Biology TZ1 (IBA)

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 16	17 - 30	31 - 41	42 - 53	54 - 66	67 - 78	79 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 16	17 - 32	33 - 44	45 - 55	56 - 68	69 - 79	80 - 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

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

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

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

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.

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

- 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.

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

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.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 16	17 - 21	22 - 25	26 - 30	31 - 34	35 - 40

General comments

More than 90% of teachers who commented on this paper felt that the level of difficulty was appropriate. Most felt that it was of a similar standard to last year and of those who thought the standard was different, more felt that it was easier than more difficult. This was reflected in the statistics for the paper, with the mean raw mark two higher than in May 2011.

About 3% of teachers thought that the clarity of the wording was poor but 97% felt that it was satisfactory or good. All teachers felt that the presentation was satisfactory or good. The statistics show that the paper was a very effective test, with most questions discriminating well or very well between the weaker and stronger candidates.

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

In many cases the questions on this paper performed as expected and no comments are necessary, so this report will focus only on the comment-worthy questions.

The paper began with three questions in which large numbers of candidates showed good knowledge, so there was less discrimination than with most other questions.

Question 4

In question 4, more candidates than was expected thought that prokaryotes have mitochondria and so chose answer A.

Question 7

Question 7 discriminated effectively between the stronger and weaker candidates, but the question was criticised by teachers for testing a small piece of factual knowledge. The curriculum review currently underway is responding to this by increasing the emphasis on understanding and reducing the emphasis on memorisation of specific facts.

Question 8

Question 8 was answered relatively poorly by candidates. There was a concern expressed by some teachers that C was a correct answer because RNA primers formed during DNA replication have uracil paired with adenine in the template DNA strand. In fact this was the least popular answer and candidates can reasonably have been expected to choose answer B as the best response. Substantial numbers of candidates chose A and D, showing weak understanding of replication.

Question 11

Question 11 was not popular with some teachers. Like question 7, it was felt to depend solely on a memorised fact, in this case the specific mutation that causes sickle cell anemia. This knowledge is specified by the programme, so could have been expected, but ideally answer C should have been slightly different so that it could have been eliminated using understanding.

Question 12

In question 12, answer B was chosen by an unexpectedly large number of candidates. Perhaps these candidates rejected answer A because they misunderstood the term genetic code. This term is sometimes used to mean the base sequence of genes in a genome, whereas the correct meaning is the correspondence between each of the 64 codons and the amino acids into which they are translated.

Question 13

Question 13 was the least effective on the paper in terms of discriminating between the candidates, which is unusual for a genetics question. Teachers raised a variety of objections to it. The statistics suggest the problem was that some good candidates chose C rather than D. To answer the question correctly it was first necessary to read the second sentence carefully and deduce from it that brown mice are homozygous recessive because they were used in the test cross. Answers A and B could then easily be eliminated. Answers C and D needed to be carefully considered. C should have been rejected because four offspring are too few to be sure that the black mouse was homozygous. There is a one in sixteen chance of getting four black offspring from a cross between a heterozygous black mouse and a homozygous brown recessive. On the other hand, answer D is undoubtedly correct. To cope with this type of question, candidates need to understand the difference between the possible outcomes of a cross as shown in a Punnett square and actual outcomes, which cannot be expected to correspond exactly with Mendelian ratios.

Question 16

Question 16 raised some interesting issues about the nature of science. The expected answer was B. The IB programme uses global warming as an example of the precautionary principle, because anthropogenic carbon dioxide emissions are not yet proven to be the cause of the enhanced greenhouse effect but we should not wait for this proof before responding. It could be argued that in A, C and D we do not have proof of causation so again the precautionary principle could be invoked but the evidence of causation in each case is very strong –arguably stronger than with the cause of enhanced global warming.

Question 17

Question 17 was an unusual question as D, which might have seemed to be a rather feeble distracter, was the answer. The candidate was expected to realise that we need to know the size of natality, mortality, immigration and emigration, to be able to work out the overall change to the size of the population.

Question 19

Some teachers pointed out that in question 19, answer C is correct for a small proportion of the cardiac cycle at the start of ventricular systole. There is an isovolumetric phase when both the atrio-ventricular and semi lunar valves are closed and contraction of the ventricles causes a very rapid pressure increase. However, D was much the best answer. Most candidates chose it and the question discriminated well.

Question 22

Question 22 was answered relatively unsuccessfully, indicating gaps in candidates' knowledge of the structure and function of motor neurones.

