BIOLOGY TZ1

(IB Latin America & IB North America)

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 16	17 - 30	31 - 42	43 - 54	55 - 67	68 - 78	79 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 28	29 - 41	42 - 52	53 - 66	67 - 77	78 - 100

Higher level and standard level internal assessment

Component grade boundaries

Higher level

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

Standard level

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

General

Most schools used appropriate investigations. Two problems persist, however. For some schools the complexity of the investigations is not up to IB standards and other schools are setting investigations for assessment that are too heavily directed.

Structured investigations often originate in collections of laboratory exercises not intended for use in assessment. Careful editing of the instructions is necessary if they are to be used for assessment. Some teachers are using these investigations without providing instruction sheets to the moderators. The moderators are quite familiar with the material that is available and can spot when it has been copied by the candidates.

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

The Group 4 Project can only be used for the assessment of Personal Skills and none of the other criteria. Fortunately very few schools this session seemed to be ignoring this rule.

Ethics

The IB has now published a document, the Animal Experimentation Policy which is available on the OCC. This and the Ethical Practice Poster, also available on the OCC, will be applied to future Internal Assessment moderation. If necessary, teachers need to make adjustments to their Practical Scheme of Work.

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 candidate based on ethical implications and how to refine the experiment to prevent any harm or distress to the animal, to reduce in the numbers of animals involved, or to ultimately replace the use of animals by using cells, plants or computer simulations.

Moderators continued to comment on investigations that were unsafe or unethical. Behavioural experiments or experiments on animal physiology were frequently quoted as examples. Experiments in these areas are still possible as long as they remain within the normal tolerance limits of the animal. Thus, exposing animals to conditions normally experienced in their natural environments is permissible. It is good practice to include a discussion with the candidates 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. Some inappropriate examples quoted by moderators this session include:

- Exposing woodlice to high temperatures (60-80°C) and high concentrations of NaOH.
- Using toothpaste as an example of a texture in judging the behaviour or meal worms.
- Exposing goldfish or *Daphnia* to solutions of nicotine, caffeine or ethanol.

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

Situations that deliberately demand the euthenising of animals are no longer appropriate. Thus, fruit fly genetics must be replaced by, for example, rapid *Brassica* plants, *Sordaria* mould, maize cobs or simulations, such as the virtual fly lab (though this would mean that as a simulation it could not be assessed using the IA criteria).

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

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

The approach to experiments on human physiology should be reconsidered by a lot of teachers. Using fellow candidates for investigations into the effect of exercise on the heart rate can be considered unsafe if the health status of the candidates is not determined first. Some schools are already expecting their candidates to use a proforma for the signed consent of the participants in experiments. This is good practice.

Clerical procedure

Earlier versions of the 4/PSOW form were still being used by some teachers. These do not provide space for the moderator and senior moderator marks. The latest versions (available on the OCC) should be used.

Teachers who included the “complete”, “partial” and “not at all” breakdown of their marks were providing helpful information to the moderators. This combined with comments and feedback to the candidates made it very clear how the teachers were awarding marks. There are a large number of teachers that take a lot of time and trouble to prepare their Internal Assessment sample. This effort is very much appreciated. They should be congratulated for their efforts and their candidates will reap the benefits. It is a lot easier for a moderator to support teacher marks when there are clear notes accompanying the sample.

There is a recurrent problem concerning the information provided by the teacher. This directly affects the progression of the moderation. Teachers MUST enclose all the instruction sheets and/or summaries of oral instructions for the investigations in the moderation sample. Most schools complied with this requirement for the investigations involving DCP assessment. It is also necessary, however, for investigations where Design is being assessed and a significant number of teachers are not doing this. Furthermore, when Data Collection and Processing is being assessed, the method (designed by the candidate or provided by the teacher) is required. When Conclusion and Evaluation is being assessed, all the steps in the scientific process are needed for moderation.

Some teachers are not designing practical programmes with sufficient numbers of hours, others are grossly inflating the time spent on an activity. It should also be noted that the Group 4 Project can only count for 10 hours on the 4PSOW.

Atypical candidates should be replaced in the sample. These would include candidates whose work is incomplete or transfer candidates where a substantial part of their work has been marked by another teacher.

When the only marks appearing on the 4PSOW form are the two marks required for the internal assessment, it causes concern for moderators. There is no indication that the candidates were marked a number of times using the criteria. One wonders how these candidates receive the necessary feedback to improve their performance.

Some moderators commented on transcription errors between the marks indicated on the work and the mark on the 4PSOW form. This should be verified before it is sent.

Some schools are sending photocopies of the candidate’s work. Usually these are of good quality. The problem is that graphs and diagrams using colour can be confusing. The originals must be sent and a photocopy kept back.

Areas of strength

The variety of investigations, the duration and coverage of the practical programme were generally good. The use of ICT in the areas of **1** Datalogging, **2** Graph plotting software and **3** Spreadsheets is good.

Areas of weakness

Although the vast majority of teachers are adapting to the requirements of the new criteria, there are many that are still presenting similar investigations to the previous programme. This was particularly apparent in those used to assess DCP, which has become more demanding.

Trivial, simplistic investigations that do not generate sufficient data to permit adequate assessment of data processing were sometimes used for assessment. If there is one significant area of weakness it is in the processing of data. Candidates are missing quite obvious conventional points (e.g. indicating uncertainties in their data) as well as limiting their processing to the calculation of a mean. Teachers are also missing these points and marking over generously. Sometimes teachers point out the errors to their candidates and still give full marks.

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

Literature sources are not consulted when they could provide valuable background information in determining the initial research question and in the discussion of the results.

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

Rules applied by the moderator

In the event of the teacher providing too much guidance to the candidates or ignoring the criteria the following scale is applied by the moderators:

Criterion	Problem	Teacher awards	Maximum moderator can award
Design	Teacher gives the problem or research question.	c; c; c = 6	p; c; c = 5 Candidates could have identified their own control variables
Design	It is clear that the candidates have been told precisely what apparatus and materials they require and have not modified it.	c; c; c = 6	c; c; n = 4
Data Collection & Processing	The candidates have used a photocopied data table with headings and units.	c; c; c = 6	p; c; c; = 5 Candidates could have added uncertainties or relevant qualitative observations
Data Collection & Processing	The candidates have been told, on the method sheet, to draw a graph from their raw data and which variables to plot or process the data in a particular way.	c; c; c = 6	c; n; c = 4
Conclusion and Evaluation	The candidate has only indicated as a criticism that they ran out of time and their only suggestion as an improvement is that they should repeat the investigation.	c; c; c = 6	c; n; p = 3

Candidate performance against each criterion

Design

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

In some cases, little research is evident or investigations are designed with little or no consideration of biological principles. It may be a small point but it would be useful for the candidate to give the scientific name of the organism being used or the organism that was the source of the material. The trivial name at least must be given.

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 candidates who decide to investigate several independent variables at once, such as the effect of pH, temperature and substrate concentration on the activity of an enzyme.

The three categories of variables must be clearly identified. It is clear that candidates need to be taught what the different variables are and what their relationship is. Moderators have observed that there is sometimes confusion over what is a controlled variable and what is a control experiment.

The investigations assessed must contain quantitative data. Moderators have reported that there are schools still presenting investigations that collect only qualitative data (e.g. microscopic observations of tissues or observations on dissections). They are inappropriate for assessment.

Even if the investigations are quantitative then they are frequently too simplistic. The range of values of the independent variable may be insufficient to establish a trend; the number of repeats may be 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 candidates when they design their investigations. We are not expecting them to re-invent the wheel. HOWEVER these standard protocols must be significantly modified or applied to the candidate's own investigation. For example, if osmosis is being investigated and the candidate uses the method of change in mass of tissue to monitor the effect of solutions of different concentrations on the tissue, this is legitimate. If the investigation is simply to determine the isotonic solution of one tissue then it remains trivial and it repeats many textbook investigations. If the investigation is used to determine the effect of the salinity of irrigation water on different root crops, the investigation becomes more substantial.

