Biology TZ2 (IBAEM & IBAP)

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 - 15	16 - 28	29 - 42	43 - 53	54 - 65	66 - 76	77 - 100

Internal assessment

Component grade boundaries

Higher level

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

Standard level

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

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

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

Ethics

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

The IB does not wish to inhibit investigations but it does want to stimulate a responsible attitude towards experimentation on animals. Any proposed experimentation involving animals, including humans, should result in a discussion between teacher and student based on its ethical implications and how to refine the experiment to alleviate any harm or distress to the animal, to reduce in the numbers of animals involved or to ultimately replace of the use of animals by using cells, plants or computer simulations. Any call for human volunteers in experiments must be accompanied by a consent form.

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

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

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.

The following situations were quoted by moderators

- Allowing crickets to get under the influence of smoke cigarette,
- Exposing goldfish to alcohol or rapid temperature change
- Butterfly survival in temperatures ranging from 0 to 100 °C.

Some of these investigations are verging on the sadistic; the design should never have been sanctioned in the first place.

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

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

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

Fieldwork often involves the sampling of animal populations. This should take place with the

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

The approach to experiments on human physiology should be reconsidered by a lot of teachers. Using fellow students for investigations into the effect of exercise on the heart rate can be considered unsafe if the health status of the students is not determined first. **Some schools are already expecting their students to use a proforma for the signed consent of the participants in experiments. This is good practice but it is still rare and moderators are frequently commenting on their absence in designed investigations involving human subjects.**

Clerical procedure

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

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

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 as to how the teachers were awarding marks. There are a large number of teachers that take a lot of time and trouble to prepare their Internal Assessment sample. This effort is very much appreciated. They should be congratulated for their efforts and their students will reap the benefits. It is a lot easier for a moderator to support a teacher's marks when there are clear, readable notes accompanying the sample.

There is a recurrent problem concerning the information provided by the teacher. This directly affects the progression of the moderation. **Teachers MUST enclose all the instruction sheets and/or adequate summaries of oral instructions for the investigations in the moderation sample.** Most schools complied with this requirement for the investigations involving DCP assessment. It is also necessary, however, for investigations where Design is being assessed and a significant number of teachers are not doing this or their information is very limited.

When Data Collection and Processing is being assessed, the method (designed by the student or provided by the teacher) is required. When Conclusion and Evaluation is being assessed all the steps in the scientific process are needed for moderation. This is essential information. Without it the student's work becomes impossible to interpret. Feedback from the moderators suggests that this is still a problem.

A few teachers are not designing practical programmes with sufficient numbers of hours; others are 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 4/PSOW.

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

When the only marks appearing on the 4/PSOW form are the two marks required for the internal

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assessment, it causes concern amongst the moderators. There is no indication that the students were marked a number of times using the criteria. One wonders how these students receive the necessary feedback to improve their performance.

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

Schools are sending photocopies of the student 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 strengths

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

The use of ICT in the areas of **1** Data logging, **2** Graph plotting software and **3** Spreadsheets is good though some schools have efforts to make in the use of data bases and spread sheets.

The use of data logging in investigations is increasing. In many schools the students (and teachers) seem to be at ease with their systems and they are being used more often in student designed investigations. The problem here is that some students copy the user manual instructions for the material into their design when this is not entirely necessary. Settings such as frequency of sampling or colorimeter frequencies should be presented but not all the technical details.

Areas of weaknesses

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

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

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

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

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

Rules applied by the moderators

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

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

The Criteria

Design

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

- Group work presented as individual work - all candidates with same plan, same data values; some candidates readily say in their reports that this was a group effort!
- Teachers using standard labs and saying they are Designed by candidates: for example, effect of solute concentrations on the osmosis of potato tuber

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

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

The investigations are frequently too simplistic. The range of values of the independent variable were insufficient to establish a trend. The number of repeats were insufficient to permit statistical analysis. E.g. testing the effect of pH on an enzyme using an acidic environment a neutral environment and a basic environment will not establish an optimal pH.

Standard protocols will, no doubt, be used by the students when they design their investigations. We are not expecting them to re-invent the wheel. HOWEVER these standard protocols must be significantly modified or applied to the student's own investigation. For example, if osmosis is being investigated and the student uses the method of change in mass of tissue to monitor the effect of solutions of different concentrations on a tissue, this is legitimate. If the investigation is simply to determine the isotonic solution of one tissue then it remains trivial and it repeats many textbook investigations. If the investigation is used to determine the effect of the salinity of irrigation water on different root crops, the investigation becomes more substantial. Osmosis was often presented this year as a Design investigation theme without any modification from a text book method.

The two point discrimination test for touch receptors on the skin is 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?

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

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

It is good practice for students to follow through their own designs. Some schools seem to have their students design an investigation that remains theoretical. The result is often an unrealistic investigation. Even when a teacher does decide to follow through a student designed investigation the result may be an unrealistic investigation. For example, measuring the effect of music genre on heart beat rates. This is almost impossible to control and students ought to be counselled against it from the outset. 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. cm not inches). Spoonfuls and cupfuls should also be discouraged.

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

Data Collection and Presentation (DCP)

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

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

Despite the clear warnings in the subject guides, a few teachers are still providing instructions on how to present the data and how to process the data. Their marks will be moderated down. The classic investigations (e.g. rates of photosynthesis using the sunken leaf disks, rates of reaction of catalase and osmosis) often create problems. Teachers 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:

- Data (raw or processed) that is inadequately presented (e.g. with superficial titles)
- There are no units in the table (note: decimal units should be used)
- No uncertainties were given in the tables of data collected using measuring instruments.
- There were inconsistent decimal places in tables
- The decimal places did not correspond to the precision of measurements
- There were no associated qualitative observations. E.g. an ecological field investigation is incomplete without some kind of description of the site used. This appears to be a common problem.
- Raw data were plotted in graphs that do not actually reveal anything (e.g. they can be used to derive maxima, minima, optima or intercepts)
- Raw data were plotted when the mean should have been calculated and plotted (often the mean is actually calculated and then ignored by the student for graphing)
- There was no statistical treatment of the data when it was possible

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- When statistical treatment is applied there is no consideration of its appropriateness. E.g. calculating standard deviations when they had only made 2 or 3 measurements (many teachers marked this as complete and made no comment about it on the student work)
- There was no presentation of uncertainties in graphical data either by using trend lines or error bars or uncertainty ranges on the axes.
- The error bars, when used, were not explained.
- A majority are putting a linear line of best fit even when the data is clearly S-shaped or clearly has a non-linear pattern.

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

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

There seems to be some confusion over where to assess the use of sample calculations and decimal places in processed data.

The use of sample calculations where they are necessary would be assessed under aspect 2 given that these would be necessary to follow the processing of the data. However, it is not always necessary to give a sample calculation. For example, a column of raw data with mean and standard deviation clearly indicated at the bottom would not require sample calculations. Their correct unambiguous presentation would be assessed in aspect 3.

The attributing of an appropriate number of decimal places (significant figures) is assessed under aspect 3 as stated in the clarifications in the subject guide.

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 and evaluation is very superficial.

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

Students in some schools show that they have developed a mature sense of criticism of the investigation. Their evaluation of their results is based upon a balanced critical analysis of the data.

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Students who have not developed this skill tend to remain superficial in their evaluation. The weaknesses they identify are hypothetical ("the seeds could have been dead") without evidence to back it up. For weaker students the experimental weaknesses are restricted to having a limited amount of time or errors in their own manipulation that once again remain hypothetical ("I could have incorrectly measured the temperature"). Evaluation is a good discriminator of the high achieving students and teachers would do well to remember this when they are marking their students.