Question 26

Fewer than half of candidates answered question 26 correctly. Many thought that a competitive inhibitor of an intermediate enzyme in a pathway would prevent any final product from being formed. This is not likely because whatever the quantity of inhibitor, the substrate of the inhibited enzyme would still sometimes manage to bind to the active site and there would be some final product. The expected answer was that the substrate of the inhibited enzyme would accumulate.

Question 28

There was a small typographical error in a column heading of the table in Question 28 but this did not seem to affect candidates' answers and more than 80% showed good knowledge of the numbers of ATP molecules produced and used in glycolysis.

Question 30

Question 30 was answered relatively poorly. Many thought that ATP is produced during the light independent reactions of photosynthesis, perhaps through misreading the question as light dependent reactions. Even more candidates thought that ribose reacts with carbon dioxide during the light independent reactions. Perhaps these candidates were thinking that the abbreviation RuBP means ribose bisphosphate, rather than ribulose bisphosphate. In assessment statement 8.2.5, the name of this chemical is given in full in the teachers' note and the abbreviation in parentheses, so the full name should be taught. Abbreviations of chemical names can be very ambiguous and in most cases Higher Level students should be familiar with the full name, not just the abbreviation.

Question 33

Question 33 was the one that candidates found hardest on the whole paper, with fewer than 25% answering it correctly; below the expected level if candidates had all guessed the answer! The most popular choice was B, which was incorrect because it implies that the chromosome number is halved in the second division of meiosis not the first. The stage of meiosis in which the chromosome number is halved is not specified in any of the assessment statements, probably because it was thought to be obvious. The first division of meiosis is the reduction division. In humans for example, it results in the formation of two nuclei, each with 23 chromosomes consisting of two chromatids. The second division of meiosis results in four nuclei, each with 23 chromosomes consisting of a single chromatid.

Question 34

Question 34 was based on assessment statements 2.5.6 and 5.4.6. More candidates than expected chose crossing over and independent assortment as the cause of variation in both sexual and asexual reproduction. Mutation was the expected answer.

Question 37

Some teachers criticised 37 on the grounds that synovial fluid both lubricates the joint and supplies glucose and oxygen to the cartilage. Nearly 95% of candidates chose the former answer, which was the expected one. As a result this question hardly discriminated between the candidates.

Question 38

Only about a third of candidates answered question 38 correctly. All of the distracters attracted substantial numbers of candidates, suggesting rather weak understanding of the topic of ADH secretion and collecting duct permeability to water.

Question 39

In question 39, substantial numbers of candidates thought that calcium ions form cross bridges between actin and myosin filaments during muscle contraction. The expected answer was that they move the molecules blocking the myosin bonding sites on actin. Teachers need to be aware that some You Tube clips on this topic are misleading and of course all material taken from the internet should be treated with circumspection.

General advice

Candidates should be advised to read all of the four possible answers to each question even if they think that A, B or C are correct. It could be that two answers are at least partially correct, in which case the best answer should be chosen.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 18	19 - 25	26 - 35	36 - 44	45 - 54	55 - 72

General comments

This paper met with general approval from most of the 139 teachers or schools who submitted a G2 form. Nearly all respondents indicated that the paper was at the appropriate level of difficulty and most believed that it was of a similar standard to last year's paper. Of those that thought that the standard was different, rather more were of the opinion that the paper was easier this year than last than thought it more difficult. In places the mark scheme was more demanding this year so that the mean mark was in fact lower. The majority of respondents felt that the clarity of the wording of the paper was satisfactory or good. Only 4% thought that it was poor. All respondents thought that the

presentation of the paper was satisfactory or good, with 65% thinking it good.

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

- The distinction between ozone depletion and the enhanced greenhouse effect
- Molecular biology techniques used in gene transfer
- Differences between gene and chromosome mutation

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

- The characteristics of stem cells
- Enzyme inhibition
- In vitro fertilisation

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

Section A

Question 1

With a total of 15 marks and no marks allocated to factual recall, this was as long a data-based question as is ever set in HLP2. As usual, the poorest candidates tended to score most of their marks here and candidates who had prepared very well for questions requiring knowledge but were less strong at analysis of novel data were occasionally caught out by some parts of this question.

(a) The unusual circular form of the graph made it more difficult to read off the value for the largest number of dolphins in a single survey and only about two thirds of candidates did this carefully enough to earn the mark.

(b) There was quite a lot to do here; three values had to be read from the graph and then a mean value calculated. Again about two thirds of candidates scored the mark.

(c) There were plenty of valid comparisons for candidates to make and most scored two marks. Some candidates failed to understand that the results are merely sightings of dolphins and not total population counts; they therefore incorrectly implied that the population size varied considerably during each season.

