasibility of the investigations they design. It will now have an impact on their marks.
- Be sure that investigations used for assessment produce sufficient quantitative data. This will now impact on several of the criteria.
- 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.
- Simulations used in conjunction with hands-on investigations producing “real data” are to be encouraged.
- Do not use the Group 4 Project for assessment. Inappropriate use will be sanctioned.
- Make sure that you are using the most up-to-date version of the 4/PSOW form. This is available from the Handbook of Procedures on the OCC. The new version for 2016 sessions is also now on the teachers support material of the OCC.
- Check to be sure that all the parts of the 4/PSOW form are completed correctly.
- Complete one 4/IA form signed by all the teachers for your school’s sample and cross moderation between colleagues is essential.
- Familiarise yourself with the new programme’s requirements for practical work and internal assessment.

Some points to consider for the new Individual Investigation:

- The criteria have changed and the new criteria should be used. Due to the nature of science, however, there are many familiar aspects within the new criteria.
- The Individual Investigation needs to have purpose and to express the personal engagement of the student.
- Ethics, safety and environmental impact will need to be considered.
- The Individual Investigation is programmed to require 10 hours of hands-on time. Thus it should generate substantial data to permit adequate analysis, interpretation and evaluation.
- Though the new programme specifically requires the students to use the χ^2 test, this is not the only statistical test that exists and it may not be appropriate for the data collected in their Individual Investigation.
- The page length of the Individual Investigation should be between 6 and 12 pages. The assessment criteria will impact on investigations that are too long.

Higher level paper one

Component grade boundaries

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

General comments

The questions not commented on did not prove difficult for the candidates and did not elicit any comments from the teachers.

Q1 In spite of some comments from teachers, the vast majority of candidates scored the point.

Q2 A was expected as the correct answer, but after a lot of analysis it was decided that both A and B were to be accepted due to the wording of A being slightly ambiguous, so either scored the mark. The question has been re-worded for publication.

Q5 There were some comments that the diagram was too small to see the ribosomes. However the vast majority achieved the mark. A significant number fell for the distractor of B (RER), but the stem said '...within the cell'.

Q12 Comments on this question varied from congratulations on a novel approach to the fact that it was tough and not on the syllabus. It is covered by 8.2.3 'explain the light dependent reactions'.

Q20 Most correctly gave A. The most common distractor was C, the candidates confusing community and population.

Q22 There was one comment that the rings at the segment edges were not clear. The examination team thought that the photograph was of sufficiently high quality to see the rings.

Q23 There were comments that the wording was confusing and that it fell outside the syllabus. It is covered by syllabus statement 6.1.5, outlining the functions of the small and large intestines. The majority gave the correct answer, with the remaining answering A, which is a correct statement, but not the answer to the question.

Questions 24 and 25 proved straightforward and it was good to see that most knew about the connection between type II diabetes and obesity in Q26. Likewise 28 and 29 were found to be quite easy.

Q29 and 30 brought some comments that the stems could have been more clearly written; however the candidates did not find them difficult in the least.

Q32 Syllabus statement 9.2.11 does say that 'no details of the structure of phloem are required'. However the candidates would be expected to know that the xylem consists of tubes of dead cells, which would not have cytoplasm, therefore excluding the main distractor A. This proved to be the most discriminating question on the paper.

Q34 proved to be very discriminating with a large number of weaker candidates answering A instead of C.

Q36 Weaker candidates were confused between volume and concentration, answering D instead of A.

Q39 brought some comments that the photomicrograph was not clear. Again the team felt that it was. About 50% correctly gave the correct answer of B, with about 25% giving the main distractor of A.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 11	12 - 16	17 - 19	20 - 23	24 - 26	27 - 30

Q1 According to a G2 comment, candidates found this question off-putting. The truth is that most candidates answered the correct option. Five candidates left the question blank. Because it was easy, the discrimination index of this question was not good.

Q2 A was expected as the correct answer, but after a lot of analysis it was decided that both A and B were to be accepted due to the wording of A being slightly ambiguous, so either scored the mark. The question has been re-worded for publication.