Suggested modifications were sometimes superficial and yet marked over generously.

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

Manipulative skills

There is evidence of the students being exposed to a sufficient range of investigations. This ensures that the manipulative skills can be assessed correctly. However, a large number of moderators notice that some schools are attributing 6/6 for the whole sample for this criterion. There is no discrimination between the candidates.

ICT coverage

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

Graph plotting using software was perhaps the easiest and most widespread for schools to apply. However the signs are that the students still need to be taught the correct conventions of graphing. There is a tendency to use bar charts for everything amongst the weakest students, perhaps because it is the default setting. Legends (keys) are not always necessary and students do not seem to know how to de-select them. When they are needed the students often have difficulty labelling them appropriately – students often present the different curves as "series 1" and "series 2" When the students used scatter plot, a trend line was not always used when it was appropriate.

It might be an idea to train the students to plot graphs manually before using a graphing program.

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

Some schools are not fulfilling the requirement for a range of ICT applications to be used in their practical programme.

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

The Group 4 Project

It needs to be repeated for a very few schools now, the Group 4 Project can ONLY be used for the

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assessment of Personal Skills. Indeed it is the only occasion when it is assessed. The Group 4 Project CANNOT be used for the assessment of Design, DCP, CE or Manipulative Skills. Once again it is evident that some teachers are awarding full marks 6/6 to all their students without any discrimination.

Recommendations and guidance for the teaching of future candidates

- Share the criteria with the students.
- Read feedback from the previous session and act upon it.
- Consult the Online Curriculum Centre (OCC) for teacher support material (TSM)
- Apply the internal assessment criteria rigorously.
- Ensure that the open-ended theme that you set has enough scope to provide a variety of research questions for the whole class.
- Give the students experience in identifying independent, dependent and controlled variables.
- Be sure that investigations used for assessment produce quantitative data.
- Encourage the students to make additional observations about their experiment. It is good practice for them to keep a log book.
- Ensure that the investigations have the potential to generate sufficient data for substantial processing.
- Teach the students that plotting graphs of raw data is often insufficient if nothing can be derived from them..
- Encourage the students to carry out research into the background literature both before starting an investigation and once the results are complete.
- Do not use simulations for assessment.
- **Do not** use the Group 4 Project for assessment of D, DCP CE or MS. Only use it for Personal Skills. Inappropriate use will be sanctioned.
- Make sure that you are using the most up-to-date version of the 4/PSOW form (available from the **Handbook of Procedures** on the OCC).
- Check to be sure that all the parts of the 4PSOW form are completed correctly.

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Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 17	18 - 23	24 - 27	28 - 32	33 - 36	37 - 40

General comments

Most teachers who commented on this thought that it was appropriate in level of difficulty, but about 10% felt that it was too easy. About half thought that it was of a similar standard, but of those who thought it the standard was different, many more thought that it had been easier. This was borne out by the statistics which showed that the mean score for this paper was one mark higher. Almost all teachers felt that the clarity of wording and presentation of the paper were either good or satisfactory.

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

More questions than usual in this paper were answered correctly by large percentages of candidates. Questions 6, 8, 9, 10, 17, 21, 24 and 38 were all answered correctly by more than 97%. In some cases this indicated careful preparation by candidates, with help from their teachers. In other cases questions were perhaps too easy to discriminate well between weaker and stronger candidates; none of the eight questions listed above had a discrimination index higher than 0.23, with 0.30 usually regarded as the lowest index for a question to have been effective enough. Stronger candidates and their teachers, if they are shrewd, should hope for harder questions, if they are to be able to prove their metal. However, the other 32 questions were more demanding and in many cases they were very discriminating.

The comments that follow relate to questions where candidate performance was better or worse than expected or to questions that aroused comment from teachers on G2 forms.

Question 5

Only half of candidates knew that the thickness of a plasma membrane is about 10nm, with large numbers instead choosing the answer 10µm. More emphasis therefore needs to be given to the difference between micrometres and nanometres.

Question 7

There were some suggestions from teachers that candidates could not be expected to understand the molecular diagrams included here, but nearly 85% of candidates identified the compound correctly as glucose. The commonest wrong answer was ribose, perhaps because candidates counted five carbon atoms in the ring and forgot the sixth carbon attached to C_5.

Question 13

This was one of the best discriminators on the paper. 72% chose chorionic villi as the source of

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chromosomes for pre-natal diagnosis of abnormalities. The most popular wrong answer was erythrocytes, which was perhaps surprising as many of these candidates will have known that erythrocytes lack a nucleus.

Question 18

Some teachers felt that answers B and C were both correct. Overproduction of offspring (B) is part of the Darwinian explanation of natural selection, but it does not in itself cause bacteria to develop resistance to antibiotics. The answer was evolution due to environmental change (C). Evolution is the process that causes antibiotic resistance to develop and the presence of antibiotics drives this. If a candidate thinks that there are two answers that are both partly or both wholly correct, they should always pick the best of the two answers. That was certainly C in this case. In fact few candidates chose B and a more popular wrong answer was D; response by bacteria to an epidemic.

Question 19

This was the best discriminator on the paper, perhaps surprisingly. Presumably the 62% of candidates that answered it correctly were the ones that had prepared most carefully for their exams and candidates relying on guesswork or intuition were caught out here.

Question 20

This was another very good discriminator. More candidates than expected thought that the pulmonary vein carries blood to the heart muscle. Perhaps these candidates did not read the question carefully and thought they were being asked which vessel supplies oxygen directly to the heart.

Question 23

Some teachers pointed out that blood pH and other variables are not controlled by homeostasis; their control is a part of homeostasis. This distinction did not seem to worry the candidates, with 70% getting the answer right and the discrimination index indicating that these were largely the stronger candidates.

Question 24

This was an example of a question that was too easy; it proved to be the easiest on the paper with candidates only needing to know that we do not shiver on a very hot day.

Question 26

This was the third hardest on the paper and an excellent discriminator. Candidates were expected to identify the structure as a channel protein and deduce that polar amino acids would line the pore.

Question 28

This was the hardest question on the paper, with only 28% of candidates answering correctly. If all candidates had guessed the answer we would expect 25% to be correct, but we should not assume that only 3% of candidates got the answer here by deduction rather than guesswork. The discrimination index shows that most candidates were not guessing. The commonest answer

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chosen by candidates was A, and was incorrect; ATP is not produced using electrons from NADP during oxidative phosphorylation. This may be another case of candidates not reading the question carefully enough, with the letter P making all the difference.

Question 32

This question elicited more comments from teachers than almost any other. A valid criticism was that the diagram was not needed for candidates to be able to answer the question. The most common criticism was that candidates could not know whether potassium is absorbed by active transport or facilitated diffusion without knowing relative concentrations in root cells and in the soil. This was not accepted by the examining team, for two reasons. Firstly assessment statement 9.2.3 requires mineral uptake by active transport to be explained, so candidates should know that the soil concentrations are lower; typically two orders of magnitude lower in fact. Secondly the question states in bold that it is how potassium is **mostly** taken up that is required, which gives the hint that there might be two methods but more of one occurs.

Question 33

This was an example of a rare phenomenon in multiple choice papers, a question that had two correct answers, with a mark awarded to candidates who chose either of them. Two teachers commented on this. P_{fr} is a promoter of flowering in some plants and so will promote flowering when nights are short and P_{fr} remains at the end of the night. These are long-day plants; answer D. P_{fr} is an inhibitor of flowering in other plants so flowering will occur when there are long nights and all P_{fr} is converted to P_r. These are short-day plants; answer C. Ironically the question still proved to be a good discriminator as weaker candidates tended to choose answers A or B.