(d) (i) Candidates found this question more challenging and in some cases it was clear that they had not studied the data carefully enough. As in all compare questions, the answer should make genuine comparisons and not describe the two things separately, in this case the winter and summer distributions. Some candidates did not understand that a population is a number of organisms and a distribution is where those organisms live.

(ii) A huge variety of suggestions for the difference between the summer and winter differences was given by candidates and many of these answers were considered valid. The answer could have been based either on possible differences in dolphin behaviour between summer and winter for example breeding, or possible differences in the environment such as water temperature.

(e) Answers were in many cases weaker than expected. Most candidates stated that as mass increased, the LCT_w of make dolphins decreased, which earned one mark. The difficulty came in earning the second mark. The mark scheme gives a variety of other points that can be made, for example that the individual dolphin with the lowest mass had the highest LCT_w or that above 187kg there does not seem to be much if any further decrease in LCT_w. Many candidates seemed to realize that to get the second mark they needed to give more than the negative correlation but then merely restated the correlation in different phraseology.

(f) Any possible reason for the high LCT_w in females was accepted, though not simply that she was older –some reason for higher LCT_w in an older female was required.

(g) Candidates found this question hard and the examining team had some sympathy with them as there isn't very much basis in the data for evaluation of the hypothesis. The most effective answers concentrated on the graph of mass against LCT_w as this shows that the metabolic rate of dolphins will have to increase if dolphins are in cold water. Some candidates realized this, but few then went on to comment on the small sample size or the fact that this data was obtained with dolphins in captivity and that in the wild there could be a different trend.

(h) This was expected to be an easy and high scoring question, but many candidates struggled with it and revealed gaps in their understanding of the data given earlier in the question. It is important to read all of the text in a data-based question, as it places the data in context and often gives information without which the data cannot be understood properly. In many cases candidates based their answer on faulty understanding. For example, a surprisingly large number decided that Cape Hatteras was on the equator and that to find cooler water dolphins could move north or south. No detailed geographical knowledge was needed to score two marks, but geographical misunderstandings did not help. The answer expected in advance by the examining team was that the dolphins population would move north in response to global warming to find cooler water. It was given be a minority, but other valid answers were accepted.

(i) This was another question that elicited a wide variety of responses. Only answers that referred to research benefits were accepted, not those referring to other benefits such as dolphin conservation.

Question 2

(a) All but the weakest candidates were able to name an enzyme involved in DNA replication.

(b) This question discriminated very well with the best candidates writing authoritatively about Okazaki fragments, but weaker candidates struggling. Some teachers felt that the word role was inappropriate here, but any answer explaining that Okazaki fragments are formed on the lagging strand because nucleotides can only be added in a 5' to 3' direction would have scored both marks. A common error was to refer to the lagging strand as the antisense strand. This is not correct -on a DNA molecule the lagging strand is the antisense strand for some genes and the sense strand for others.

(c) (i) and (ii) About half of the candidates knew that the transcribed strand is the antisense strand, with the others either getting the strands the wrong way round or thinking that the mRNA was either the sense or the antisense strand. When asked in part (ii) to show where the next nucleotide will be added to the mRNA strand the weakest candidates labelled various places other than an end of the mRNA; of the other candidates, more than half labelled the right hand end, whereas the left hand was the 3' terminal so that is where the 5' end of a nucleotide would be added.

Question 3

3(a) This question could perhaps have been worded more clearly as many candidates described the electrical stimulation of contraction of the atria and ventricles of the heart. What was required was a description of how the rate of beating of the heart is controlled, as in assessment statement 6.2.4, with the teacher notes for that statement giving all the points that were expected.

(b) This was answered more successfully, with many candidates explaining that heart valves prevent backflow and giving details of specific valves. Few candidates explained that pressure differences on the two sides of a heart valve cause opening and closing, but it was still possible to score two marks without including this.

4(a) *In vitro* fertilization was understood well by many, though some answers were too vague to score some of the marks. The main area of misunderstanding was over what is put into the mother's uterus. Many candidates thought that it was fertilized eggs or zygotes and others thought that it was blastocysts. The latter was accepted as they are at least embryos, but much older than the stage usually implanted; embryos at the four cell stage.

(b) (i) and (ii) Many candidates were able to identify X as a Sertoli cell, but not all could then state the function correctly.

(c) This is a question that has often been asked but it is still an area that many candidates find difficult. Crossing over and independent orientation have sometimes been awarded marks in previous papers, if the terms are stated without any understanding of them being shown. In this paper the stage of meiosis was also required or some details of what the processes involve. As a result many candidates scored one mark only or none. Candidates should be encouraged to develop deep understanding of biological processes and not merely learn names; this will very much be the focus of the new IB Biology programme currently under development.