Q3 Most candidates answered this question correctly, as mitochondria are only found in eukaryotes. Many candidates erroneously believed flagella are only found in prokaryotic cells, but there are some protozoans that have them.

Q4 Mostly well answered and a good discriminator.

Q5 Many candidates believed the correct answer was the rough endoplasmic reticulum. The key word in the question is that the protein synthesized are used within the cell, therefore ribosome is the correct answer. There have been some complaints about the diagram, but the examining team considered it is clear enough.

Q6 An easy question and good discriminator.

Q7 Most candidates answered that solvent properties of water allows transport of nutrients, but some candidates erroneously believed thermal properties are also involved.

Q8 Mostly well answered and a good discriminator.

Q9 Mostly well answered.

Q10 Although not all candidates are familiar with the term matrix, candidates could still get the correct answer if they knew the end product of anaerobic respiration.

Q11 Mostly well answered and a good discriminator.

Q12 Mostly well answered and a good discriminator.

Q16 There were complaints about this question, as the stem does not specify whether this is an autosomal or whether it is a dominant or a recessive trait. It is not possible for the trait to be sex-linked recessive, as the daughter in FI would not be affected. It cannot be sex-linked dominant; otherwise the FII males would be unaffected. The only possibility is therefore autosomal recessive and D the only possible answer.

Q17 Although most candidates answered 50%, many candidates answered 25%.

Q18 Many candidates answered that the genetic code is semi-conservative instead of that it is universal.

Q22 The word arm includes the forearm; therefore both terms are correct. A better terminology would have been forelimb.

Q23 Although there has been a complaint about the clarity of the picture of the annelid, the photograph is very clear, showing the rings and the clitellum.

Q24 This happened to be a very difficult question for candidates and a bad discriminator. This means that good candidates believed that colonic irrigation should be avoided because the large intestine absorbs water. Only a few candidates realised that the problem of this practice is that it eliminates vitamin-producing bacteria. The topic 6.1.5 expects the functions of the large intestine and the production of Vitamin K is one of them.

There was a typographical error in the Spanish version (enguajar instead of enjuagar), but this did not affect the answer to the question.

Q28 Most candidates believed that the lung air pressure falls below atmospheric pressure after expiration. This is incorrect, as it reaches the atmospheric pressure.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 8	9 - 16	17 - 24	25 - 33	34 - 42	43 - 51	52 - 72

General comments

Thank you to the 32 teachers who returned G2 feedback forms. 65% thought that the paper was of a similar standard to last year's, with the remainder being almost equally split between easier and more

difficult. 25% thought that the clarity of wording was only fair or poor. This will be mentioned later. All thought that the presentation was at least fair.

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

Cell structure – extracellular matrix (Q2), Why light and CO_2 limit photosynthesis (Q6), Therapeutic cloning (7b)

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

Heart structure (Q4), Translation (Q5). Leaf structure (Q6), stages of mitosis, ABO Blood Groups (Q7), In Vitro Fertilisation (8b)

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

Section A

Question 1 (Data Analysis)

Some G2 comments seemed to think that Question 1 was longer this year. It was worth 1 mark more than last year, but did include some factual questions, for example 1c, making it very similar.

a) Nearly all students gained the first mark for stating that that the blood pressure increased with increase in Sodium concentration. Few gained the second mark for mentioning hypertension (as prompted in the introduction) or describing the fall after treatment.

b) In (i) very few suggested a reason for the decrease in blood pressure, simply stating that the sodium concentration had been reduced. Part (ii) was better answered, with better students spotting that the control also decreased, suggesting that other factors could be influencing it.

c) Most knew about the muscle and elastic tissue, but failed to achieve the marks for not stating that the layers are thick and give strength and flexibility. Weaker students tried to compare arteries and veins without addressing the question.

d) The graph seemed to confuse many students, and judging by the G2 comments, some teachers as well. However most were able to state that the greatest difference was in women with a low sodium diet. There were some G2 comments that the ‘hyphen -’ should have been replaced with a ‘slash / ’. In fact the hyphen was meant to be a minus sign as indicated by the negative numbers on the Y axis.