Question 39

This attracted the most comments from teachers, with many saying that the quality of the micrograph was poor and that the Sertoli cell did not show clearly. The examining team re-evaluated the micrograph, because the statistics for this question were very unusual, but it was decided that the Sertoli cell showed about as clearly as it they ever do. The cytoplasm does not usually stain densely so can appear as a gap between other cells rather than a strong feature itself. The possible answers to the question allowed candidates to identify the cell by eliminating the incorrect answers. The cell was clearly not a sperm or a Leydig cell, so two answers could easily be eliminated. The remaining answers were Sertoli cell and germinal epithelium. Although more candidates chose the former, large numbers of candidates decided that the cell was a germinal epithelium cell. This is not possible, because the cell is about half way through the wall of the seminiferous tubule, not in its outer layer of cells.

Many of the stronger candidates thought that the cell was in the germinal epithelium and there was therefore a negative discrimination index. On average, weaker candidates answered the question slightly better than strong candidates. This is an area of the programme that should be emphasized more by teachers to ensure that candidates' knowledge is better. Perhaps as it comes at the end of the AHL it is sometimes neglected.

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Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 13	14 - 23	24 - 33	34 - 43	44 - 53	54 - 72

General comments

214 teachers completed G2 forms. 87% indicated that they thought the paper was of the appropriate level of difficulty and most believed the paper was of similar standard to last year's paper. The majority of respondents believed that the clarity of wording and the presentation of the paper was good.

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

This examination paper was one where students did well on nearly all aspects of the paper with few content areas appearing to cause students difficulty.

Understanding the role of a placebo as a control as explained in the stem of question 1 was a problem for some as was the correct interpretation of the negative values from the monocyte graph.

Many students lost marks due to the incorrect or careless use of terminology.

Most of the candidates misunderstood the role of ATP in muscle contraction. The majority wrote that hydrolysis of ATP causes the power stroke.

Many students do not distinguish between heat capacity and specific heat capacity. Many do not use the term latent heat of evaporation.

A good number of students used the terms species, population and community interchangeably.

Students often did not understand the nature and function of mucous in the respiratory system. The relationship between genes and enzymes was poorly understood.

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

Most of the exam provided evidence that the students were well prepared. Particular areas of strength included standard deviation; lactose production; osmoregulation; role of lipids protein functions, digestion; the transpiration pathway and muscle contraction;

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

Question 1

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1a Most candidates correctly identified the placebo as the treatment involving the greatest nasal obstruction relief.

1b Most understood the concept of control though some did expand into unnecessary explanations of human behaviour.

1c A surprising number of candidates after having correctly identified the placebo as a control, described the placebo as another drug. This misunderstanding often carried through to questions 1c to 1f. They failed to recognize that the other drugs reduced the immune response and instead discussed the influence of the drug programmes in positive rather than negative terms.

1d Generally answered correctly, though aspirin was the most common incorrect choice.

1e This question is one in particular where students did not appreciate the reduced immune response of the drugs. This required careful reading of the stem. Many interpreted the high levels of monocytes in the blood to be a strong immune response. Many did not discuss the individual effects of the drugs. Few recognised that antifever drugs reduced monocyte migration into tissues.

1f. If students misinterpreted the graph in e), then they were likely to say that the data was equivocal. Students did a reasonable job of drawing upon all of the data.

Question 2

2a The correct numerical value was commonly given, but a large number of candidates did not include units.

Questions 2b and 2c were well answered by the majority.

Question3

3 a (i) and (ii) were well answered by many though a significant minority wrote only ‘gland’ in 3 a (i).

3a (ii) A surprising number of candidates incorrectly wrote the alveoli as the source where carbon dioxide is brought into the blood.

3b Candidates did well on this question. Many mistakenly wrote that mucus was secreted by alveoli which would impact gas exchange negatively and many failed to appreciate the collective impact of many alveoli giving rise to a larger surface area. In both b and c, many students referred to membranes as being one cell thick. The term alveolar membrane is ambiguous as many students do not sufficiently differentiate between cell membranes and the wall of the alveolus. The term ‘wall’ is preferable to membrane. Again students must not confuse this with cell walls.

3c Candidates did reasonably well here though answers were poorly articulated when describing pores and many referred to leakage only rather than indicating the materials including plasma and phagocytes that would leave through the pores. Many did not specifically link the structures of capillaries to their functions. Students need to recognize that an explanation requires reasons and mechanisms so the demands of question 3c were greater than those of 3b where only a description was required. In both 3b and 3c many students needed to more careful with word choice as they referred to the alveolus and capillary as being one cell thick when both structures have thin walls that are one cell thick.

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Question 4

4a (i) Many left off the term ‘palisade’ from their answer.

4a (ii) The most common error was to refer to the label as stomata. Few referred to the tissue as epidermis.

4a (iii) Again approx. 50% correct responses

4b Many students listed features rather than providing the outline that was required. Few recognized that water is trapped around the leaf by some adaptations which raises the humidity which limits further evaporation.

4c Many students stated the function of vascular tissue, but did not adequately discuss why it allows for functionality not present in bryophytes. Bryophytes can also move water and carbohydrates into cells. Vascular plants are able to move these across greater distances from source tissues to sink tissues.

Question 5

5a The two most common errors for this question occurred when students listed functions of proteins that were membrane proteins and when students were too vague regarding the statement of protein function.

5b Candidates here strayed from the reference to protein and did not correctly state the breakdown to polypeptides before amino acids. Candidates understood absorption but rarely showed understanding of assimilation. Candidates showed a surprisingly poor ability to summarize the processes involved in protein digestion. Frequently irrelevant aspects of digestion were included such as in the processes involved in digestion of fats and carbohydrates.

5c This question was generally well answered by the majority though the sequencing was often incorrect. The ATP cycle was poorly outlined in the majority of answers.

Question 6

6a This part of the question was poorly answered. Candidates were usually able to relate genes to translation but were less likely to adequately relate their responses specifically to polypeptides beyond that.

6b Aspects of allosteric inhibition were usually a strength within student responses to this question. Answers for this question were generally not very well constructed.

6c This part of the question was generally well answered. Sources of lactase was less commonly included in answers.

Question 7

7a This part of the question was an area of strength in terms of student understanding of concepts and structure of answers. The most likely aspect to cause problems was the distinction between pollination and fertilization.

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7b This question was answered reasonably well with improvements seen over previous years in terms of the degree to which candidates carried out a comparison throughout. There was occasionally a digression into irrelevant aspects of the menstrual cycle.

7c There was a failure here to understand the difference between overpopulation and population growth. Many students went into a detailed description of the sigmoid growth curve. This was the most likely question where a lack of conceptual understanding was evident with a very poor use of terminology. Students frequently confused the distinctions between individuals, populations, communities and species. Some argued that the carrying capacity was the maximum population that could exist. They did not realise that the carrying capacity could be exceeded as a result of overpopulation.

Question 8

8a Many did not understand the difference between heat capacity and specific heat capacity. Heat capacity is a property of a quantity of matter. For example, two litres of water has a greater heat capacity than one litre of water. Specific heat capacity is a property of certain substance. Water has a greater specific heat capacity than iron. Nor did they understand why water made for a good coolant. Many focused too narrowly on an aspect of thermal, cohesive or solvent properties rather than discussing these properties from a more 'big picture' perspective. 8b The role of ADH was well described an many candidates scored full marks here. Students need to take greater care when using the term concentration as water represents the solvent. 8c This question was generally well answered.