Section B

Question 5

(a) The types of carbohydrate referred to in this question were structural. Candidates who outlined monosaccharides, disaccharides and polysaccharides, with examples of each were able to score the marks quite easily. Those who classified carbohydrates according to function without any reference to structural differences did not fare so well.

(b) The examining team adopted a broad interpretation of the meaning of this question, as it would have been difficult to sustain an answer of its literal meaning beyond a few marks. Many candidates wrote good answers, explaining both the need for digestion and the relationship between hydrolysis and digestion.

(c) This was well answered by many of the stronger candidates, with detailed accounts of competitive and non-competitive inhibition. The only common omissions were end product inhibitors and examples of each type of inhibitor. Although not specifically requested in this question, examples are always worth including and are often rewarded with marks.

Question 6

(a) The characteristics of stem cells and their uses were generally well known. Almost all candidates mentioned that they are undifferentiated cells and that they can differentiate in different ways. Some distinguished pluripotent from totipotent stem cells which was impressive. Fewer candidates than expected mentioned the ability of stem cells to divide repeatedly. Some candidates who were struggling to find much to include in their answer wrote extensively about the ethics of stem cell research, which was not required.

(b) This was answered more poorly than expected. The examining team was anticipating thorough accounts of gene transfer using reverse transcriptase, restriction enzymes, plasmids, sticky ends and plasmids but few of these were seen. In many cases the techniques were not well understood, with errors and omissions in candidates' answers. The word splice was often used to mean slice or cut, when it actually means linking together. One use of this word before the days of molecular biology was the act of joining the ends of ropes by weaving together their strands –this image might help candidates see the word splice is used for joining together fragments of DNA using sticky ends and DNA ligase.

(c) Despite an apparently narrow focus, this was one of the better answered questions in Section B. Most candidates at least knew that Down syndrome is due to trisomy of chromosome 21. The best answers included details both of how karyotypes are prepared and also what can be learned from them. The weakest candidates mostly wrote in vague terms about testing for genetic defects and did not appreciate the difference between gene and chromosome mutations.

Question 7

(a) This question was based on assessment statement 9.1.3, which includes the relationship between the structure of the leaf and its role in gas exchange. All that was needed was an outline of the structure of the spongy mesophyll, guard cells and stomata, in relation to the diffusion of carbon dioxide into the leaf and oxygen out. Scores were typically poor, with many candidates missing the basic points. More candidates for example for example seemed to state that CAM plants open their stomata for gas exchange at night than that most plants open their stomata in the day.

(b) Scores were mostly much better in this part of the question, with nearly all candidates at least mentioning warming due the enhanced greenhouse effect and an example of the abiotic and biotic consequences. The cause of the enhanced greenhouse effect was less well understood, with vagueness about what is causing carbon dioxide levels to increase and other greenhouse gases often not mentioned. There was considerable confusion, as so often, between ozone depletion and the greenhouse effect. It is easy to assume that candidates will be able to distinguish between these two phenomena easily and that little teaching is required, but all those who marked this exam will know that careful teaching is very much required.

(c) This was another area of relatively poor understanding, perhaps because weaker candidates tended to choose question 7. A basic minimum was to know that light intensity, temperature and

carbon dioxide concentration are the three main limiting factors of photosynthesis. Many failed at this first hurdle, omitting one or more of the main three and including instead pH, water availability or various other biotic and abiotic factors. Perhaps some candidates were confusing enzyme activity with photosynthesis. What was required for each of the three factors was a clear statement of the relationship between the level of the variable and the rate of photosynthesis, ideally by means of an annotated sketch graph, and then some details of the reasons for the rate of photosynthesis changing as the level of the variable changed. A common misconception was to say that the rate reduces at higher temperatures because of enzyme denaturation when in fact the rate reduction occurs at much lower temperatures than those at which this would happen. The problem at higher temperatures is due to RuBP carboxylase failing to fix carbon dioxide effectively.

Question 8

(a) Answers were variable here with some exemplary accounts but also some very vague ones. Weaker candidates tended to omit the idea that homeostasis is control of the *internal* environment. Some candidates suggested instead that it involves a person controlling their external environment. There was also some confusion between homeostasis and response to external stimuli such as touching a hot object.

(b) There were some relatively easy marks to be earned here but even so answers ranged from zero to five. A persistent area of confusion is vasoconstriction and dilation. Fewer candidates than at one time now write about blood vessels moving closer to the skin or further away but some still suggest that it is capillaries in the skin that actively constrict or dilate, rather than the arterioles that serve them.