e) Few used the ‘compare’ instruction correctly, failing to state the obvious fact that the reduction of BP happened in both sexes. Weaker students got tangled up in quoting figures, and the better ones spotted that women had a greater decrease from high to low than men, but men had a bigger decrease from high to intermediate.

f) There were few good suggestions for the difference.

g) The graph seemed to confuse weaker students. Better ones spotted that as potassium increases it tends to lower the BP regardless of the sodium level, but the difference is greater at high sodium concentrations.

h) Better students immediately connected the three Na^+ out for every two K^+ in, so an increase in potassium would remove more sodium. Weaker students forgot that it is an active process, so talked about diffusion of ions.

i) Many answers were very vague, not using all the data as stated. Better students used the conclusions from all 3 graphs, and noted that only one of them was data collected on humans.

Question 2 (Cell structure)

Most could identify I as an integral protein/glycoprotein and II as a phospholipid/tail. Many labelled 1 as a channel protein although there was no channel in evidence. The extra cellular matrix III and its function were not well known. Some G2 comments were unclear about the extracellular components, even although it is covered by syllabus section 2.3.6. Some also said that II was not clear. The mark scheme was set to accept several possible correct answers.

Question 3 (Enhanced Greenhouse effect and Population Size)

Part a) was answered correctly by well-prepared students, however weaker ones simply stated the result instead of providing an explanation as asked.

In part b), a large proportion of students failed to grasp the fact that immigration and emigration always happen, and that to gain the mark they must be qualified – i.e. increased immigration etc. Many vaguely stated that the 'carrying capacity had been reached', without any explanation of why.

Question 4 (Heart)

Only the weaker students failed to label the aorta and left ventricle correctly. Some confused the semilunar valves with the atrio-ventricular valves in b). Only the very weak students did not realise that the contraction of the heart muscle is myogenic. However many answers lacked the detail that was expected, for example the SAN controlling the muscle contraction, not simply 'heart contraction'.

Section B

Question 5 (Proteins)

a) Four functions with named examples were asked for. Very few students achieved what should have been four straightforward marks. 'catalysis' was looked for as a function with a named enzyme, as was 'regulation/homeostasis' and a named hormone.

b) The process of translation seemed to be well known, with some almost textbook answers.

c) Weaker students latched on to the phrase 'evolution by natural selection' and seemed to write all they knew about it, without applying their knowledge to the specific question of why one protein would be expressed above another.

Question 6 (Photosynthesis and Leaf structure)

a) Most gained three marks for stating that there is high level of absorption of red and blue light and that there is low/least absorption of green light as it is mainly reflected. Few stated that blue has the greatest absorption.

b) Most gained at least one mark for the graph of CO_2 concentration and rate. The graph for light should not have started at the origin on the X axis. The explanations of the effects of low light and low CO_2 were not well known.

c) Well prepared students were able to describe the structure of a leaf. However some weaker ones took it as an opportunity to write all they knew about dicotyledons and, although they knew that water travels in the xylem, they did not really indicate why it is needed in the leaf.

Question 7 (Mitosis, codominance and therapeutic cloning)

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

a) Most gained some marks for the mitosis diagrams. Common mistakes were not showing any membrane (intact or disappearing) in prophase, the number of chromosomes changing during the different stages, movement of chromosomes not chromatids in anaphase and showing the two cells after cytokinesis and labeling as telophase. Some diagrams were so small and the structure so indistinct that they failed to score marks. In general the diagrams were of an acceptable standard.

b) The definition of codominance was well known, but that of multiple alleles was not. Care should be taken to use the nomenclature stated in the syllabus, I^A, I^B and i. On the whole, this part was answered well.

c) Therapeutic cloning as technique for the creation of an embryo to supply embryonic stem cells was not well known, with many different explanations of Dolly the sheep etc. Few knew about the benefits, but most attempted to write reams about it being ethically unacceptable.