In field work, the control of sampling procedures is often almost totally ignored by the candidates. 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 candidates to follow through their own designs. Some schools seem to have their candidates design an investigation that remains theoretical. The result is often an unrealistic investigation. Even when a teacher does decide to follow through a candidate designed investigation, the result may be an unrealistic investigation. For example, measuring the effect of music genre on heart beat rates. This is almost impossible to control and candidates ought to be counselled against it from the outset.

Data Collection and Presentation (DCP)

It may be that class data is required in order for the candidate to gain access to sufficient data for significant data processing and the determination of uncertainties. The moderators understand this; biological systems are often difficult to coax and slow to give data. If class data is to be used and DCP is to be assessed, a number of precautions must be respected. The candidates must present their own data or clearly identify which is their own data in a pooled data table. The candidate must plan and produce their own data table. Copying a table from other candidates will be counted as collusion and the school's IA work will be subject to an enquiry. Teachers who provide the candidates with a pre-formatted data table can expect their candidates to be moderated down.

Despite the clear warnings in the subject guides, teachers are still providing instructions on how to present the data and how to process the data. Their marks will be moderated down.

The classic investigations (e.g. mark and recapture, chromatography of leaf pigments, rates of photosynthesis using sunken leaf disks, rates of reaction of catalase and osmosis) often create problems. Teachers are using standard textbook protocols without modifications. A little imagination and editing could easily solve the problem.

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

- There were no quantitative data collected
- No uncertainties were given in the tables of data collected using measuring instruments.
- There were inconsistent decimal places in tables
- The decimal places did not correspond to the precision of measurements
- There were no associated qualitative observations. E.g. an ecological field investigation is incomplete without some kind of description of the site used
- Raw data were plotted in graphs that do not actually reveal anything (e.g. maxima, minima, optima or intercepts)
- Raw data were plotted when the mean should have been calculated and plotted (often the mean is actually calculated and then ignored by the candidate for graphing)
- There was no statistical treatment of the data when it was possible
- When statistical treatment is applied there is no consideration of its appropriateness
- There was no presentation of uncertainties in graphical data either by using trend lines or error bars
- The error bars, when used, were not explained.

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, especially the assessment of this criterion. It is not possible to provide a biological explanation in these cases.

Overall literature values or the theoretical background were not consulted enough by the candidates. When they were consulted the sources were often not correctly cited. For guidance on the correct way to cite a reference, the guidelines in the Extended Essay are very helpful.

Candidates in some schools show that they have developed a mature sense of criticism of the investigation. Their evaluation of their results is based upon a balanced critical analysis of the data. Candidates who have not developed this skill tend to remain superficial in their evaluation. The weaknesses they identify are hypothetical ("the seeds could have been dead") without evidence to back it up. For weaker candidates the experimental weaknesses are restricted to having a limited amount of time or errors in their own manipulation that once again remain hypothetical ("I could have incorrectly measured the temperature"). Evaluation is a good discriminator of the high achieving candidates and teachers would do well to remember this when they are marking their candidates.

Suggested modifications were sometimes superficial and yet marked over generously.

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

Manipulative skills

There is evidence of the candidates being exposed to a sufficient range of investigations. This ensures that the manipulative skills can be assessed correctly.

ICT coverage

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

Schools seem to have made an effort to equip themselves with the necessary materials to carry out data logging. However, the use of this material in investigations for internal assessment of the criteria was not always appropriate. Teachers and candidates are strongly advised to read the relevant section of the subject guide.

Graph plotting using software was perhaps the easiest and most widespread for schools to apply. However the signs are that the candidates still need to be taught the correct conventions of graphing. There is a tendency to use bar charts for everything amongst the weakest candidates, perhaps because it is the default setting. Legends (keys) are not always necessary and candidates do not seem to know how to de-select them.

When they are needed the candidates often have difficulty labelling them appropriately – candidates often present the different curves as "series 1" and "series 2" When the candidates used scatter plot, a trend line was not always used when it was appropriate. It is a good idea to train the candidates to plot graphs manually before using a graphing program.

The use of spreadsheets for data processing was less apparent in the sampled investigations. When spread sheet tables are inserted into document files the conventions of presenting tabulated data were often ignored or forgotten (e.g. centering numbers, adjusting the number of decimal places, column headings).

Some schools are not fulfilling the requirement for a range of ICT applications to be used in their practical programme. It is the use of databases and computer modelling/simulation that are most often missing.

The Group 4 Project

It needs to be repeated for a few schools, the Group 4 Project can ONLY be used for the assessment of Personal Skills. Indeed it is the only occasion when it is assessed. The Group 4 Project CANNOT be used for the assessment of Design, DCP, CE or Manipulative Skills.

Recommendations for the teaching of future candidates

- Read feedback from the previous session and act upon it.
- Consult the Online Curriculum Centre (OCC) for teacher support material (TSM)
- Apply the internal assessment criteria rigorously.
- Ensure that the open-ended theme that you set has enough scope to provide a variety of research questions.
- Give the candidates experience in identifying independent, dependent and controlled variables.
- Be sure that investigations used for assessment produce quantitative data.
- Encourage the candidates to make additional observations about their experiment.
- Ensure that the investigations have the potential to generate sufficient data for substantial processing.
- Teach the candidates that plotting graphs of raw data is often insufficient.
- Encourage the candidates to carry out research into the background literature both before starting an investigation and once the results are complete.
- Do not use simulations for assessment.
- **Do not** use the Group 4 Project for assessment of D, DCP CE or MS. Only use it for Personal Skills. Inappropriate use will be sanctioned in subsequent sessions.
- Make sure that you are using the most up-to-date version of the 4/PSOW form (available on the OCC).
- Check to be sure that all the parts of the 4PSOW form are completed correctly.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 16	17 - 23	24 - 26	27 - 30	31 - 33	34 - 40

General comments

Of the 32 G2 reports received by the time of grade award, 66% thought that the paper was of a similar standard to that of last year. More than 97% of teachers thought that the level of difficulty was appropriate. Most teachers thought that the syllabus coverage, clarity of wording and presentation were satisfactory to good.

There were many discriminating questions on this paper and a small number of questions that performed less well. It is surprising that many questions were not answered at all by candidates, as no marks are deducted for wrong answers.

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

Some questions performed in a predictable way and no comments need to be made about them. The comments that follow relate to questions where candidate performance was very good or very poor or to questions that aroused comment from teachers on G2 forms.

Question 2

This seemed quite an easy question. Many candidates were confused with the 70S and 80S ribosomes. This statement is clearly addressed in the teacher notes, so candidates should have known the difference.

Question 5

This question discriminated well. Many candidates answered the correct option, but many went for C. This clearly showed they did not know the difference between mitosis and meiosis. The question may have been badly worded, as candidates might have been looking for a process that occurred in both the stages rather than either of them. In this case there would have been no correct answer.

Question 6

Although very few candidates went for option D, some teachers commented on the G2s that some antibiotics contain sulfur. This is true, but generally antibiotics are not found in prokaryotes. The most correct answer was then proteins. Surprisingly many candidates were answering phospholipids, showing that they did not know the structure of these chemicals.

Question 8

Some teachers have argued that C could be a correct answer to this question. This is not true, as the transfer RNA joins with the amino acid and then it joins to the codon. The drawing was a little bit unclear as it did not show the amino acid joined to the tRNA.

Question 9

There were some comments on this question. The diagram is quite clear, but the fact that this is occurring in humans can be easily missed. The idea is not to trick the candidates so we shall try to avoid this in the future. This question was however, a very good discriminator.

Question 14

Although one teacher complained about the use of a non-standard carrier notation, this question was in general well answered by the most capable candidates.

Question 16

There are some complaints in the G2s about asking questions where candidates need to memorize data. I do not believe this is the case, as if a candidate understands that a pyramid of energy is showing energy per unit of surface in a period of time, the only possible answers are A and D. A candidate ought to know that the unit of time cannot be a second, so the only possible answer is A. Most candidates did have this answer right, but many were going for B.