(c) There were some long and detailed answers to this part of the question, although the eight marks could be scored in relatively short answers if they were confined to the processes in the kidney that vary depending on the condition of the blood. There was no need to write about ultrafiltration in the glomerulus or selective reabsorption in the proximal convoluted tubule. Processes occurring in the loop of Henle should have been mentioned, but only so as to explain how they establish hypertonic conditions in the medulla and allow the production of hypertonic urine. The main focus of the answer should have been on how the secretion of ADH is regulated and how this hormone controls the rate of water reabsorption in the collecting duct.

Recommendations and guidance for the teaching of future candidates

- Examiners try to ensure that all the text in a data-based question gives the candidate relevant information and that irrelevant material is edited out. Candidates should therefore be encouraged to read all the text including the stem of the question, the axis legends of graphs and the key to symbols on the graph.
- Candidates should also read structured questions; one word can make all the difference when it comes to understanding what is being asked.
- In Section B it is often useful to include examples of what is being described in an answer.
- Illustrations of answers such as drawings, diagrams, flow charts and graphs can be valuable but they should be incorporated into the main body of an answer and not be confined to a separate section at the start or end. Candidates should ensure that

illustrations are fully labelled or annotated or they rarely make a point clearly enough to be awarded a mark.

- Although examiners will read all parts of candidates' answers even if they are continued on extra sheets of paper, the space allocated in the boxes for answers is almost always enough. If long extensions to answers are given, the candidate has probably not interpreted the scope of the question correctly. It is therefore best to fit the whole answer for a question into the box provided.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 15	16 - 20	21 - 25	26 - 30	31 - 40

General Comments:

The comments on the G2 forms indicate that the vast majority of respondents felt the paper was of a similar standard to last year's paper while some felt it was easier and some more difficult. As for the paper's level of difficulty, 94% felt it was at the appropriate level of difficulty with the remaining 6% evenly split between thinking it was too easy or too difficult. The clarity of the wording was found to be suitable or good by 99% and all of the respondents felt the presentation of the paper was suitable or good. Teachers' comments are all considered at the Grade Award Meeting and all teachers are encouraged to fill out the G2 Form at the end of each examination session. The actual percentage of teachers who do this is improving although it is still very small.

Option D was the most commonly chosen option. Option E, G and H were all frequently chosen. Very few chose Option F. It was positive to see fewer candidates attempting more than two options than have done so in the past.

The areas of the programme which proved difficult for candidates

Many found the longer response questions (Q3) difficult and did not have sufficient depth of knowledge to answer these. Instead, candidates wrote vague generalities that did not earn marks.

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

Topics which proved difficult were:

- Cultural and genetic evolution (which has been on this list in previous examination sessions)
- Photoautotrophic and photoheterotrophic microorganisms
- Good named examples of how both species benefit in a mutualistic relationship
- *In situ* conservation

- myoglobin

The level of knowledge, understanding and skill demonstrated

Some candidates produced very good scripts and it was obvious they had been given sufficient time and instruction to cover the options thoroughly. They were able to both analyze the data in Question 1 as well as indicate their level of subject knowledge in Questions 2 and 3. They were able to demonstrate an impressive knowledge and understanding.

However, many scripts indicated only a superficial knowledge of the options.

Many candidates were better at the data analysis questions as Question 1 for each option did not require recall of facts. Interpretation of graphs and identification of trends was generally strong.

One area of difficulty continues to be the interpretation of the command verbs and thus knowing what precisely is required to answer accurately. 'Evaluate' and 'compare' were often problematic. Many candidates are simply listing whatever facts they can remember and not really looking at what is being required to answer the question asked.

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

Option D: Evolution

This was the most popular option again this examination session.

Question D1

(a) Almost every candidate was able to identify 1972 as the year with the highest frequency of the melanic form of *O. bidentata*.

(b) Many obtained one mark for correctly estimating the percentage of non-melanic moths in 1978.

(c) This part proved more discriminating. For (i), many candidates obtained one mark for indicating that in all species, melanics showed a decline. However, most did not compare the trends but simply stated what was happening for each of the three moth species over time. They also did not connect the fall in percentage melanics with a rise in percentage of non-melanic forms of the species but instead incorrectly stated that the species number fell. For (ii) many were able to suggest the trends were due to a change from the polluted environment to a cleaner one for one mark but did not get a second point.

Question D2:

(a) Some were able to get one mark for indicating that RNA is self-replicating or catalytic.