Question 8 (Male reproductive system, IVF and the placenta)

a) The diagrams were, to say the least, very varied. Tubes should be shown as such, not just lines and every tube should be connected, not just emptying into the lower abdomen somewhere.

b) The process of *in vitro* fertilisation seemed to be well known, with many markers noting the detail included.

c) Weaker students read the question as ‘write all you know about the placenta’. Only the better students were able to link structure and function correctly.

Recommendations and guidance for the teaching of future candidates

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

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

If you run out of space and continue in an answer booklet, then SAY SO / put continued……. at the end of the answer box.

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

Additional Comments

Very few students answered more than two questions in Section B. This is a good development.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 15	16 - 21	22 - 27	28 - 34	35 - 40	41 - 50

General comments

Most candidates showed a good knowledge of the syllabus and were able to answer questions across all areas of the course. A number of candidates did not seem well prepared with large gaps in their knowledge. Candidates generally made an effort to be clear and well organized in their responses to Section B questions.

Those teachers who completed the G2 forms overwhelmingly indicated that the exam was of an appropriate difficulty. A clear majority thought the exam was of a similar standard to last year's paper and that the clarity of wording was very good or excellent. A far greater majority ranked the presentation of the paper as very good or excellent.

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

Many candidates were unable to write answers as directed by various **command** terms. Marks were lost with: **analyze** when conclusions were not reached, **compare** when differences and similarities were not given, **discuss** when alternate ideas were not developed (lists are inadequate) and **explain** when causes and reasons were not give (simple outlines or descriptions are inadequate). Candidates should be encouraged to write in complete sentences and paragraphs in Section B.

Distinguishing key terms such as autotrophs and heterotrophs or detritivores and saprotrophs appeared challenging because knowledge was lacking and comparative language was missing. Candidates struggled with the precautionary principle. Though candidates had an understanding of sickle-cell anemia, they often lacked detailed knowledge to explain the causes of the disease.

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

Overall, candidates could read the graphs and interpret the data. Candidates accurately predicted the effect of environmental changes on the enhanced greenhouse effect but lost the mark when no reason was given. The energy flow in a food chain was well known. Drawings of mitosis and *E. coli* were generally clear and well done. Good knowledge of carbohydrates, glucose metabolism and glucose control was seen. The questions selected by candidates in Section B seemed to work well for them as they generally scored well or better than Section A.

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

Section A

1a Most candidates correctly calculated the difference in the number of cells after five days. Arithmetical errors hurt some candidates.

1b The 2/2 mark maximum was achieved by most. Marking points a, b and c were usually awarded.

1c Generally correct.

1d In this comparison question most candidates did not give a similarity so lost one mark. Some candidates just quoted data from the graph without making any comparison. Simply repeating the numbers and expecting the reader to make the conclusions about the comparisons earned no marks. Other candidates tried to describe the changes over the five days using words like increasing and decreasing rather than looking just at day 5 (as expected in the question) and using comparative language such as greater or lesser than. Use of charts or tables to answer such a question only works if the candidate makes comparisons.

1e Most candidates achieved 2 out of 3 marks. Marking points a, b and c were commonly awarded. Some candidates repeated what had been written for 1d without seeking the analysis requested by the question.

2a, b This was a difficult question for many since the image of the extracellular material was unfamiliar. However, the question was not off syllabus. On page 48 of the guide in the Teacher Notes for A.S. 2.3.6, glycoproteins that form the extracellular matrix are mentioned. Although there were many NRs, this question had a good number of candidates who achieved 4 out of 4 marks so the question was discriminating. For component I “channel/transport” protein was not accepted since no channel was evident. Some under-analyzed III by labeling it cytoplasm. Others were confused by III and thought it was one of the structures rather than the whole matrix as suggested by the bracket.

3ai-aiii The vast majority of candidates lost marks because they did not state what effect the environmental change had on the enhanced greenhouse effect or a reason for the effect. Both were needed for each mark. The fact that only one line was given for each answer did not help. Unfortunately, some candidates interpreted reforestation as deforestation. Others suggested that increasing oxygen would reduce the enhanced greenhouse effect.