Recommendations 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 and include details when responding to an outline prompt;
- Use organizing diagrams for their answer such as t-charts for compare questions;
- Read questions carefully to ensure that all aspects of the question are being addressed and avoid writing down memorized mark schemes without ensuring that they are fully relevant to the exam question;
- Use the number of marks allocated as a guide to the required number of unique ideas required.
- Take greater care with word choice: for example, take time to qualify the term concentration when referring to a solvent and membrane when referring to a tissue.
- Use specific terminology with greater frequency;
- Include units in numerical answers;
- Consider the 'reasonableness' of results: does the answer make sense? If all other sources of data suggest a certain conclusion, evaluate carefully data which suggests a contrary conclusion. The example to illustrate this is question 1e.

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- 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:

- Provide classroom exercises which probe conceptual understanding. For example, provide fill in the blank exercises with several terms that are likely to be confused by students and provide feedback on incorrect choices. Language use in ecology is a recommended area to focus on.

- Address apparent gaps in syllabus coverage including the use of the term control; the ATP cycle in muscle contraction; the distinction between heat capacity and specific heat capacity; protein digestion; pollination;

- Cover all the curriculum rather than presuming material has been covered in earlier courses. Understanding of the basics of digestion was limited 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.

- Candidates should know the differences between a list and an outline; i.e., that when they are asked to outline something a simple statement of a fact is not enough. Candidates should learn and practice to use biological vocabulary in their answers and to link all relevant ideas in a logical sequence.

- Review the role of mucus in the respiratory system even though it not on the syllabus;

- Discuss with students examples of careless word choice in answers such as why “the alveolus is one cell thick” is not correct;

- Provide homework exercises where the standard of grading requires clear demonstration of conceptual understanding rather than repetition of memorized answers. Concept maps, multiple choice practice and vocabulary exercises are a way to achieve this.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 12	13 - 16	17 - 21	22 - 25	26 - 30	31 - 40

General Comments:

Nearly 94% of teachers responding on G2 forms felt that the level of difficulty of this paper was appropriate. Of the minority who thought that the difficulty was inappropriate, most felt that it had

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been too difficult. When comparing the paper to last year's, most teachers thought the standard similar, with almost an equal number thinking it was easier than more difficult. Teachers felt that both the clarity of the wording and presentation of the paper was satisfactory in almost the third of the cases and good in approximately two thirds of the cases.

Candidates seemed to know which options they were prepared for and most of them attempted all questions for these options. It seems at first glance that there was a decrease in popularity for option D, whereas there was and increase for option F, mainly due to the largest centres preparing candidates for it.

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

Although candidates seemed to be able to read the graphs from the data based questions properly and compare different pieces of data, they generally had more difficulty interpreting the significance of these data and relating their knowledge to new situations. In some instances candidates would have earned more marks if they had justified their answers or used appropriate and precise terminology. They also had some difficulty in expressing clearly the principles of natural selection, transmission of genes in gene pools and mechanisms of evolution. Using terms such as presynaptic and postsynaptic neurons, synaptic cleft, depolarization and hyperpolarization to describe decision making at the cellular level in the nervous system was difficult. They exhibited poor knowledge about dating fossils, using indicator species and biotic indices, the concepts of inhibition (*e.g.* of gastrin or hepcidin), concepts of negative feedback and the detailed mechanisms of food absorption. Most candidates used examples that were probably presented to them in class, but their answers were very often anecdotal, contained distorted information and failed to properly explain the principles involved. Many candidates seem to still have some difficulty to address the command terms presented in the question and to use appropriate terminology.

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

Candidates were generally able to read data properly and, where appropriate, make the correct calculations, except for option E. They seemed well prepared to answer the questions in the options that they had chosen and displayed a reasonable knowledge of factual information about the material covered by these options, except in the areas mentioned previously.

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

Option D - Evolution

Question 1

This question presented simplified data from a variance analysis, showing the relatedness of two variables. A simple reading of the graph was required from candidates who then had to show their understanding of natural selection.

a) This part required candidates to read the highest escaping ability correctly, which was done by the vast majority of candidates.

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b) The vast majority of candidates suggested a plausible feature that could increase the escaping ability among butterflies, most mentioning camouflage.

c) This part seemed more challenging for candidates who nevertheless managed to gain marks. In (i), stating the principles of natural selection clearly in terms of adaptation, survival, reproduction and relating to populations and/or gene pools was the most difficult part, with many answers failing to include the words *adaptation*, *population* and *gene pool*. In (ii), many candidates managed to state that unpalatable butterflies were not eaten by predators, but had much difficulty to figure out that it was regardless of escaping ability; many answers had a lamarckian connotation, stating that butterflies who could not escape had to evolve to become unpalatable, which is incorrect. Furthermore, candidates largely failed to explain palatable butterflies here. Very few marking points were awarded for "palatable butterflies with high escaping ability can survive to pass on genes / palatable butterflies with low escaping ability are eaten and their genes are lost."

Question 2

a) What seemed to be a straightforward question proved to be difficult for many. Many candidates ignored the command term *outline* and simply answered ^{14}C and/or ^{40}K, sometimes with an incorrect radioisotope. The principle of dating seemed to be unknown, as well as half-lives and the approximate age of fossils that could be dated with either radioisotope.

b) This part presented a cladogram of larger primates and the two subparts were interpreted correctly by the vast majority of candidates.

c) This part required candidates to name a barrier that may exist between gene pools and describe its action and the results in terms of gene pools. Mixed results were obtained here, although many candidates gained all the marks. Some candidates confused between types of barrier and types of evolution (*e.g.* geographic vs allopatric), were vague about its action and could not relate to gene pools.

Question 3

The command term *discuss* was used in this question about the importance of the genetic and cultural evolution in the recent evolution of humans. A good knowledge of factual information was displayed and many candidates indeed engaged in a discussion, weighting the importance of each aspect. Some candidates failed to describe each type to start with, and others wandered off displaying knowledge about the trends illustrated by different fossils of hominids.

Option E - Neurobiology and behaviour

Question 1

Three circular graphs relating toad reproduction events with moon phases were presented as data. A certain number of candidates read the amplexus events as being the least influenced by the lunar cycle instead of the first spawn events in part (a); it is difficult to know if this was due to a misinterpretation of the graph or a misreading of the negative question. Candidates usually presented good data comparisons in part (b), but kept comparing data in part (c) where they were expected to find a causality relationship between arrival and amplexus; many provided incorrect answers such as "inversely proportional", trying to find a mathematical relationship. For part (d),

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most candidates provided a valid environmental variable, but some of the reasons were either vague or irrelevant (*e.g.* food, affecting red deer reproduction when the data was about toads).

Question 2

The vast majority of candidates provided correct answers for part (a). Part (b) was more discriminating, ranging from good descriptions using correct terminology (presynaptic, postsynaptic, depolarization, hyperpolarization, etc.) to irrelevant answers about reflex arcs. Most candidates could outline the effects of cocaine on synapses in the brain in (c), but many answers contained inaccuracies concerning the neurons involved, the neurotransmitter and the effect on membrane receptors; there was no provision for marks about the behavioural aspects of cocaine use.

Question 3

Most candidates gained their marks relating factual information for this question, but fell short in engaging in a discussion about the evolution of altruistic behaviour. Some answers failed to define altruistic behaviour as an animal risking its own life for the reproductive success of another individual in the colony, although most examples related to this; there were inappropriate examples about parental care or organisms not showing strict altruistic behaviour such as jays, side blotched lizards, ants, etc. Many answers provided distorted information or were not specific enough about animals' names (*e.g.* bats instead of vampire bats), benefit to others and risk to self.