(b) The first section (i) was poorly answered. Some knew they were to use the Hardy-Weinberg equation and thus earned one mark. The question asked for the frequency of phenotypes but many of those who did the calculation gave the frequency of genotypes instead.

Almost all could give one correct condition for the use of the Hardy-Weinberg equation in (ii).

(c) The table was given so that candidates could easily distinguish between analogous and homologous structures clearly but some still did not compare like points.

Question D3:

The question on the contributions of cultural and genetic factors in recent human evolution was very poorly answered. There was the comment on G2 forms that this was beyond the assessment objectives but this is clearly given in D.3.10 and links with TOK. While many candidates were able to get a couple of marks for general information on cultural evolution, most did not look at recent genetic evolution as indicated through changes in allele frequencies but instead looked at the fossil record and trends in early hominid evolution. Candidates did not clearly indicate what genetic and cultural factors were and many vaguely wrote about differences they were familiar with in our present multicultural society.

Option E: Neurobiology and behaviour

This was a popular option and candidates tended to score well on it.

Question E1

(a) Almost all candidates were correctly able to identify the lowest head circumference measured in high cocaine users.

(b) Many were also able correctly state that the relationship shown was a positive correlation.

(c) Many were able to get one mark for using the data to describe the relationship between cocaine use and head circumference but few received a second mark.

(d) There was a similar response to this section as to part (c).

Question E2:

(a) Many gave vague answers to this section and did not make reference to the role of the environment or experience in distinguishing between the two types of behaviour. Candidates should not describe ‘learned’ behaviour as that which we learn.

(b) A surprisingly large number of candidates incorrectly stated that the coordinates balance.

(c) Candidates did surprisingly poorly on this simple task of naming the structures of the ear. Structure IV was often incorrectly named. It was unclear why so many indicated that these were the bones of the middle ear as this is indicated in E.2.6.

(d) The better candidates were able to get 3 or 4 marks for comparing the effects of the sympathetic and parasympathetic nervous systems but many simply stated that one had an effect in ‘flight or fight’ responses with no other details which was insufficient for marks.

Question E3:

There were many good responses to this question with many candidates earning 5 or 6 marks. There were however, an almost equal number who wrote generalizations and gave anthropomorphic attributes to bees.

Option F: Microbes and biotechnology

This was the least popular of the HL options but it was encouraging to note a few more schools studying this option with some good standards seen.

Question F1:

(a) Most were able to correctly state that coliphage viruses were more resistant to heat treatment than the bacteria.

(b) Many were able to correctly compare the effect of the heat treatment on the coliphage viruses and bacteria and earn two marks.

(c) Only some were then able to discuss whether the treatment should be continued beyond 60 minutes.

(d) Many were able to suggest one, but seldom two, possible consequences of the release of sewage into rivers although the brighter ones did earn two marks for a variety of consequences.

Question F2:

(a) The definition of epidemiology was very poorly done, as was true of most definitions.

(b) Many candidates were able to correctly indicate that the diagram was of a Gram-positive bacterium and why.

(c) It was surprising that many candidates did not get the two marks for listing two roles of microorganisms in the environment as this was very basic.

(d) Many candidates did not seem to know what photoheterotrophic microorganisms were and therefore could not accurately compare them with photoautotrophs. Very few earned marks on this section

Question F3:

There were some very complete answers to this question about the cause, transmission and effects of malaria. However, this is not only a disease of poverty as many indicated.

Option G: Ecology and conservation

This was a popular option again this session.

Question G1:

(a) (i) Almost all candidates correctly indicated that tank 6 had the highest quantity of algae but many incorrectly stated in (ii) that tank 6 had the lowest mercury accumulation in *Daphnia*. Tank

6 has the least difference between the two measurements of mercury accumulation but the lowest level was in tank 4.

(b) While many candidates were able to get one mark for stating that increasing phosphorous decreases mercury accumulation in *Daphnia*, few were able to get a second mark in this outline question.

(c) The better candidates were able to get two marks here by suggesting increased phosphorous concentrations led to algal blooms which absorbed the mercury and the result of this on mercury levels in *Daphnia*.

Question G2:

(a) Most were able to correctly identify the trophic levels for one mark. Some were able to correctly give the predicted energy levels as roughly 10% of the previous level although some indicated that only 10% was used or lost so that 90% went on to the successive level. Few drew a good pyramid of energy diagram.

(b) Again, the definition was not clear and concise in most cases.

(c) Many candidates were able to get two marks by indicating different characteristics of r- and K-strategies.

(d) Although there were so many possible answers to this question on mutualism, there were few really good responses seen. Candidates were vague on the organisms involved and vague concerning the benefits each received from the relationship. Candidates seemed to rely more on common knowledge than biological information.