3bi-biii In bi, autotrophs produce their own food not their own energy! In bii, the best answers focused on ingestion/internal digestion for detritivores and external digestion for saprotrophs. The latter organisms were not well described and usually the reason for a lost mark. In 3biii, many exaggerated heights were given for mosses. The distinction between mosses and ferns was very poorly understood. Positive marking saved many confused answers. There were many more Candidates writing nothing at all for this than the previous two.

3c Energy flow in a food chain was well explained by many candidates. Sometimes short essays were produced that easily earned 3 out of 3 marks.

3d Many candidates understood the precautionary principle but lost a mark because their answer was restricted to the environment. The principle has been applied to medical practices as well. Given examples were often flawed because they were not credible or did not include a consequence. Few papers gained full marks.

4ai Many candidates just wrote “increasing growth” and lost the mark. Acceptable answers were rapid growth/logarithmic/exponential (growth phase).

4aii Usually answered well with acceptable references to more food/nesting sites and less predators/disease. Some candidates just mentioned increasing natality/immigration with no mention of emigration/mortality thereby losing marking point a.

4b Most candidates only gained a mark for the named organism. Candidates often confused the effect/result of the selection pressure as being the selection pressure. For example, increased resistance to antibiotics in bacteria is the effect/result of use of antibiotics. Use of antibiotics is the selection pressure.

Section B

Question 5. (Mitosis, DNA profiling and sickle cell anemia)

(a) The stages of mitosis were generally drawn well for full marks. Errors occurred when meiosis was confused with mitosis. For example, telophase was drawn with chromatids/chromosomes still joined as in telophase I of meiosis.

(b) Generally well understood. Some marks were lost when accounts were too vague or terms were poorly developed as in PCR and electrophoresis.

(c) Many candidates answered this well. Some mistakenly suggested that mutation occurs as transcription takes place or that it occurs during translation. Marking point k was rarely found in an answer.

Question 6. (Saccharides, respiration and blood glucose)

(a) Sometimes answered well but marks were lost when no function was given or when the molecule was not correctly associated with plant/animal. Some of the better scripts inaccurately named fructose as a disaccharide in plants.

(b) Quite well done by many candidates. All marking points were eventually awarded. The essentials of anaerobic and aerobic cell respiration appear well understood.

(c) Blood glucose regulation was another topic familiar to many candidates. Surprisingly marking point a about homeostasis/negative feedback was not see that often. Overall, the question was well answered.

Question 7. (Pathogens, bacterial ultrastructure and HIV/AIDS)

(a) Some candidates just mentioned the role of skin and/or mucus as a defence mechanism against pathogens while others only mentioned leucocyte ingestion/phagocytosis of pathogens and/or lymphocyte production of antibodies. Only the very best gave both mechanisms.

(b) A wide range of quality was seen in the drawings of *E. coli*. However some drawings were too "eukaryotic" in that organelles not found in *E. coli* were shown.

(c) This discussion question on HIV/AIDS prompted many answer styles, very few of which were in the true form of a "discussion". Unfortunately, some candidates responded just with a list or brief outline. Too many included details of the disease itself. However, there were some essays were carefully considered the issues surrounding the transmission and social implications of HIV/AIDS. All marking points were eventually awarded.

Recommendations and guidance for the teaching of future candidates

Teachers need to explicitly teach the command terms. This will enable candidates to competently use the terms knowing that their answers will meet the requirements of the question.

Practice in the interpretation of experimental data should be done on a regular basis. In treating data, it is useful to quote numbers in an answer although the numbers, by themselves, are not enough. Candidates need to elaborate on the significance of the numbers as dictated by the command term. Comparative wording such as "greater/lesser" or a concluding statement as in "This shows…." might be enough. The reader should not have to infer the meaning of any quoted numbers. Data analysis questions from previous IB exams are a good resource for such exercises.

All diagrams that candidates must be able to draw are clearly stated in the syllabus. These can easily be practised long before the November/May IB exam. Drawings should be large and clear with accurate labelling. Any structures should have realistic proportions and proper juxtaposition of parts.