Option F - Microbes and biotechnology

Question 1

Data showed the concentration of three monosaccharides issued from the hydrolysis of wheat straw and after the addition of yeast over time. The vast majority of candidates could read correctly the highest concentration of glucose and give the units for part (a) and distinguish between the concentrations of xylose and arabinose in part (b) although with few candidates obtaining two marks. Although most gained marks, part (c) was more challenging for them; a certain number stated incorrectly that the increase in xylose was the result of glucose fermentation, probably only looking at the data and failing to relate to their basic knowledge about fermentation. They were not very successful either for part (d), a large number stating vaguely that wheat straw was a good source of energy without looking into the availability and cost of it.

Question 2

The majority of candidates exhibited knowledge and gained marks in part (a), but some failed to gain all of them because of imprecision in their answers; a certain number of candidates, especially in French scripts, confused between the type of clusters characteristic of certain bacteria seen under the microscope (e.g. grape-like clusters in *Staphylococcus* sp.), and aggregates causing a change in properties. Most students gained marks for part (b), but a certain number ignored the words *traditional* and *people* in the question, which limited the wide range of methods that could be listed; answers not mentioning *high concentration* for salt and/or sugar were not accepted, nor elements listed third or above. A large number of candidates gained all the marks for part (c), but some failed to mention inorganic substances and/or organic compounds as a source of carbon.

Question 3

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Candidates seem generally prepared for this question and some displayed an extensive and detailed factual knowledge about the biological effects of radiation and antiseptics, but many failed to address the command term *evaluate* and/or fell short in expanding the range of control aspects for each method in their answers.

Option G - Ecology and conservation

Question 1

A stacked bar graph was presented to show the mutualistic relationship between some species of *Acacia* and *Pseudomyrmex*. Candidates had no difficulty to identify the requested species in part (a) and to calculate a percentage in part (b). The vast majority could also suggest correctly how the stated adaptations benefited the mutualistic ants and the *Acacia* in part (c). For part (d), most candidates could deduce that mutualistic and parasitic species were in competition, but had more difficulty completing their answers in terms of thorns and extrafloral nectar presence and generally only gained only one mark.

Question 2

Most candidates gained all the marks in part (a), although many answers demonstrated a poor understanding of primary succession and did not relate to an increase in species diversity. The majority of candidates answered part (b) in terms of recapturing marked mice, but many answers missed out on a few details, mainly counting the mice; a limited number of candidates confused methods, mainly with quadrats or diversity indices and rare were the candidates commenting of methodological details or limitations of the method. Part (c) was usually well answered, but some candidates lost marks because of imprecise organism name (for the invasive species and/or the control method), not stating the impact, or stating an unrelated control method with the named species; most candidates used textbook examples, but there were also valid regional examples and a certain number of plausible "creative" examples that were dismissed by examiners after some time wasted searching for their validity.

Question 3

Most candidates gained a variable number of marks for this question, mainly for stating factual information. Only a limited number of candidates clearly defined what indicator species and biotic indices are, and related to changes over time. Most could provide valid examples, but only a few could explain clearly the principle of calculating biotic indices. Many answers contained imprecise vocabulary.

Option H - Further human physiology

Question 1

It seems that this question was extremely difficult for many students. In part (a) the majority read the graph as "without anemia" being the group with the greatest range of hepcidin concentrations, but only a part of them added "CHF patients" to gain the mark, since the control group was also without anemia. Most calculated the difference correctly for part (b), but a certain number of answers were out of acceptable range, probably due to a too imprecise reading of values. For part (c), only a part of candidates gained their only mark for deducing that anemia with CHF was more significant in affecting hepcidin concentration; many failed to consider medians when comparing the

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data, in spite of the focus on the median of the part (b), and many also only compared differences in values without stating if it was higher or lower than the control median value. Some candidates nevertheless noticed how the ranges overlapped and that the data could therefore not be completely trusted. For part (d), candidates could say that the CHF patients with anemia had lower hepcidin levels, but they often misunderstood the mechanism of why that was true and did not seem to understand that iron could be obtained from nutrition and could be absorbed when hepcidin levels were low to restore iron deficiencies and low hemoglobin. Many stated that the iron was coming from the breakdown of hemoglobin in anemic patients.

Question 2

Most candidates had no difficulty to state the required factual information in part (a). Most gained marks in part (b) as well, but some parts of answers were irrelevant (*e.g.* smell and taste) whereas other answers lacked precision (e.g. *hormone* instead of *gastrin*; *gastric juice* instead *of HCl/pepsin*). It was similar in part (c), where some candidates had difficulty incorporating enough precision to gain some of the marks, for instance mentioning *aerobic* cell respiration, chemosensors in *aorta* or *carotid arteries*, naming the medulla of the breathing center instead of the brain only, the appropriate respiratory muscles, etc.

Question 3

Most candidates gained a range of marks for this question, but most answers lacked enough precision to gain all of them, being limited to generalities about absorption and transport of nutriments by the ileum and/or addressing only core assesment statements instead of option H's. Many candidates used inappropriate terminology (*e.g. membrane* instead of *epithelium*; *blood vessel* when *capillary* is meant) and limited themselves to stating factual knowledge without providing an actual explanation of the mechanisms (e.g. glucose is actively transported *through sodium carriers*). Many students reported epithelial cells having pinocytic vesicles to absorb various types of molecules, not realizing that these vesicles are the result of endocytosis and not the cause.

Recommendations and guidance for the teaching of future candidates

Interpreting data

- Data analysis is a necessary skill that should easily be applied throughout the duration of the course.
- Candidates need more practice in paying attention to accuracy of reading data. They should be reminded to use simple geometry instruments to read data accurately (this is permitted in Paper 3).
- Students should be exposed to the concept of control treatments, and understand that a control treatment usually has no effect on the dependent variable and is carried merely for purposes of comparison.

Syllabus coverage

- The principles of natural selection and the vocabulary associated with natural selection are key concepts that should be emphasized throughout the course work.
- Where an example is required by the programme to illustrate a biological phenomenon, it should be chosen very carefully, and if candidates are allowed to make their own choice,

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this should be checked by the teacher. The use of Latin names of species is not always necessary, but names should be precise enough to limit the example coverage.

Examination and communication strategies

- Candidates should practise using subject-specific vocabulary throughout their coursework if they want to be able to use it in their answers.
- Candidates should be advised to read the questions more than once. Answer and reread the answers as well.
- Candidates need guidance in how to consider the depth of their answer and the mark allocations. The command term must be considered carefully, as well as the number of marks for the question. If a question is worth six marks, at least six specific statements must be made, but candidates should be encouraged to include a couple more to be sure that they can gain all the marks.
- A good rule of thumb for any essay question is to define the main concepts with an academic definition before discussing the topic. It was obvious that some candidates knew the material, but did not stop to define all of the terms before getting in the main part of their answer. Furthermore, candidates should practice aiming for the bigger picture of the topic instead of elaborating on only a few minute details. Taking a few minutes to lay out ideas before writing the answer usually helps.

Familiarization with the format of Paper 3

- The examination paper usually provides sufficient space to answer each question, but when candidates use continuation sheets for parts of a question they should indicate that an answer is to be continued elsewhere.
- Teachers should explain to candidates that this paper is scanned to be emarked, and thus answers written outside the provided squares could be a source of omissions.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 12	13 - 17	18 - 20	21 - 24	25 - 27	28 - 30

General comments

Of the G2 forms submitted by the time of grade award, 55% thought that the paper was of a similar standard to that of last year, while 22% thought that it was a little easier. 91% of respondents thought that the level of difficulty of the paper was appropriate. Most teachers thought that clarity of wording and presentation were satisfactory to good. There were many discriminating questions on the paper, and questions 15, 20, 23, 28 and 30 had many candidates leaving them blank.