Question G3:

This question was very poorly answered by the majority of candidates with many confusing *in situ* with *ex situ* conservation. Those that did understand the concept could not really 'discuss' the advantages of it clearly and were vague in their responses; thus few received more than 3 marks.

Option H: Further human physiology

This was a popular option and candidates tended to score well on it.

Question H1

(a) Although the majority of candidates correctly indicated the time for the diameter to return to the original value, a sizeable number incorrectly indicated 49 minutes. This was the time from the start of the experiment, not the completion of exercise (which was at 40 min).

(b) Many candidates were able to gain two marks by indicating that both showed exercise induced dilation of the artery but that the increase was greater in non-smokers. The third mark was harder to find for most. The results did seem somewhat equivocal, so no marks were awarded for comparison of 'back to normal'.

(c) This part of the question was not done very well. Although a reasonable number were able to obtain one mark, usually for the arteries of non-smokers being more flexible than those of smokers, few received two marks.

Question H2:

(a) Many understood the role of the valves in causing the heart sounds although few referred to changing pressure in the heart causing this to occur.

(b) This was fairly well done with most candidates obtaining one mark and a very good number receiving two marks for products from the breakdown of hemoglobin.

(c) Although this table seemed very straightforward to fill in, many candidates wrote vague responses, incorrectly said that pancreatic juice worked in the pancreas and listed incorrect substances in the spaces for the enzymes in each digestive juice.

(d) Almost all were correctly able to list one material egested; usually cellulose was the reply.

Question H3:

There were variable responses from very poor to very good. Many could draw the oxygen dissociation curve of myoglobin correctly although many had it looking vaguely sigmoid. Many understood that myoglobin was found in muscle, was used for oxygen storage and that it had a higher affinity for oxygen than hemoglobin. Few could actually discuss its saturation with oxygen or its release of oxygen in active muscles.

The type of assistance and guidance the teachers should provide for future candidates

- As has been noted before, sufficient time should be allotted for the teaching of the options. Teachers should choose the two options according to their own strengths so that the candidates benefit by the knowledge and enthusiasm of the teacher.
- The options should not be left for self-study. It needs to be ensured that candidates acquire the depth of knowledge required to be successful on this paper. Discussing topics in general does not help.
- Where the syllabus asks for an unspecified example, such as the example of mutualism in Option G, teachers need to ensure that this is covered.
- Teach students how to use tables when comparing or distinguishing between two things so that they make a point by point comparison.
- Stress the need to be accurate as the examiner can only mark what the candidate has written and cannot assume anything about knowledge or understanding.
- Use the command terms in homework, tests and exams to make candidates familiar with the question stems so that they understand what is required of them when they are asked to ‘describe’, ‘compare’, ‘evaluate’ or ‘explain’.

- Practice interpreting data in different formats. Use scientific journal articles and past paper data analysis questions throughout the two-year programme to develop this skill. Encourage candidates to look deeper into the data to identify features they may not see at first glance.
- Use past examination papers and mark schemes as well as the CD Question Bank to provide suitable questions so that candidates are familiar with the examination format.
- Give guidance on the appropriate length of answers as candidates should not write as much for a 1 mark answer as they do for one worth 6 marks.
- Candidates should know that they answer in the spaces provided and that the number of lines is a guide to the length of answer expected. They should not repeat the question. They can continue to write a few sentences below the lines but within the box rather than use so many continuation sheets.
- All teachers need to attend workshops periodically to keep themselves up-to-date on the IBDP Biology programme.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 10	11 - 14	15 - 18	19 - 22	23 - 26	27 - 30

General comments

Of the G2 forms submitted by the time of grade award, 48% thought that the paper was of a similar standard to that of last year, while 23% thought that it was a little easier. 96% of respondents thought that the level of difficulty of the paper was appropriate. Most teachers thought that both clarity of wording and presentation were satisfactory to good. There were many discriminating questions on the paper, and questions 5, 8, 13, 25, 28 and 30 had many candidates leaving them blank.

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

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

Question 4

This question was a good discriminator, which was testing two elements of understanding, those of the condensation process and where in the cell amino acids are assembled into polypeptides. Just over half of candidates gave the correct answer of C, with many being drawn to B, the Golgi apparatus.

Question 5

Although this question discriminated well, a large proportion of candidates chose option B instead of the correct response of A (endocytosis). It was thought that perhaps students had been drawn by the connection of osmosis and the word “fluidity” in the question.