Question 19

This question proved to be very difficult for all candidates and was not a good discriminator. Many candidates included overproduction of offspring as an answer and did not include selective breeding of domesticated animals. It is clear for a teacher in the G2s that as overproduction of offspring is a component of natural selection; this distracter might have confused them.

Question 20

In most sources, the optimum pH for lipase is shown as weakly alkaline, not neutral. This question could be answered without the pH column, so it did not affect the answer.

Question 21

This question turned out to be a very good discriminator. Many candidates believed that due to the high rate of mutation of the virus, the antibiotics are ineffective against them.

Question 23

The guide clearly states that intercostal muscle function in breathing has to be known.

Question 25

The roles of testosterone are clearly stated in the teacher notes in the guide.

Question 27

There have been complaints about the fact that some candidates found it hard to understand that a plus meant present and a minus meant absent. Having said this, this was the most discriminating question of the paper, showing most good candidates did understand it.

Question 29

Some teachers complained that the sequence of glycolysis is not needed, only the processes. It is hard to imagine how one can teach the process without doing so in a sequence.

Question 32

The options could have been worded more clearly eg. *Active translocation of sucrose in the phloem from the source to the sink*. Nevertheless, this question turned out to be a very good discriminator.

Question 33

There are some complaints about the level of detail of this question, but the topic is in the guide exactly as stated in the question. Several candidates did not answer this question at all.

Question 34

Candidates are still finding it hard to identify recombinants.

Question 35

This question would have read more clearly if instead of ‘activates’ ‘acts on’ had been used. This question did turn out to be a very good discriminator.

Question 37

The word hybridoma does not appear in the guide. This did not affect the candidates' performance, as it had a good discrimination index.

Question 38

There were some complaints about the level of depth that the candidates must know. This question was a very good discriminator and the question did not seem too hard for most candidates.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 18	19 - 26	27 - 36	37 - 47	48 - 57	58 - 72

General comments

Of the 39 teachers who commented on G2 forms, half believed that this paper had been of a similar standard to last year's exam and thirteen percent believed it was a little more difficult. Seventy six percent of teachers thought that the paper was appropriate in difficulty.

Most teachers felt that the clarity of wording and the presentation of the paper were satisfactory or good and there were few criticisms of specific questions, though four teachers thought the syllabus coverage was poor.

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

- Distinguishing between concentration and diffusion in question (d) (i)
- Interpreting instructions in question 1 (d) (i) and 1 (g)
- Providing both reasons and mechanisms regarding the use of lactase to create glucose and galactose from lactose.
- Taking sufficient care in the construction of DNA diagrams including the correct details
- Recounting accurate details of kidney function.
- Interpreting the meaning of extracellular components.
- Distinguishing between unique and highly repetitive sequences
- Distinguishing between karyotyping and DNA profiling
- Distinguishing exocytosis from intracellular vesicle traffic

The levels of knowledge, understanding and skill demonstrated

Within section B, all questions were equally chosen, indicating a broader understanding of the curriculum.

While variation existed between the performances of candidates, some generalizations are possible. Reasonable knowledge of factual information in the syllabus was common among candidates. Candidates were most often able to show adequate comprehension of most basic concepts and principles but many demonstrated a limited ability to apply these concepts to questions they had not seen before. This was in evidence when candidates gave answers that showed detailed knowledge that was irrelevant to the question. Candidates were able to demonstrate some analysis or evaluation of quantitative or qualitative data, though this depended on the question type. Candidates were able to communicate adequately with clearly written and well structured answers, especially in part B answers.

The misinterpretation of questions, especially in part B is an area that was problematic. The inclusion of irrelevant material was common in part B questions. A common scenario was candidates writing down answers memorized from mark schemes from previous exams without being sufficiently discriminating about what the question was asking for. Inaccurate or incomplete use and interpretation of terminology was also a general weakness. Diagrams were of an acceptable standard though stem diagrams were in general better done than the DNA diagrams. Some excellent standard root and leaf diagrams were included when a stem diagram was called for.

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

Section A

The data analysis was, in general, well done.

Question 1

a) (i) Many candidates stopped at outlining one aspect of the data.

(ii) Candidate's gave one factual statement rather than the required two.

b) Many were able to successfully link the concept of aerobic respiration to the question.

c) There was poor understanding of the second graph. Even those who spotted the regular oscillation usually linked this to a 2 year interval rather than an annual cycle. Some answers to (c) ii) were vague making reference to 'pollution' as the cause. Some showed confusion by arguing that the general rise in CO_2 was caused by the greenhouse effect rather than being the cause of the greenhouse effect. Candidates should be familiar with the atmosphere data as this is required in the syllabus.

d) (i) For the greatest number of candidates, the pattern discussed in (d) i) was that of concentration rather than the pattern of diffusion. There was very little reference to time data.

(ii) Many were able to discern that the lines would intersect, so that there would be no net diffusion.

e) (i) and (ii) Surprisingly some candidates managed to get the highest temperature wrong. Very few failed to put in the correct units though many included the solidus in the units; i.e., the units were CO_2 / ppm rather than just ppm.

f) The greatest number of candidates earned this mark. The graph suggests that CO_2 levels were the cause of the temperature. The markscheme did not penalize candidates for this, but candidates did confuse the dependent and independent relationship.

g) There were two aspects of the prompt that were commonly left unaddressed by candidates. "Using the data in this question...." invited the candidates to consider all of the data but many referenced just the first graph on page 2 of the booklet. "...Antarctic species, such as ..." was meant for candidates to discuss organisms more broadly than the particular species in the question. Some talked about habitats other than the Antarctic ocean.

Question 2

a) And b) This was a question which illustrated clearly the difference between different centres. Most had obviously been well prepared and found the factual elements simple.

c) Many were able to supply accurate reasons for the use of lactase but wrote incomplete answers that were not full responses to the 'explain' command term. Some of the G2 forms from teachers argued that the question was not justified by the syllabus and the teacher's notes.

The three most economically important reasons for the creation of lactose free milk are for the production of ice cream, for the production of flavoured yoghurt and for the production of milk that can be consumed by people who are lactose intolerant.

Candidate knowledge was not the main problem with performance. The syllabus requires candidates to be able to "Explain the use of lactase in the production of lactose-free milk." An 'explain' requires both reasons and mechanisms. A common statement would be 'some people are lactose intolerant' as one of their answers without unpacking the statement.

Here they have left unstated that using lactase would allow the creation of milk products that people with lactose intolerance could consume. Another common answer was 'glucose and galactose taste sweeter'. Here they have left unstated that this would lead to a decreased need for sweeteners in the production of flavoured milk drinks or fruit yoghurt.

The next most common reasons given were 'for making ice cream that did not have crystals in it' without stating that lactose was less soluble than glucose or galactose and would lead to sugar crystals forming.

d) This was better answered than part (c) with the use of the lower temperature often being understood to relate to less denaturation of enzymes or longer lasting enzymes or less spoilage, but some considered that it changed the amount of the monosaccharides produced rather than the rate of production.

Question 3

a) For question 3 a (i) and (ii) Too many were just guessing and, even if correct, did not give a reason. Many argued that crossing over does not occur in sex chromosomes. A failure to use the introductory information "in the human testis" caused a problem for many.

b) Although this was most commonly answered correctly, there were a surprising number that did not know what should have been a very straightforward bit of factual knowledge.

c) This was quite commonly answered correctly though many candidates should be advised to take greater care in the construction of lower case and upper case letters in genetics problems.

d) A surprising number indicated polygenic inheritance showing conceptual misunderstanding.

Section B

The distribution of choices was more even than in previous years.

Question 4

a) The command word **list** was understood by most candidates but many wrote long descriptions of the components and their action. This would have been more appropriate if the command term had been 'outline'. Also "**other**" was sometimes ignored and those elements in the stem were used in their answers.

b) Although there were many excellent accounts which easily scored maximum marks, there were a large number where the hypothalamus or liver were considered to be responsible for the regulation of blood sugar.