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

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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 the G2 forms.

Question 2

This question discriminated well, and many candidates chose option A, which is a correct statement, but is not answering the question asked.

Question 5

Although this question discriminated well, a large proportion of candidates chose option C instead of the correct response of A (10nm). It was thought that students were confusing the different units used in those two options.

Question 6

The majority of candidates did pick the correct answer of B, but comments on the G2 feedback forms suggested that the question was too hard for a Biology paper. However, it was felt that students should be able to recognise the different ways of representing the molecules of important compounds such as glucose.

Question 11

Feedback on the G2 forms suggested that there was too much information given in the question, and that candidates may have been disadvantaged by this. It was accepted that this type of question was difficult for some candidates, and many were distracted by option A, but the majority did choose the correct response of B, and the question gave good discrimination

Question 14

Quite a few candidates picked option A instead of D, but this statement is invalid when dealing with sex-linked genes. The question had a high discrimination index.

Question 19

Most students picked the correct response of A, so the question was not a very good discriminator. G2 feedback suggested that the wording of the question was misleading, since the question asked "which are decomposers", which could lead candidates to the conclusion that there was more than one answer. However, the term "decomposers" is usually used in the plural, and students should be familiar with this standard usage.

Question 22

G2 comments thought that the term natural selection should have been used in the question, rather than evolution. However, it was felt that use of antibiotics could not be called natural selection. Most candidates gave the correct response of C, although a large number did choose D.

Question 24

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G2 feedback commented that the wording of this question should have been about the consequences of the presence of HIV. The question was designed to be about AIDS rather than the state of being HIV positive. It was in fact a poor discriminator, with most students giving the right response, which was C. Very few candidates were distracted by the other alternatives.

Question 27

There were a number of comments on the G2 forms suggesting that this question was more appropriate for option E questions. However the reflex arc does appear in statements 6.5.2 and 6.5.3 of the core syllabus, stating that students should be able to draw and label a diagram of a motor neuron. The diagram in the question could have been improved by labelling the muscle, or showing the direction of the impulse, and it was accepted that students studying option E may have had a slight advantage over others, but the good candidates gave the right response, (D) and the question discriminated well.

Question 28

Feedback from the G2 forms implied that it is unclear whether the function of the lacteal is a required part of the knowledge of the digestive system. Assessment statement 6.1.7 of the core syllabus requires students to explain how the structure of the villus is related to its role in absorption. It was therefore felt that the lacteal was a necessary part of the understanding of the villus, and that the question was fair. Many candidates gave options A, B and C as the answer, but the question did discriminate well, with the majority choosing D, the correct response.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 18	19 - 24	25 - 29	30 - 35	36 - 50

General comments

Overall, the 249 teachers who completed the G2 form were satisfied with the paper. Compared with last year's paper, 133 considered this paper to be of a similar standard, 48 a little easier, 8 much easier and 13 a little more difficult. 229 of respondents believed it to be of the appropriate level of difficulty, while 7 thought it to be too easy and only 2 too difficult. 149 of respondents felt that clarity of wording was good and 84 thought it was satisfactory. Only 3 believed it was poor. 175 of the respondents felt that presentation of the paper was good and 57 though it was satisfactory.

In Section A, most candidates were able to answer the data based questions correctly. Lack of detailed knowledge, is one of the main aspects for which candidates did not score properly. They seemed to have some knowledge, but not enough, resulting in very poor answers. Many of the students didn't read the questions properly and carefully, so they didn't answer what they were asked.

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In Section B, candidates had a preference for question 5, although many candidates also answered questions 6 and 7 equally. The quality of the diagrams was in general of very high standard. The candidates were able to draw the structure of DNA as a double stranded molecule in a clear manner. The structure of the plasma membrane was very well achieved too. Candidates were not able to distinguish between Bryophyta and Coniferophyta.

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

Section A

For the most part, students were able to describe trends in data. Nevertheless, many candidates did not fully read question 1(a) and did not find trends that were “common” to both Yanomamo and Ache women. Instead they described the trends as individual lines. Many candidates could do the mathematical applications (including an understanding of standard deviation) very well but forgot units, so lost the marks. Many candidates struggled to evaluate the data in terms of the Grandmother Hypothesis (Q1e), and found Q1f equally challenging. The idea that a genetic trait that gives an advantage to a group of individuals will be selected for was often overlooked. In question 2, Students found it difficult to identify the processes causing movement of molecules, in this case osmosis and active transport posed difficulties for many candidates. Many students did not know that the transport of sodium ions was through active transport. In the case of facilitated diffusion, the role of channel proteins was not fully understood. In question 3b the candidates misunderstood 'greatest energy content' (selected) rather than 'greatest variation in energy content' (required). Students could describe features of alveoli very well but did confuse membranes for thin cell walls. In other cases they wrongly stated that alveoli were covered in mucous. Q4c was the weakest part of question 4, as students had difficulty in using scientific terminology when explaining how the structure of capillaries relates to their function.

Section B

Very few candidates obtained full marks for section B. Long answers, with very poor knowledge, was observed in many of the cases. Different processes were described, instead of the required ones, for example genetic engineering instead of DNA profiling.

Candidates appeared to be very well prepared in the areas of cell study and human physiology, as well as effects of global warming in the arctic.

In question 5b) the ratio aspect of the surface area/volume ratio was often ignored leaving a focus on changes in surface area only. Links to cellular heat loss and mitosis were usually omitted. In 5c) concerning the protein digestion, full sequence of protein – polypeptide–aminoacid–new protein rarely followed through.

Many candidates seemed to really know protein synthesis and biotechnology information, trying to work that into questions 6b and 6c even though marks were not given for that information.

Many candidates attempted question 7, but the responses for 7a) and 7b) were weaker. In particular, Q7a) proved to be very difficult and many candidates failed to score marks, as factual knowledge of the differences between phyla of plants was lacking, or comparisons were not made. Q7b) had many incorrect statements, and many very vague responses regarding global warming.

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

Interpreting the data presented in questions, whether simply reading values from a graph or performing simple calculations using those data, was typically well done - although an unfortunately high number of candidates still lost easy points by neglecting to include units in their answers. Recognizing structures (e.g. cell membrane components, or macromolecular components) was typically well-handled. In short, questions requiring "draw", "describe", "outline" actions - simpler cognitive challenges based on knowledge recollection rather than more difficult analysis or synthesis tasks were well answered. Most of the questions related to macromolecules were answered satisfactorily.

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

Question 1

1a) Most students responded well to this question and gained a least one mark. Many of the candidates referred to each society, instead of making reference to common features of both. Trends were sometimes difficult to identify, mentioning numerical data instead.

1b) Most of the candidates estimated correctly the percentage of both physiological systems.

1c) Most candidates got two marks for this question although many were not good at distinguishing between important ideas and less important ideas i.e. that the menopause might bring about a alteration in the decline rates of the cardiac and breathing systems (an important idea) and that both systems decline to different end points, for example (a less important idea)

1d) Having to do a calculation involving slightly uncertain numbers seems hard for students, they like to have mathematical calculations clear cut. Candidates failed sometimes for not being neat in reading the graphs, therefore not falling within the proper range, or by forgetting to write the correct units next to the numerical data. Some who thought (and reasonably enough, in absence of any other data) that time spent foraging was not a reliable measure of foraging skill or effectiveness, and so performed the calculation using the low values in each group, implicitly assuming that the really skilful foragers would obtain their daily food in the shortest time, not the longest time.