Finally, candidates can show understanding of concepts and principles by providing accurate detailed knowledge of relevant content. To help candidates reach this level of achievement, teachers should employ teaching strategies which actively engage candidate thinking. Such approaches can complement traditional lectures/"chalk talk" where learning is relatively passive. Writing assignments based on questions from former IB exams can help candidates improve their organizational skills so their answers show coherent logical development of thought.

Higher level paper three

Component grade boundaries

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

General comments

Comments were received about the English (78%), German (13%) and Spanish (9%) versions of this paper. The vast majority (88%) of the 32 teachers responding found the difficulty of the paper appropriate, whereas a few (12%) found it too difficult. When comparing the paper to last year's, most teachers thought the standard similar although some found it a little more difficult. Slightly more than half of the teachers felt that the clarity of the wording was very good, the others ranking it either poor (9%), fair or good (31%), or excellent (3%). About the presentation of the paper, the proportions were 6% poor or very poor, 16% fair, 28% good, 34% very good, and 16% excellent. The vast majority of teachers believed that the paper was accessible to all students, including those requiring special support or access.

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

The areas of the programme which appeared most difficult for some candidates were cladistics, application of natural selection principles, finer knowledge of the social organization of honey bees, the concept of maximum sustainable yield, the relation between succession and diversity, and the relation between absorption mechanisms and specific molecules.

Within the examination itself, many candidates had more difficulty with the parts of data based questions requiring a discussion or an evaluation. Some candidates had difficulty in stating relationship between variables or in interpreting the data. In fact, answering objective level 3 questions in general and addressing the requirements of action verbs such as *explain*, *discuss*, *evaluate* and *deduce* appears more difficult for candidates, although apparently somewhat less than in past years. Some candidates also had great difficulty in using the appropriate terminology. Although most candidates could lay out the general design of experiments, there was a certain difficulty with adequately controlling them, leading to the eventual collection of a sufficient amount of relevant data.

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

Most candidates demonstrated a good knowledge of factual information from the programme in areas relating to fossils, cultural evolution, reflex arc, methane production, *ex situ* conservation, alien species and digestive enzymes.

In the examination, many demonstrated well-developed skills in reading the graphs and manipulating data. A good number of candidates showed care in reading the stem of questions by highlighting key terms, a very useful skill. Most candidates answered well to the question requiring an extended answer in each option, except for the cladograms in option D.

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

Option D – Evolution

Question 1

Although most candidates generally stated the relationship correctly, they often had some difficulty with the other parts of the question, mainly because there was considerable confusion in identifying which were the yeast parasites and their relationship with *Daphnia*, phytoplankton, nitrogen content of water and predatory fish.

Question 2

The majority of candidates could state uncertainties with the fossil record and provided an acceptable definition of *half-life*. Most could use the graph correctly, although some misread the value on the *x*-axis; they also deduced a reason why carbon dating could not be used for specimens older than 50 000 years, but were not always able to express it with enough detail. Two distinctions between genetic and cultural evolution could easily be established by most candidates.

Question 3

Only a few candidates could discuss adequately the use of cladograms, a significant number having almost no idea at all other than what was in the stem of the question, and others limiting themselves to generalities on cladogram structure.

Option E - Neurobiology and behaviour

Question 4

Communication of food sources by worker honey bees is part of the expected description of their role in the social organization of honey bees; a limited number of candidates knew about the waggle dance, many incorrectly mentioning pheromones. The vast majority of candidates knew the meaning of a 1.00 ratio and stated that Eaat-2 showed the highest expression, but some did not calculate the probability correctly. A surprising number had difficulty relating natural selection to scouting behaviour.

Question 5

The sequence of components of a reflex arc was listed very well but many candidates had more difficulty accurately labelling the parts of the eye. Very few were able to give details of the action of endorphins in terms of synapses.