The answers here indicated an unfortunate tendency to write down answers based on memorized mark schemes from past exams, without addressing what was being asked for. For example, answers including the actions of glucagon or alpha cells are irrelevant to rising glucose concentrations. This would affect quality of construction marks due to the inclusion of irrelevant material.

c) Again there were many excellent answers which scored maximum marks well before reaching the end, but there were also a large number, where their knowledge was so fragmentary and scanty that very little was credit worthy. Common misconceptions included the fate of proteins and blood cells. This was another sub-question where many candidates wrote down answers based on memorized mark schemes from past exams without addressing what was being asked for. The list of elements in 4 (a) were meant to be used to guide the construction of the answer to 4 (c). However, many candidates simply summarized the processes that occurred in the nephron without referencing these elements.

Question 5

a) There were some clear and well drawn diagrams showing a marked improvement over previous years. A minority were unclear as to what was required and so drew a picture of a leaf cross section or in some cases a root section or a monocotyledon stem cross-section. A positive note was that these irrelevant diagrams were well drawn. In stem diagrams, a common error was inverting the location of phloem and xylem in the vascular bundle.

b) Not very well answered on the whole. Most were aware of the branching of roots and root hairs and their role in increasing surface area, but many considered that mineral salts were moved into roots only by diffusion.

c) Here candidates were able to outline the effects of temperature on photosynthesis and transpiration, but explanations failed to adequately address mechanisms such as the role of enzymes in photosynthesis and the role of evaporation in transpiration.

A very high number of candidates stated that higher temperatures meant more light and it was this that increased the rate of photosynthesis. Others went off into the idea that transpiration was a type of sweating and was used **normally** by plants to keep them cool. Few linked increased rate to enzyme activity and a further increase beyond optimum to a decrease in rate because of denaturation.

Question 6

a) Very poorly answered, as many failed to understand what was meant by extracellular and so were unable to provide an example or give functions. A very high number referred to the plasma membrane or flagella and cilia as extracellular.

b) There were some very good answers to this section which included all possible marking points, but far too many only knew one fact, that it expelled material form a cell. A large number of candidates summarized intracellular vesicle traffic which again suggests that candidates have memorized mark schemes rather than applying what they know to novel questions. In this question, the details of a specific example were rarely included.

c) It was surprising that so many managed to omit the basic facts on codon/anticodon binding by complementary base pairing. Some explained DNA replication and transcription instead. Answers were in general, poorer on this topic than they have been in the past which suggests that teachers are not spending adequate time on this topic.

Question 7

a) Knowledge of the nature of unique and repetitive sequences of DNA was very poor. Very few scored anywhere near full marks. Often odd marks could be picked up by linking widely separated comments, as descriptions of the two types were attempted. Where candidates possessed knowledge, some did not follow the command to distinguish the two types of sequences.

b) This was a difficult diagram to draw unless it had been well learnt and many showed that this had not been achieved. A few were good enough to get every possible mark and exceed the maximum. The antiparallel nature of the two strands, arrangement of base, phosphate and deoxyribose and the base pairing relationship were widely known. Individual nucleotides were almost never identified. Hydrogen bonds were indicated with a solid line suggesting that they were equivalent to covalent bonds. Sometimes the bases were only given as letters. Commonly, more than four nucleotides were shown.

c) It was clear that this was a popular section but accounts were still rather vague and unscientific. “Suspects can be identified” and “paternity can be decided” but without any indication of having a DNA sample first and then another with which to compare.

Very few mentioned using satellite /repetitive sequences in creating a DNA profile. Gel electrophoresis was often outlined but specifics were missing such as the use of restriction enzymes and the creation of a pattern of DNA fragments. Some accounts confused karyotyping and amniocentesis with DNA profiling.

Recommendations and guidance for the teaching of future candidates

Candidates should be encouraged to:

- Understand what is required of command terms; e.g., provide both reasons and mechanisms in response to the 'explain' prompt.
- Use organizing diagrams for their answer such as t-charts for distinguish questions; sketches of processes such as translation diagrams or the effect of high temperatures on stomata and inclusion of explanatory graphs such as the effect of temperature on photosynthesis
- Make precise measurements from diagrams in questions as in 1 (e) (i) and (ii)
- Take greater care when writing down answers based on memorized mark schemes from past exams. Teachers could provide candidates with several versions of similar questions and have candidates suggest how the mark schemes should differ between the questions.
- Read questions carefully, perhaps using a highlighting pen. Questions 1(d) (i), 1 (g), 2(c) and 4 (c) could be used as teaching tools by teachers. In this exam, these were the questions where candidates most commonly did not respond to the directions of the question.
- Use the number of marks allocated as a guide to the required number of unique ideas required.
- Review the meaning of the solidus in graphical presentation; e.g., the units from the graph in question 1 should be ppm rather than CO_2 / ppm
- Review what is required to earn quality of construction marks. A significant problem was the inclusion of irrelevant material that would have an impact on the award of quality of construction marks.

Teachers are encouraged to:

- Address apparent gaps in syllabus coverage including the use of lactase in the production of lactose free milk; unique and highly repetitive DNA; extracellular components; linkage; polygenic inheritance; and dicotyledon stem cross-section.
- Cover all the curriculum rather than presuming material has been covered in earlier courses. Diagram of DNA and translation answers were poorer than previous years suggesting that perhaps teachers are not giving these topics adequate time in class.
- Obtain a library of past papers or use the CD Question Bank so that old exams and mark schemes can be used in teaching as classroom based reinforcement exercises, homework assignments and revision exercises. These resources are also essential so that candidates can be given practice in analyzing data presented in different formats.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 14	15 - 19	20 - 24	25 - 29	30 - 40

General comments

The comments on the G2 forms indicate that all respondents felt the paper was similar to or easier than last year's paper. As for the paper's level of suitability, 92% felt it was at the appropriate level of difficulty with the remaining 8% evenly split between thinking it was too easy or too difficult. The majority, 88%, felt the syllabus coverage was satisfactory or good. The clarity of the wording was found to be suitable or good by 96% of the respondents as was the presentation of the paper. Teachers' comments are all considered at the Grade Award Meeting and all teachers are encouraged to fill out the G2 Form at the end of each examination session. The actual percentage of teachers who do this is very small.

Options and D and G were the most commonly chosen options. Option E was frequently chosen as was Option H. Very few chose Option F.

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

Many found the longer response questions difficult and did not have sufficient depth of knowledge to answer these. Instead, candidates wrote vague generalities that did not get awarded marks.

Definitions were often poorly stated, even when they are clearly given in the syllabus.

Topics which proved difficult were:

- Cultural and genetic evolution
- Contralateral processing of visual stimuli
- Brain death
- endotoxins and exotoxins
- Gene therapy
- Simpson diversity index
- Use of indicator species

Levels of knowledge, understanding and skill demonstrated

Some candidates produced very 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. However, many scripts indicated only a superficial knowledge of the options or less.

Many candidates were better at the data analysis questions as Question 1 for each option did not require recall of facts. In some cases, entire cohorts of candidates from some schools left all the sections of Questions 2 and 3 blank. Those that did attempt these questions often did not indicate any detail and depth of knowledge.

One area of difficulty was interpreting the command verbs and thus knowing what precisely was required to answer accurately. 'Evaluate' and 'compare' were often problematic.

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

Option D: Evolution

This was the most popular option on this paper although it was not the one that had the highest mean score.

Question D1

a) Almost every candidate was able to identify the relationship shown in the graph. Candidates sometimes confused latitude with altitude which caused problems when answering the other sections of D1.

b) Many obtained one mark for correctly indicating that the European flies showed more variation than the American flies but few were able to get a second point in (i) or to suggest an acceptable reason for this in (ii). Those that did answer (ii) got a mark for understanding the role of selection pressures. Candidates need to be sure to make comparisons when asked rather than write descriptions.

c) Many were able to get one mark for indicating that a new species may form and some indicated this was a result of separation of gene pools due to geographic isolation.