1e) This was hard as many were not clear on how to answer the question, many had good ideas, but translating this into an answer than was biologically accurate proved challenging. Such analysis, of being able to evaluate and idea, is a high level skill which only the most able students are able to carry out. Many candidates could identify that post-menopausal women (group III) did most of the foraging but not many candidates went beyond this. The idea of post-menopausal women sharing food and teaching the younger generations did not even occur to most candidates.

(1f) Again many got the wrong idea in answering this question as there were a number of levels of understanding needed to answer it correctly i.e. how does natural selection work for humans, what would give humans a selective advantage, what would an early menopause mean for women and why would this help pass on such genes. Time after time students made the claim that post-menopausal women would pass on the genes (for foraging skill, not early menopause) to their granddaughters, clearly revealing the rote quality of their understanding of evolutionary processes.

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Question 2

Candidates misinterpreted 2a(ii) as diffusion rather than active transport.

Question 3

b) Mean values compared i.e. 'greatest energy content' rather than use of standard deviation to compare variation in energy content (required). In many cases, the data was described rather than compared.

Question 4

4a. (i) Many struggled to answer this question. Candidates found identifying sites of absorption difficult, largely due to the awkwardly worded stem. Many students did not receive marks for referring to glands, without specifying that they were endocrine.

(ii) Named organs were mentioned and did not obtain the mark.

(iii) Most of the candidates obtained the mark for this answer.

4b. The most common reason for not scoring properly was that membranes were mentioned instead of walls, so they did not obtain that mark. The answers were rather incomplete, and in many cases only a list of characteristics was given.

4c.Many candidates often missed points by assembling lists of attributes rather than responding to the specific question asked. Most were able to correctly identify one or two required features of capillaries.

Section B

Question 5

5(a) Most candidates correctly answered this question with diagrams that were well done and appropriately labelled. If one or two labels were incorrect many candidates still had at least 5 correctly done. In most cases, the incorrect structure of cholesterol was drawn or they did not label carbohydrate part of glycoprotein. A common error was the peripheral protein drawn embedded in hydrophobic region.

5(b) Many candidates could describe how surface area and volume changed as a cell gets bigger but they did not mention how the ratio between the two decreases. Many candidates understood surface area to volume ratio with increasing size, but were unable to relate this to 'limiting cell size' which was needed in this question. As well, many candidates did not understand what happens to the metabolic activities of the cell when the ratio changed. They wrote about this in general terms but did not go into specifics in terms of food/oxygen entering and wastes leaving the cell via the surface and having a larger volume means longer diffusion time.

5(c) This question is of higher order since it required information not only form digestion (human physiology), but also proper mode of absorption and assimilation which was lacking in most of the responses. Many candidates incorrectly wrote that proteins are broken down directly into amino

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acids in the stomach instead of polypeptides. Most candidates did mention the importance of the villi in the small intestine.

Question 6

6(a) Most candidates correctly answered this question with diagrams that were well done and appropriately labelled.

6(b) Many candidates did this question well; most candidates did not mention that DNA samples are taken from the crime scene, the victims and the suspects however; they only mentioned suspects. Many of the candidates were not fully familiar with the actual technique involved in DNA profiling; this might be due to lack of exposure of students to the laboratory working with steps involved in DNA profiling.

6(c) This was one of the tough questions for most of the candidate since candidates thought "one gene one polypeptide" scope was only up until explaining the DNA-Gene-codon-polypeptide, most of the students did not mention the involvement of transcription and translation and exceptions to one gene one polypeptide hypothesis. In other cases, candidates went into great detail to explain transcription and translation (which was not asked for) and completely forgot about the purpose of the question.

Question 7

7(a) Many answered this question very poorly. They did not identify bryophytes as mosses, liverworts or hornworts instead they identified them as angiosperms. They could write about conifers but not distinguish between the two.

7(b) The knowledge of consequences of a global temperature rise on arctic ecosystems tended to be very general and simplistic (certainly not specific enough). Many candidates wrote in great length about how the polar bear population is decreasing but forgot to mention any other consequence of global warming on the arctic ecosystem. As well, many candidates incorrectly wrote about increasing sea levels as this applies to all coastal ecosystems not just the arctic. Many candidates believed that penguins were arctic.

7(c) Many candidates drew graphs about population change and described in great detail how populations change from the exponential growth phase to the transitional phase and lastly the plateau phase but forgot to answer the question.

Recommendations and guidance for the teaching of future candidates

- Candidates should be taught how to write answers that reflect the direction of the ‘Command Terms’ pages 11 and 12 of the guide. Many of the candidates had difficulties with responding appropriately to the command terms: more than often they had the knowledge but didn't recognize what was being asked. In many cases the candidate’s answer was accurate enough, but just wasn't addressing the question asked. "Compare" as a command term needs to be recognized as needing direct (often, paired) comparisons to obtain each point, not triggering unconnected lists of attributes. "Distinguish between" calls for pair-wise differences (not similarities), but often doesn't get them. "Explain" is another challenging command term, which needs to be recognized as needing cause-and-effect connections in each component of the response to be awarded points. Too frequently the candidates would seize on the key terms in

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a question as a cue to write out everything they could recall on that general topic, in hopes of producing something to trigger awarding of points. This would often generate paragraphs, even pages, of sensible and accurate information that failed to address the intended thrust of the question, and therefore consumed time and effort without any concrete reward. This sort of candidate might well exit the exam session thinking they had done well, and subsequently be astounded at their final course grade.

- Teachers should integrate the analysis of data in tables and graphs and calculations with units wherever possible throughout the SL course. Percentage calculations must be included.
- Candidates should practise constructing tables which make direct comparisons. This could also be done in a complete answer.
- Candidates should be taught how to thoroughly and carefully read the exam questions.
- Candidates should be aware that they are expected to write at least as many facts/clearly stated ideas as the mark value of the question, shown in brackets at the end of the question.
- Candidates should be shown how to write a plan/rough draft for a well-constructed answer, as an approach to writing organized answers. This is especially important for questions that start with discuss or explain. It is important for candidates to practise linking information in their answers. There is no need to repeat the question, since this takes up time and space. This would allow students to score the two quality marks.
- It is recommended that teachers emphasize the importance of legible handwriting. If a candidate's answer is correct but unreadable, the candidate may lose marks if deciphering the handwriting is impossible and the examiner misinterprets the script.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 9	10 - 12	13 - 16	17 - 21	22 - 25	26 - 36

General comments

Of the 217 G2 forms submitted, the vast majority thought that the paper was of a similar standard to that of last year, while a few though it was a little more difficult and a few thought it was a little easier. Of the respondents, the vast majority thought that the level of difficulty of the paper was appropriate while a few thought it was too difficult.

Clarity of wording was thought to be good by 58% and satisfactory by 45%. 74% thought the presentation of the paper was good and 27% thought it was satisfactory.

There were differences in the degree of difficulty presented by the different options. The data in Option B was somewhat harder to understand for candidates.

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As always Options A, E and G were the most popular. 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. Surprisingly, some candidates attempted more than the required two options, and some questions were still left unanswered.

It should be noted that this paper was prepared to be e-marked. Students should be made aware that it is essential to write inside the boxes or on additional answer sheets only as examiners will see scans of these areas.