Question 6

This was a relatively easy question for most candidates who related the type of investigation that they had carried out during their course, although the details of the experimental work were sometimes incomplete. Some candidates either confused the definitions of kinesis and taxis or designed an experiment that was not measuring the behaviour they had stated. Most were able to name the organism (although some planned using organisms that were not invertebrates), identify the environmental condition and describe an apparatus providing contrasting conditions. However, a discussion of what specific variables needed to be controlled was often omitted as well as the identification of the dependent and independent variables. Similarly, candidates tended to give very vague qualitative means of observing taxis or kinesis rather than a quantitative means of measuring these.

Option F - Microbes and biotechnology

This was probably the least popular option chosen in this examination.

Question 7

Most students did not understand that the data was from abyssal core sampling and related their answers to the sea surface; although they could read the values and compare the trends, this made the task of making suggestions for differences in oxygen consumption more difficult.

Question 8

There were mixed answers for this question.

Question 9

Some answers lacked specific details of methane production from biomass, whereas other students provided good accounts.

Option G - Ecology and conservation

Question 10

Most candidates provided correct answers, although some had more difficulty expressing their suggestion for the difference in feeding. There were some very good, well-expressed deductions about the relationship between temperature and growth rate, but others showed difficulty in interpreting the data.

Question 11

The majority of candidates could list two methods of *ex situ* conservation, but many had poor answers in outlining the concept of maximum sustainable yield. A surprising number had difficulty expressing primary succession in terms of species diversity and listed the stages or provided examples instead.

Question 12

Most candidates scored very well about alien species. Candidates using the same example throughout usually provided more substantial answers than candidates who repeated the same points using multiple examples. There were nevertheless poorer answers showing confusion about the chosen example.

Option H - Further human physiology

Question 13

Many candidates did not have the correct notion of the role of platelets in spite of the information given in the stem. Most listed characteristics correctly although some were too vague. The mean change was calculated correctly although some did not include the negative sign. Comparing the effect of the changes and evaluating the hypothesis were not well answered by many, showing a considerable amount of confusion in the actual interpretation of the data. Many did not relate to the data specifically enough, using all the markers, in their evaluation although they appeared to have the general idea correct.

Question 14

Many confused the two structures on the micrograph, which could be deduced from the wall thickness; some left out “portal” in III and some simply had no idea. Many had no idea of the chloride shift whereas many others limited themselves to the production of bicarbonate ions or stated an incorrect method of exchange. Many candidates did not associate specific food molecules to a mechanism.

Question 15

Many candidates answered this question on pepsin and trypsin very well with a high degree of detail, but some gave only the most basic information, or made errors about the location of the secretion and/or confused the active with the inactive form of the enzyme.

Recommendations and guidance for the teaching of future candidates

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

Teachers should have candidates practise past exams and mark schemes and direct them in ways to fully answer questions. This should be done for each topic throughout the course and not only before the examination session. All kinds of data should also be presented to candidates, either as class discussions or homework. Candidates should practise considering all pieces of data. Memorizing answers from previous papers should be discouraged as new questions are usually worded slightly differently and require answers to be adapted accordingly. Candidates could therefore be given exercises or homework to practise applying their knowledge to new situations.

Candidates should be exposed to the appropriate meaning of command terms throughout their course, especially objective level 3 command terms. Candidates should be aware that describing data and stating values is usually not sufficient for a comparison.

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

Candidates must practise using appropriate terminology throughout their course and make sure their answers are not too superficial for a higher level course. For example, the word “species” does not mean “an organism” or “any taxon” (in biology they have a special meaning), nor is “the body” responsible of some mechanisms when specific cells or structures are involved.

As examination strategies, highlighting key words in stem of data based questions and body of other questions helps draw attention to the focus of questions.

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

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 12	13 - 16	17 - 20	21 - 25	26 - 29	30 - 36

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

The candidates were often let down in their interpretation of the question and knowing what was being asked. Many times they did not provide enough detail in their answers so were not awarded full marks. To give an example, in question 2 (a) where they were asked about the function of the appetite control centre, there were many vague references to hormones but few more specific answers naming the hormones or the glands from where they are secreted.