Question D2

a) Some were correctly able to get one mark for indicating that RNA is self-replicating and catalytic but as this was an 'outline' question they needed to be able to give more for a second mark.

b) This was poorly done. Some correctly indicated that DNA was the genetic or hereditary material for all living organisms and that the genetic code is universal. Many wrote about pentadactyl limbs, DNA being made of 20 amino acids or about chimps and humans which did not get marks.

c) Many candidates correctly interpreted the cladogram, deducing that A and B were most similar. Some were able to get a second point.

d) Many were able to get one mark for indicating that cladograms showed ancestral/evolutionary relationships but only a few got the second mark for another reason for using cladograms.

Question D3

The question on the importance of cultural and genetic factors in human evolution was very poorly answered. Candidates did not clearly indicate what such factors were and many vaguely wrote about differences they were familiar with in our present multicultural society. It was disappointing to see some answers which seemed culturally insensitive in their tone.

Option E: Neurobiology and behaviour

This was a fairly popular option.

Question E1

a) Almost all candidates were correctly able to identify the relationship between the downwind approach distance and the nest-feeder distance.

b) Many were also able to get 2 or 3 marks for this section.

c) The most common suggestion given was variation in the wind.

d) Many found this section on the type of behaviour more difficult but both innate and learned were accepted if the candidate was able to support their choice with a good reason.

Question E2

a) Candidates did surprisingly poorly on this simple task of naming the structures of the eye. The label line for IV was on the border of the choroids and the sclera, and thus either one was accepted as correct.

b) This question on contralateral processing was very poorly done. The only point that tended to be awarded was for the right and left optic nerves crossing in the optic chiasma.

Candidates confused images from the left field of view, which occurs in both eyes, with the left eye itself. Others described the basic function of the rods and cones.

c) Many were able to get both marks for this as examples of these types of drugs are clearly stated in the syllabus. However, others used brand names or street names which did not earn any credit.

Question E3

Many candidates were able to get two marks for correctly describing the pupil reflex and its role in determining brain death. However, they were seldom able to obtain more than that as detail was lacking.

Option F: Microbes and biotechnology

This was the least popular of the HL options but it was encouraging to see a few more schools studying this option. Too often however, it was answered by candidates with little knowledge who attempted all options.

Question F1

a) Most were able to correctly read the graph to identify the time as 28 hours after sewage was added.

b) Many were able to correctly deduce the effect of sunshine on (i) coliform bacteria and (ii) coliphage viruses.

c) Only some were then able to correctly suggest that coliphage viruses were the most useful fecal indicator as they were less affected by the sun.

d) Many were not able to suggest another possible consequence of the release of raw sewage although brighter ones did mention deoxygenating and eutrophication.

Question F2

a) (i) The definition of chemoheterotroph was poorly done, as was true of most definitions.

(ii) Although many candidates were able to state a bacterial chemoheterotroph, some listed a eukaryote instead.

b) Very few candidates were able to distinguish between endotoxins and exotoxins. This did not seem to be something that candidates were familiar with at all.

c) There were some good answers to this section although several candidates confused antibiotics with antibodies. Those that did mention a correct antibiotic often did not link it to a correct mechanism for action against bacteria.

Question F3

Points were awarded for use of viruses as vectors and for a possible risk of gene therapy. Some better candidates were able to give one verified example such as SCID. Very few were able to discuss somatic cell therapy and germ-line therapy. Candidates tended to confuse gene therapy with other genetic topics.

Option G: Ecology and conservation

This was a very popular option.

Question G1

a) Almost all candidates correctly indicated that arsenic accumulates in the leaves and better candidates were able to expand on this and get two or three marks.

b) (i) While the mean rate of arsenic accumulation was thought to be a difficult concept by respondents on G2 forms, many candidates were able to get this correct.

In (ii) most candidates indicated that the Chinese brake fern could be used to remove arsenic from contaminated soil but only a few received a second marking point.

c) The majority of candidates were able to get the mark here by either indicating that the plants would become toxic to consumers or that biomagnification may occur.

Question G2

a) Many were able to correctly identify the trophic level as tertiary consumer. Candidates should not use unexplained symbols when answering questions.

b) Very few descriptions of the capture-mark-release-recapture technique were given. Several candidates mentioned the use of 1 m^2 quadrats. While they do give a marked unit area, they are not suitable for mobile species such as rabbits.

c) Most candidates did not know what the N and n stood for in the formula for the Simpson diversity index.

Question G3

This question was very poorly answered by the majority of candidates with many not actually knowing what an indicator species was. The answers were very general, lacking in any detail. Some wrote about migration and changes in weather. Those that knew an indicator species did not link it with a specific environmental factor.

Option H: Further human physiology

This was a fairly popular option.

Question H1

a) Many were able to see that both P_{O2} and P_{CO2} fell with increasing altitude but only the best candidates could correctly identify another change.

b) This was a very difficult section and many did not refer to the table provided when answering this question. Most of the candidates tended to refer to oxygen rather than carbon dioxide.

c) Many were able to calculate the percentage change correctly in (i). Those that didn't usually had 18.7% rather than 81.3%. In (ii) many were able to get a mark for answering that the reason was due to the low partial pressure of carbon dioxide in the air

d) The most common correct adaptation given was that those who live permanently at higher altitude had a larger lung capacity.

Question H2

a) Most gave an incomplete definition of a hormone in (i) and therefore did not get the mark. Part (ii) was often well-answered although some indicated the type of hormone as a sex hormone rather than stating it was a steroid hormone.

b) This was very poorly done by the majority of candidates. Those candidates that did know some facts about the two digestive juices did not make point by point comparisons despite the table provided. The table did seem to discourage better candidates from giving a similarity which would be expected for a comparison of two things. This was not penalized.

c) Many were able to get the 2 marks here for cellulose and lack of cellulose.

Question H3

There were variable responses from very poor to very good. Many confused the role of the SA node as the pacemaker with the actual opening and closing of the valves in the heart. Candidates did seem to do marginally better on this question 3 than in the other options.

Recommendations and guidance for the teaching of future candidates

- Sufficient time should be allotted for the teaching of the options. Teachers should choose the options according to their own strengths so that the candidates benefit by the knowledge and enthusiasm of the teacher.
- The options should not be left for self-study. It needs to be ensured that candidates acquire the depth of knowledge required to be successful on this paper. Discussing topics in general does not help.
- Teachers should teach only two options to their candidates. Those candidates selecting from the entire range of options do poorly. Schools that prepared their candidates for only two options did much better on average.

- 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'
- Practice interpreting data in different formats. Use past papers throughout the 2-year programme to develop this skill.
- Use past examination papers and mark schemes as well as the CD Question Bank to provide suitable questions so that candidates are familiar with the examination format.
- Where the syllabus asks for an unspecified example, teachers need to ensure that this is covered.
- Give guidance on the appropriate length of answers as candidates should not write as much for a one mark answer as they do for one worth 6 marks.
- Candidates should know that they answer in the spaces provided and that the number of lines is a guide to the length of answer expected. They can continue to write a few sentences below the lines rather than use so many continuation sheets.
- All teachers need to attend workshops periodically.

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

General comments

Of the 14 G2 reports received by the time of grade award, 75% thought that the paper was of a similar standard to that of last year. More than 92% of teachers thought that the level of difficulty was appropriate. Most teachers thought that the syllabus coverage, clarity of wording and presentation were satisfactory to good. There were many discriminating questions on this paper. Questions 13, 19, 24 and 30 had many candidates leaving them blank.

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

Some questions performed in a predictable way and no comments need to be made about them. The comments that follow relate to questions where candidate performance was very good or very poor or questions that aroused comment from teachers on G2 forms.

Question 2

In the G2 forms, some teachers comment that answer C is also correct, as there are some unicellular organisms that perform meiosis before cell division. This may be true; nevertheless answer A is more correct as it applies to all unicellular organisms. Most good candidates had this answer correct, this question turning out to be a good discriminator.