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

Answering questions calling for analysis, explanations, and calculations seemed to be the areas which proved more difficult to all candidates. Also, writing good definitions and knowing the difference between discussion and list or outline was an area of difficulty for many candidates. Few candidates were able to write concise answers. Candidates do not always read the question correctly and this can mean they get no marks for that question.

Options C and F seemed to provide the greatest challenge. The data in B proved difficult for many candidates.

Some candidates are still not responding to the command terms “explain” or “discuss” appropriately. The former needs explanations Discuss” needs a balance of arguments. Few candidates scored well on A3(b) where they were required to discuss ethical issues concerning animals and animal products.

The levels of knowledge, understanding and skill demonstrated

Although there has been some progress, many candidates still have trouble reading graphs and using that information to make a calculation or to explain the results and its probable meaning.

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

Option A: Human nutrition and health

Question 1

The data in A1 was well understood by most candidates who were able to analyse the data in and connect the amount of chewing to absorption. In A 1 (b) Many students failed to analyse the data and only repeated the statement in the stem. In A1 (c) Most candidates identified the fact that chewing releases more lipids for absorption, but few realized it was because chewing breaks cells.

Many candidates had difficulty evaluating the importance of the data and connecting it to weight control in A1 (d).

Question 2

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A2 (a) was well answered by most, and in A2. (a) Most candidates mentioned monounsaturated and polyunsaturated and some cis and trans. In A2 (b) The majority of candidates explained the importance of fibre in the diet with in-depth explanation, although some candidates gave answers without biological jargon, such as "fibres clean the guts". In A2 (c) Many candidates gave very long answers talking about the dangers of the fats associated to proteins (for example in beef) but did not make reference to the dangers of a protein-rich diet.

Option B: Physiology of exercise

A relatively small number of candidates answered this option, but those who did generally achieved well.

Question 1

(a) Most answers were correct. In B1 (b) Almost all answers were correct, although some candidates failed to place the units, thus lost the mark. In B1 (c) Almost all answers were correct, although some candidates failed to place the units, thus lost the mark.

(d) Most candidates realized that the purpose of a control in this investigation was to compare the effect of lactic acid on the samples. Some candidates believed it was to see the effect of potassium.

(e) Although stated in the question, few candidates made reference to the graph. There were only a few good answers to this question.

Question 2

(a) Most answers were correct. In B2.(b) Most candidates recognized that increases in tidal volume and ventilation rate during exercise help in the removal of carbon dioxide.

(c) Few candidates were able to explain how muscle contraction causes changes in cardiac output during exercise. Some did mention an increase in blood carbon dioxide concentration.

Question 3

(a) Only a few candidates were able to evaluate the effectiveness of dietary supplements containing creatine phosphate in enhancing performance. Most recognized its use in the production of ATP and that it is only useful in exercise involving intense bursts of energy, but most failed to see the negative effects on the body. In B3(b) Most candidates were able to distinguish between a sprain and a torn muscle.

Option C Cells and energy

A relatively small number of candidates answered this option, but those who did generally achieved well.

Question 1

(a) Most candidates had this answer correct. In C1 (b) there were many good answers.

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In C1 (d) Most candidates explained the change in activase activity at temperatures higher than 42 °C by the denaturation of the enzyme. In C1 (e) Most candidates failed to analyse the data, they simply described the information on the graph without making any prediction.

Question 2

(a) Most answers were correct. In C2 (b) Very few candidates were able to outline the importance of polar and non-polar amino acids in proteins. In C2 (c) In general candidates did know how non-competitive inhibitors work.

Question 3

(a) Most candidates knew the parts of the mitochondrion. In C3 (b) The question was either very well answered or the answers were very vague.

Option D: Evolution

Question 1

In Option D Candidates had little trouble with the data presented in this question and D1 was well answered, though in D1 (d) (i) Many candidates scored full marks in this question, although some responses did not indicate why natural selection would favour the ability to escape.

Question 2

D2 (a) was well answered. In general candidates identified the ways in which comets may have affected the early Earth, although some candidates mentioned inorganic molecules instead of organic.

(b) Most candidates did know how organic compounds may have been synthesized in deep-sea hydrothermal vents in the oceans.

Question 3

D3 was reasonably answered by most candidates, though many answers in (b) were vague.

Option E: Neurobiology and behaviour

Question 1

(a) and (b) Almost all candidates had correct answers. In E1 (c) Most candidates deduced it was the lunar cycle affecting both events. In (d) In general answers were correct, where candidates recognized an innate response to the lunar cycle, but most failed to give a reason for this. In (e) Most candidates mentioned the temperature could affect the survival of offspring.

Question 2

(a) and (b) Almost all answers were correct. E2 (c) was well answered. E2 (d) was answered in very vague terms; there was a lack of biological language.

Question 3

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Most candidates were able to outline the development of birdsong.

Option F: Microbes and biotechnology

Few candidates answered this option.

Question 1

(a) Most candidates scored full marks in this question, although some omitted units. In (b) Most candidates were able to interpret the graph properly. In (c) the question was well answered, although some candidates failed to evaluate the data and only repeated information obtained from the graph.

Question 2

(a) The answers to this question were very vague. Most candidates only mentioned that studies of rRNA provided evidence for a new classification. For (b), most candidates answered this question correctly, and in (c) (i) and (ii) almost all scored full marks.

Question 3

(a) Most candidates knew that reverse transcriptase catalysed the production of copy DNA from RNA, but few recognized that this was a way to exclude introns. In (b) Most candidates only scored one or two marks in this question as they only explained that bacteria are used to transform organic matter. No further detail of the process was provided.

Option G: Ecology and conservation

This seemed to be an easy option this time. The graphs were straight forward and candidates on the whole responded well to it in G1.

Question 2

Almost all correct answers, mainly food supply and competition. For (b) candidates were able to draw and label the energy pyramid. In some cases the bars were not at least one third of the size of the previous bar, therefore scoring no mark for the drawing. For (c) In general, answers were correct.

Question 3

(a) Many candidates did not know how plants affected the environment in a primary succession. (b) Many incorrect answers. Some candidates invented examples of biological control. In some cases, the candidate mentioned an invasive species and then a different example of biological control. In (c) Most candidates could define biomagnification.

Recommendations and guidance for the teaching of future candidates

- The importance of the command terms cannot be overemphasized. Comparisons require comparatives (more, greater, fewer than….etc) or a clear table to distinguish differences (or

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similarities if relevant). Similarly “evaluate” a hypothesis requires information that supports or refutes it and the candidate must state as such, not just regurgitate data from the question.

- Candidates should read the questions carefully. This may seem obvious, but there are always candidates for whom this seems to have not happened.
- More practice at answering questions that require the candidate to discuss or explain should be given. Invariably suitable examples are required in these questions - specific examples the candidates don't seem to have.
- Many candidates run out of space for their answers – it is not a requirement to write full sentences nor is it necessary (or wise) to rewrite the stem of the question. Pertinent phrases that make the point are often better. Try to get candidates to avoid restating the words in the question because they will gain no marks.
- Similarly explain to candidates why occasionally arbitrary units are used in expressing data.
- Teachers should integrate the analysis of data in tables and graphs and calculations with units wherever possible throughout the SL course. Percentage calculations must be included.
- Candidates must practise drawing the diagrams given in the subject guide. Attention should be given to accurate labelling, juxtaposition of structures and relative size.
- It is recommended that teachers emphasize the importance of legible handwriting. If a candidate’s answer is correct but unreadable, the candidate may lose marks if deciphering the handwriting is impossible and the examiner misinterprets the script. This is especially the case now that scripts are scanned for marking.

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