Overall, interpretation of the data was good when it required taking readings or making observations from tables, charts or graphs. When some application of the data to a new situation was required most weaker candidates found this difficult e.g. in 7(d), 10(e), 13(d) and 19(d).

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

Overall the level of knowledge seemed good with a few areas still giving difficulty as outlined in the section on individual questions below. The paper discriminated well and there was no part of the examination that could not be answered by the stronger candidates.

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

Option A — Human nutrition and health

Question 2

(a) This question required the candidates to describe how the appetite control centre in the brain functions. Most candidates obtained the point for “makes a person feel satiated”.

(c) Candidates had difficulty naming the fatty acid.

Question 3

Most students could successfully state problems caused by long distance food transport. Many failed to notice that both environment and health were required.

Option B — Physiology of exercise

Question 4

The data for this question showed the amount of glycogen in different muscle types in the legs of healthy males. Only the better candidates scored full marks in part (c).

Question 5

(b) The students knew the difference between the movement of the two joints but often had difficulty in expressing their answers correctly.

Question 6

(b) The question was complex requiring the effect of exercise and training on cardiac output and heart rate. Most candidates scored two out of a possible four.

Option C — Cells and energy

Question 7

The table showed how iron deficiency affected the growth of algae. Part (d) evaluating the impact of iron deficiency of *C. reinhardtii* proved difficult.

Question 9

(b) The candidates were asked to explain the control of metabolic pathways by end-product inhibition. This question discriminated well with only a few of the better students obtaining all four marks.

Option D — Evolution

Question 10

The data showed how nitrogen in a lake affected the parasite epidemic in *Daphnia dentifera* and how this in turn was related to the change in resistance to the parasite.

In part (d), many candidates discussed “survival of the fittest” at length without actually answering the question.

Part (e) where the candidates had to predict the effect of fish on resistance to the parasite was badly answered.

Question 11

(b) Most of those failing to score both marks were vague in their understanding of cultural evolution.

(c) The question should have said different “hominid” species that coexisted during hominid evolution but most answers were correct.

Option E — Neurobiology and behaviour

Question 13

The data showed the response of three strains of fruit flies to a pheromone and a chart which shows repolarization of the receptors. Parts (a) and (b) were mostly correct but fewer candidates could suggest the role of carboxylesterase in the behavior of Drosophila or suggest an application of the data in insect pest management.

Question 14

Around half the candidates failed to outline innate behavior in invertebrates.

Question 15

(b) The candidates tended to list causes without any discussion as was required by the question, scoring only two out of four marks.

Option F — Microbes and biotechnology

Question 16

The data for this question compared how sugar beet pulp for fermentation is first broken down to glucose by different methods of treatment. Most scored full marks in part (a) and half marks in (b) and (c) due to incomplete answers.

Question 18

Most students had awareness of the role of reverse transcriptase in part (a) but could not give explanations of the use of reverse transcriptase in part (b). Answers tended to be vague with most candidates scoring only one mark out of four and a few scoring three marks.

Option G — Ecology and conservation

Question 19

(b) The candidates were asked to distinguish between the trends in the nematodes during the study. The word “trends” was not well understood and most referred to individual months. Few actually gave distinctions with contrasting statements preferring to give two unrelated descriptions.

(c) Most did not refer to temperature in their analysis of population changes discussing only changes with month or season.

(d) Few candidates suggested that the nematodes were in competition and many failed to give a reason.

Question 20

(c) Many candidates could describe the niche concept though many weaker answers referred only to “the role of an organism”.

Recommendations and guidance for the teaching of future candidates

Teachers seem to be doing a good job preparing students as the candidate performance this session seems better than usual.

Candidates should be made familiar with the stems of questions so they know what type of answer is required e.g. the difference between outline and explain. In particular, they should know that questions asking them to distinguish or compare require contrasting statements, not two separate descriptions where the examiner has to hunt for the answers to the question.

Candidates should be continually reminded to include units with any calculation questions, to provide relevant detailed information and to think about their response and whether or not, it answers the question providing sufficient information for the available marks.

Practice with previous exams is recommended with an in depth analysis of the mark scheme.