Question 4

This seemed quite an easy question. Many candidates were confused with the 70S and 80S ribosomes. This statement is clearly addressed in the teacher notes.

Question 7

Although very few candidates did go for option D, some teachers commented on G2s that some antibiotics contain sulfur. This is true, but generally antibiotics are not found in prokaryotes. The most correct answer was then proteins. Surprisingly many candidates answered phospholipids, showing that they did not know the structure of these chemicals.

Question 9

Some teachers argued that C could be a correct answer to this question. This is not true, as the transfer RNA joins the amino acid and then it joins to the codon. The drawing is a little unclear as it does not show the amino acid joined to the tRNA.

Question 10

There were some comments on this question. The diagram is quite clear, but the fact that this is occurring in humans can be easily missed. This question was however, a very good discriminator.

Question 11

There was a mistake in the diagram, as adenine is shown joined by three hydrogen bonds to thymine and cytosine by two hydrogen bonds to guanine when it should have been the other way round. Nevertheless, the usefulness of the question was not affected, as most candidates answered this question correctly.

Question 15

There was a complaint in the G2 that this question was tricky and confusing. This is not the intention. As a matter of fact, this question turned out to be a very good discriminator and most good candidates chose the correct answer C. Many other candidates went for answer A, showing they did not quite understand the concept of homologous chromosomes.

Question 17

Although one teacher complained about the use of a non-standard carrier notation, this question was in general well answered by the most capable candidates.

Question 22

There were some complaints in the G2s about asking questions where candidates need to memorize data. This is not the case, as if a candidate understands that a pyramid of energy is showing energy per unit of surface in a period of time, the only possible answers are A and D. A candidate ought to know that the unit of time cannot be a second, so the only possible answer is A. Most candidates did answer correctly but many went for B.

Question 24

In most sources, the optimum pH for lipase is shown as weakly alkaline, not neutral. Nevertheless, this question could be answered without the pH column. Many candidates went for option B; showing candidates did not know the function of lipase.

Question 25

Some teachers complained that this question was very difficult. Although quite difficult, this question turned out to be a very good discriminator.

Question 27

This turned out to be a quite easy question, the third easiest question of this paper. Most candidates had this question right.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 16	17 - 22	23 - 29	30 - 35	36 - 50

General comments

The data analysis section in Part A seemed to elicit good efforts and reasonably good answers from many of the candidates. However, the various portions of the core tested through the short answer questions revealed many gaps of knowledge. In Section B, the number of candidates who chose to answer Question 5 (DNA replication and mitosis) was overwhelming whereas Question 7 (plant diversity, starch and cell comparisons) attracted little interest. Levels of competence in Section B on any of the questions varied from excellent to extremely poor.

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

Section A

Discussing the causes of correlation between the density of grey partridges and the density of birds of prey using the given data appeared difficult for many candidates. They did not use all the data provided.

Basic recall of knowledge about carbohydrate biochemistry was mediocre and few candidates could explain reasons for converting lactose to glucose and galactose during food processing. For many, knowledge of the hormones involved in the menstrual cycle was poor. Frequently, there was no response to different parts of question 3 (menstrual cycle). The final step in the process of inserting a gene into a DNA circle was not understood. Few mentioned DNA ligase. There was poor understanding of gene transfer. Most candidates could not provide a named example of gene transfer between species and then discuss a potential benefit and possible harm. Often there was no response.

Section B

Clear explanations as to why DNA must be replicated before mitosis were only seen occasionally. Many explanations of how the base sequence of DNA is conserved during replication were incomplete. Understanding of the roles of atria and ventricles during the pumping of blood by the heart was mixed-sometimes strange, other times good.

Rather than discussing the inheritance of ABO blood groups, many candidates just described ABO blood groups. The unpopularity of Question 7 which asked for characteristics of different eukaryotic plant groups, reasons for the digestion of starch, and a structural comparison of prokaryotic and eukaryotic cells probably indicated a lack of knowledge of these topics.

Overall, in Section A, there were many gaps of knowledge and levels of understanding were disappointing. Candidates who did reasonably well on data analysis, often collapsed on question 2 and beyond.

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

Section A

Many candidates recognized population trends of different birds in the initial graph that showed mixed data. Also, many candidates recognized the inverse correlation shown in the linear bird density graph. Most candidates were able to calculate a correct percentage using data from the pie chart. Candidates showed diverse thinking in their suggestions for preventing extinction of the grey partridge. Candidates often suggested valid reasons for using lactase at 5°C during food production rather than at a much higher temperature where the reaction rate is faster.

Section B

In Question 5, many descriptions of the events occurring during mitosis were quite complete with correct chronology. In Question 6, many candidates gained at least a few marks describing how the structure of an artery aided its functioning. In Question 7, the few courageous candidates who chose to describe different characteristics of eukaryotic plant groups (and the other parts of question 7) were somewhat successful

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

Question 1

a) The answers here were usually fine, but sometimes candidates faltered because they never summarized an overall trend or reached any conclusion about a trend. Just noting yearly population fluctuations for individual bird species was not enough to gain marks.

b) (i) Answers were divided between giving the term negative correlation or inverse proportion or using a sentence such as “birds of prey density goes down as grey partridge density rises. “ Either style was acceptable.

(ii) Those answers that gained the maximum of two marks provided a prediction/observation supported by some reasoning. For example, “fewer partridges are present when more birds of prey are seen because partridges are eaten by birds of prey.” Another acceptable reason was that the partridges moved to areas with fewer birds of prey. Converse accounts also gained credit such as “more grey partridges can exist (through reproduction) when fewer birds of prey are around.” Some candidates just repeated their response from 1(b) (i) and gained no credit.

c) (i) A correct percentage was usually calculated. Although it was not required, many candidates applied significant figures rules in determining their answer.

(ii) Answers were quite varied. Many candidates had difficulty using the data provided. The discussions of some candidates covered more than the maximum number of marks while others wrote vague and ambiguous explanations for no credit. Many candidates showed some sort of reasoning. All the marking points eventually appeared over the range of scripts. Often, candidates mentioned that birds of prey were attracted from outside to the shooting area because of the abundant food i.e. the released partridges and grey partridges.

d) Many thoughtful realistic answers were given for preventing the extinction of grey partridges. They matched up well with the mark scheme. However, the banning of all sport shooting was not one of them.

Question 2

a) Candidates were often correct, but some stated a disaccharide instead of a monosaccharide. Common errors were sucrose or maltose.

b) (i) Most candidates correctly identified lactose as a disaccharide.

(ii) Hydrolysis was often given, yet some erred by stating decomposition.

c) The answers for this question were especially poor. Lactose intolerance was often mentioned but without further explanation. Increasing sweetness was also mentioned but without further elaboration. Such responses were incomplete and fell short of being explanations. The few candidates who were well informed on reasons for converting lactose to glucose and galactose during food processing wrote beautiful answers that easily gained full marks. In contrast, there were many candidates who left the answer space blank. As for HLP2, ome of the G2 forms from teachers argued that the question was not justified by the syllabus and the teacher's notes. The three most economically important reasons for the creation of lactose free milk are for the production of ice cream, for the production of flavoured yoghurt and for the production of milk that can be consumed by people who are lactose intolerant.

d) Generally answered well with most candidates referring to denaturation and/or controlling the rate of reaction.

Question 3

a) Progesterone and estrogen were often interchanged. In an apparent effort to salvage one mark, some candidates named the same hormone for answers I and II. This attempt failed because of the contradiction. Some candidates used FSH or LH as labels.

b) Few candidates understood the role of FSH in the menstrual cycle. Often, it was described as stimulating the production of eggs or triggering ovulation.

c) Only a select few knew that FSH is inhibited by progesterone or estrogen during pregnancy. Some wrote that the embryo causes inhibition.

Question 4

a) Many candidates identified DNA circle as a plasmid, although some called it mRNA or used names of enzymes.

b) Ligase was frequently given but very few used the term DNA ligase, as seen in Assessment Statement 4.4.8 of the IB biology guide. Very few spoke of sealing nicks or gaps, or mentioned joining sugar phosphate bonds. It was not realized that the sticky ends were already joined i.e. complementary base pairing had already occurred.

c) This question was answered poorly. Actual examples (not hypothetical or unsuccessful) of gene transfer were required. Transfer details such as source of gene and transgenic species were rarely mentioned. Sometimes, the cited potential benefit and possible harm of the gene transfer did not relate to the example provided.

Gene transfer was also confused with cloning, cross-breeding, IVF, gene mutation or even bone marrow transplant. Some candidates gave only very general answers that gained no marks. Others left the answer space entirely blank.

Question 5

(Question 5 was the most frequently answered question in Section B.)

a) Practically everybody knew the role of helicase in DNA replication. Extremely few could clearly explain the need for mitosis.

b) The question was often confused with other details of DNA replication, transcription and even translation. Though DNA replication was correctly described as semi-conservative, further expansion of that term became muddled. Most knew A-T and G-C base pairing but the idea of complementarity was not always included. Diagrams were drawn but lacked labels and annotations most of the time. Occasionally, candidates mentioned that DNA polymerase was used.

c) Of all the parts in Section B, this one (describe the events of mitosis) was answered best. Many candidates earned close to the maximum number of marks. A few candidates thought that interphase is a part of mitosis.

Question 6

a) Most candidates answered the question by trying to trace the blood flow through the heart rather than collectively explaining the roles of atria and ventricles. It was generally known that the right atrium collects blood from the body and pumps it into the right ventricle but the timing was misunderstood. Blood flow to and from the lungs was usually mentioned, including the pulmonary artery and pulmonary vein.

b) Valves were mentioned but not their prevention of backflow. The idea of ventricles generating high pressure due to thick walls was mostly lacking.

c) The only structural feature of an artery consistently mentioned in relation to its function was that the thick wall of an artery enables it to withstand high blood pressure. Many other important features such as muscle fibres to help blood movement or elastic fibres to allow an artery to stretch were ignored. Statements such as “arteries are the biggest blood vessels in the body” or “are bigger than other blood pathways” suggest that candidates lack an understanding that the relative sizes of blood vessels can vary. Very few candidates included mention of the role of a narrow lumen or smooth inner lining.

d) Candidates often confused the term blood group with blood allele. The terms were used synonymously without distinction. Though the question called for a description of the inheritance of ABO blood groups, that whole realm of thought was often neglected.

Most marks were gained only because candidates gave the correct genotypes for the various blood groups. However, potential marks were lost here because candidates failed to use the standard notion I with superscripts and I to represent the alleles. Sometimes a Punnett square was used successfully to support an answer when inheritance was addressed. Much irrelevant information was given about universal blood donors or recipients and the related antigens and antibodies.

Question 7

a) Only a few candidates could mention more than one distinguishing characteristic for each plant group. Within this category, there were a few elite candidates who earned maximum or close to maximum marks. They wrote comprehensive answers, full of detailed knowledge. For example, in terms of reproduction, they stated that bryophyta produce spores in capsules, that filicinophyta produce spores on the undersides of leaves (in sporangia), that coniferophyta produce seeds in cones or that angiospermophyta produce seeds in fruits.

b) That starch is useful for energy was the only idea candidates seemed to know about starch. Few candidates realized that starch molecules are large and must be digested to the size of glucose before being absorbed in the intestines of humans.

c) There were some good attempts to distinguish the types of cells, but all points were not described to gain full marks. Sometimes diagrams were drawn with no differences pointed out. There was general confusion about bacteria having a cell wall while eukaryotes not having it.

Recommendations and guidance for the teaching of future candidates

Exam questions need to be read carefully and understood fully before answering. If a question asks about the inheritance of ABO blood groups, candidates should note that “inheritance” is the key term and should structure their answer around it.

Candidates must be taught to use appropriate vocabulary and appreciate the difference between terms such as allele and blood group or gene transfer and gene cloning.

The command term “outline” can be a challenge when writing answers. Candidates must be able to summarize information or draw conclusions. This is especially true when looking for trends in graphs where individual fluctuations may preoccupy candidate thinking.

Graphs showing various hormone changes during the menstrual cycle are classic areas for testing. Candidates must know what each hormone does and what negative/positive feedback mechanisms are involved and how they operate.

As this paper is to be emarked, teachers should not allow drawings on graph paper or the use of coloured pens/pencils/highlighters which can obscure the answers. Also, it is more difficult to read poorly written or poorly drawn answers so teachers should insist on legible handwriting and neatness from their candidates.

Although no drawings were required on this exam, candidates should practice drawing and labeling diagrams because they invariably appear on exams. All the diagrams that candidates must know appear as assessment statements beginning with the Objective 1 command term “draw.” There is no doubt about what is expected, so preparation should not be too difficult.

For questions involving the command terms distinguish or compare, candidates are advised to establish a table of comparison. Three columns should be drawn. On the same line crossing each column, the aspect being considered should appear in the first column and then the paired examples which may be contrasting or similar, depending on the command term, would appear side-by-side in the next two columns.

This format of presentation makes candidates focus on the question and makes marking easier for examiners. This effective use of formats such as charts/tables to compare and contrast information about a topic should be practiced.

Stress the importance of including named examples in answers when this is specifically required in the question.

As suggested on previous subject reports, teachers are reminded to have their candidates practice essay writing using questions from past papers. Candidates need help in structuring answers with sufficient detail. Many candidates are usually not specific enough in the use of language or in the application of details to support a general answer.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 9	10 - 14	15 - 18	19 - 23	24 - 27	28 - 36

General comments

Of the G2 forms submitted, 85.7% thought that the paper was of a similar standard to that of last year, and all respondents thought that the level of difficulty of the paper was appropriate.

Syllabus coverage was judged to be good by 37.5% and satisfactory by 37.5%. Clarity of wording was thought to be satisfactory by 75% and 62.5% thought this of the presentation of the paper. 25% of teachers felt that the syllabus coverage was poor and 12.5% felt the same about paper presentation.

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

The standard of performance showed a wide spread, but generally candidates showed reasonable achievement, and there were also some very good answers seen. Pleasingly, the majority of candidates followed the rubric of the paper and only attempted the required two options, and few questions were left unanswered.

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

On the whole comprehension was good, but discussion questions were often descriptions or outlines lacking the various points of views expected by the command term. Also, when asked to “outline” many candidates would simply “state”. The term “deduce” seems to cause problems, with many candidates failing to understand what was required.

For many, summarising multiple trends in data proved to be challenging. Often clear distinctions were not made in comparative questions, and candidates tended to write incomplete statements which were not sufficient to gain any credit.

When describing graphical trends, many could only identify the basic pattern, and did not see more subtle points such as changes in rate or a plateau.

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

Many candidates did better on date-response questions than those relating directly to the syllabus. There was an improved level of analysis and interpretation of numerical data and graphs. Some of the shorter recall questions were done well, but this often varied between the options, with D and G being the weakest. The level of subject knowledge was good for many centres, but disappointing from others.

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

Option A: Human nutrition and health

Question 1

a) Most candidates correctly identified middle ear infection, but many gave answers referring to different types of breast feeding for a(ii).

b) There were many answers which gave no reference to specific types of health care (ie follow-up visits, medications, etc).

c) Most candidates could suggest the presence of antibodies in breast milk, but few realised that the nutrients are in the correct proportions for the baby, and there were some who thought that milk contains antibiotics.

Question 2

a) Few could give the correct figures and/or units.

b) Most candidates could give at least some appropriate responses to this question and many scored maximum marks.

c) (c) This question produced a lot of vague answers that were not specific enough to gain credit. Many gave “swollen stomach” instead of “swollen abdomen” which was not creditworthy.

Question 3

a) Many gained the mark here, but a large proportion could not list two valid dietary sources of vitamin D, often giving fruit and vegetables as a possibility. The emphasis should also have been on oily fish.

b) This question was badly answered on the whole. The main misconception is that sunlight contains vitamin D, and many did not explain the role of the skin in the production of the vitamin. There is, however, an overall general awareness of the connection between UV light and skin cancer

Question 4

A surprising number of candidates had no understanding of this concept, and many suggested that it is the amount of exercise needed to burn up the energy gained from food intake. Those that did know what the concept is about, generally managed to gain both marks.

Option B: Physiology of exercise

Question 1

a) Most candidates were able to name one or two appropriate variables, and many could name three.

b) The majority were able to identify the increase in heart rate with workload, but few could describe other aspects of the relationship, such as the plateau.

c) (i) Most knew how to do this but some did not read the scale well. A few did percentage change instead. In quite a few cases the units were omitted.

(ii) While many described a decrease due to training, very few were able to gain a second mark. Some candidates appeared not to have used the data, but based their answers on their own knowledge.

Question 2

a) (i) Most candidates could label “antagonistic muscles” on the diagram, but very few could name them.

(ii) Many thought that structure A was simply the joint, and gave superficial responses such as “helps the arm to bend”, which did not gain any marks. Others said incorrectly that A was synovial fluid.

b) This challenging question proved to be a good differentiator for the more able candidates, as a lot of understanding and detail were required in order to gain the marks.

Question 3

a) There were few correct definitions of tidal volume. Few said that it was in one quiet inhalation/exhalation, and many stated oxygen rather than air.

b) Many gave inappropriate responses, writing about the cardiovascular system instead of the pulmonary system. Overall this was not well done.

Question 4

Most candidates gained at least a mark for this relatively easy question. However, it was a “discuss” question and candidates need to include alternative points of view when answering this type of problem.

Option C: Cells and energy

Question 1

a) (i) A range of answers were given, usually within the range acceptable in the mark scheme.

(ii) Many gained both marks for this question, but weaker candidates gave incomplete statements, mainly failing to link light intensity and CO2 exchange to photosynthesis.

b) This was answered correctly by most candidates.

c) Some candidates were able to interpret the data correctly, but there were few references to temperature and its effect on the growth of maize.

Question 2

a) This was answered well by the majority of candidates, and they could give suitable named examples.

b) Many candidates gave vague responses, and many appeared to not understand the concept of hydrophilic and hydrophobic. Few could discuss the roles of the amino acids in proteins.

Question 3

a) The majority were able to gain three marks from the parts of this question

b) As the question asked, candidates need to be precise in their answers, and many simply gave “mitochondria“ as their answer instead of specifying “matrix”

Question 4

Only the better candidates understood what was required in this question and gained some marks. Many did not attempt an answer.

Option D: Evolution

Question 1

a) Most candidates answered this correctly.

b) The majority of candidates answered this part poorly, and weaker candidates struggled to give clear answers. Many seemed to be confused between latitude and altitude when trying to explain the differences in wing size. In part (ii), there were many vague answers, hinting at different selective pressures, but little worthy of a mark.

c) A reasonable number of candidates gained marks for the concepts of isolation and speciation.

Question 2

a) This was relatively straightforward for most candidates, although some appeared to not know what the question was asking.

b) Many candidates gave good answers to this question, showing awareness of the two key properties of RNA.

Question 3

a) There were a large number of poor answers to this question, showing that many had little understanding of the process of carbon dating. Some gained one mark for knowing that the isotope decays over time, or they knew the correct time frame for dating.

b) Very few candidates produced comprehensive answers, most failing to distinguish between the two genera, or not giving the sequence in which they had evolved. Many appeared to lack knowledge about the topic.

Question 4

This question tested candidates' knowledge of the two processes. Many struggled to give balanced comparisons, and weaker answers were mainly muddled and irrelevant.

Option E: Neurobiology and behaviour

Question 1

a) This was probably the most challenging data-response question on the paper, and many candidates found the graphical information difficult to interpret. Few could outline the correct relationship.

b) This was also poorly answered. Some thought that the % frequency referred to the number of ants.

c) The majority of answers did make appropriate suggestions, despite the difficulty with the previous parts of the question.

d) The majority of candidates do not appear to understand the term "deduce". Some could suggest either innate or learned behaviour, but few could give a reason.

Question 2

a) Many candidates could not give a correct definition of a reflex.

b) The labelling was also not well done, and in (ii) there were many references to "signals" rather than "impulses" in the explanation, with often little connection to the parts shown in the diagram.

Question 3

a) (i) Most candidates were able to give the correct answer to this.

(ii) Few correct answers to this part, many suggesting "eardrum", or simply "hairs in ears".

b) This was generally not answered well apart from a few candidates who had obviously been well prepared. Most answers were vague and did not address the points in the mark scheme.

Question 4

Most candidates have some understanding of the effects of cocaine, but answers were often lacking in sufficient detail for two marks. The majority did not understand the way that cocaine affects the synapse.

Option F: Microbes and biotechnology

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

Question 1

Most of those who did this question had a reasonable understanding of the information presented for all parts.

Question 2

(a) and (b) Understanding of the nitrogen cycle is not good, and few candidates answered these questions correctly.

The majority were able to discuss changes in the level of algae and the lack of oxygen, so most achieved one or two marks.

Question 3

a) Very few marks awarded in this question. Most candidates had no detailed knowledge or understanding of the process.

b) Many gave correct explanations, but often failed to give an example.

Question 4

There were a lot of confused answers. The most common mistake was to discuss the role of reverse transcriptase in retroviral life cycles rather than in molecular biology. For those who attempted the question, there were some correct ideas, but not an overall clear understanding of how the enzyme is used for biotechnology purposes.

Option G: Ecology and conservation

Question 1

a) This was a relatively straightforward graph, and most candidates were able to gain some marks for correct interpretation. Many gave the required numerical detail to achieve maximum marks.

b) The calculation was not a problem for many candidates. In part (ii) most said that the fern had potential, and better answers gained two marks for using data from the table.

c) This was generally answered well.

Question 2

a) Many candidates did not “outline” the factors, but merely stated them. Consequently, they did not give enough detail to gain marks. There was also some confusion between distribution and dispersal (ie of seeds). Where points had been elaborated, they were often superficial, and references to light were common, rather than the required light intensity or wavelength.

b) Poorly answered on the whole, suggesting that candidates may not have sufficient experience of actual fieldwork on which to base their knowledge.

Question 3

a) This was a difficult question, and many examples given were not accidental releases of alien species. Where correct examples were given, they were not accompanied by enough detail to gain the mark.

b) The majority of candidates could gain one or two marks in this question, but some answers were generalised and vague. This was a “discuss” question, so candidates should have been able to expand their answers beyond a reference to competition.

Question 4

a) There were some well informed answers, but many candidates seemed to have little knowledge of this biome, giving muddled descriptions of its location and the type of vegetation found there. Better candidates were able to comment on its distribution in light of global warming.

Recommendations and guidance for the teaching of future candidates

- Candidates should be taught the mathematical skills necessary to manipulate data, such as percentage change calculations, not just using past papers but also through the practical programme so that they become familiar with using the techniques on their own data collected during experiments.
- Teachers should draw candidate’s attention to the different types of action verbs used in questions and what they mean. Link the action verbs to the number of marks in questions, using past papers and mark schemes as examples.
- Teachers should ensure candidates have experience in analysing a variety of data, including graphs with multiple-scales. Ideally the data should be related to the options being studied.
- Teachers should draw candidates’ attention to the key definitions relevant to their option, and encourage familiarity with them in preparation for the examination.
- Teachers should remind candidates to read the data response questions very carefully and thoroughly, as they often contain important information that can help them with their answers. Candidates should be made aware that whilst their own knowledge and understanding is often asked for, sometimes key points may be found within the text provided.
- Teachers should remind candidates to illustrate their answers with appropriate examples, whether or not these are asked for directly in the question.