Question 9

Although this question was only an average discriminator, almost as many candidates picked option A as those who chose the correct answer, B. Also a large number picked D. There was a concern expressed by some teachers that C was a correct answer because RNA primers formed during DNA replication have uracil paired with adenine in the template DNA strand. In fact this was the least popular answer and candidates can reasonably have been expected to choose answer B as the best response. Substantial numbers of candidates chose A and D, showing weak understanding of replication. It is felt that students need to understand and be able to apply the concepts of semi-conservative replication, rather than simply committing the points to memory.

Question 11

Some G2 feedback suggested that option A was the best answer to this question, and although many candidates chose this, it is wrong, as the wording of the question clearly states “during both aerobic and anaerobic respiration”. Furthermore, it was felt that the use of the word “produced” had not presented a problem to the candidates.

Question 13

This question was perhaps not as fair as it could have been, as it did require candidates to remember difficult details about specific amino acid sequences. However, it was the fourth most difficult question on the paper, and it did discriminate well.

Question 15

Three quarters of candidates gave the correct response of A. G2 feedback suggested that information about the man’s parents should have been given, but this in fact formed the basis of the question.

Question 17

Comments on the G2 forms suggested that the question was poorly worded, and this may be a legitimate point. Many candidates picked option B (same genetic material) rather than A (same genetic code), but it was felt that the word code is precise and often used too loosely by students. It does have a different meaning to “material”.

Question 20

There was a comment on the G2 forms that this question could be answered by either C or D. Many students chose C, but it is not a valid statement, and candidates need to appreciate the concept of insufficient data when drawing conclusions.

Question 22

This question was testing candidates’ ability to apply their knowledge about evolution. Many chose option C, which is describing Lamarkism and so is good distracter statement.

Question 27

This question presented a different way of comparing blood vessels, since students often compare arteries and veins, rather than capillaries, so it was an indirect assessment of the structure of the three types of blood vessel. Many candidates picked options A or B, but overall the question discriminated well.

Question 30

Interestingly this question had the greatest number of blank responses, and more than a quarter of those who did answer chose option C. This would seem to suggest that this is a difficult topic for many students. The question was a good discriminator.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 15	16 - 21	22 - 26	27 - 32	33 - 37	38 - 50

General comments

Of the 84 G2 forms submitted, 40 thought that the paper was of a similar standard to that of last year, and 81 respondents thought that the level of difficulty of the paper was appropriate.

Suitability of the question paper in terms of clarity of wording was judged to be good by 41 and satisfactory by 41. In the overall presentation of the paper 61 thought that it was good, while 23 thought that it was satisfactory.

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

Section A

In general, the data analysis questions were more difficult for most candidates than the short answer questions which involved recall. All given information must be considered when formulating answers to data based questions. In Q1(d), some candidates could not identify a relationship between body mass and LCT_w. In Q1(e), candidates had particular trouble in evaluating the hypothesis. They didn't mention evidence to support or refute the hypothesis. Few talked about sample size or reliability of data. Poor answers in the two "suggest" questions, Q1(c) and (g), may have resulted from careless reading of the questions. This was obvious again in Q3(c) where many candidates overlooked the word "nucleotides" and simply gave any differences between RNA and DNA. Two of the greatest gaps of knowledge on the entire test appeared in Q4(b) where evolution had to be defined and Q4(c) which required an explanation of how sexual reproduction promotes variation in a species. In both cases, answers were often incomplete or vague so that full marks were rarely achieved. There was poor understanding of evolution, natural selection, and variation within a population. Lamarckian language was prevalent. Candidates were challenged to explain sexual reproduction in cellular and genetic terms.

Section B

In general, candidates should choose essays where they can answer all parts and they should write different points to get more marks.

Among the essays, Q5 was least popular. In part (a), almost nobody mentioned the meaning of the prefixes mono-, di- and poly- in describing the types of carbohydrates. In part (b), candidates offered shabby descriptions of hydrolysis and poorly linked it to digestion, sometimes never! Examples of the hydrolysis of carbohydrates, proteins and fats were often missing. In part (c) discussion was usually restricted to transfer of energy from plants to primary consumers and then to secondary consumers. Other important points about energy, e.g. its conversion during photosynthesis, the idea that is not recycled, its loss as heat through respiration, and its use by decomposers were usually overlooked.

In Q6, weak candidates generally know something about stem cells in part (a). However, serious difficulties arose in part (b) where incorrect examples, such as sickle cell anemia, were cited as a sex-linked condition. Answers which correctly identified hemophilia or colour-blindness often lacked clarity when inheritance of the sex-linked disorder was described. In part (c), karyotyping was often confused with forensic investigations where DNA profiling using PCR is used as evidence in crime or paternity cases.

In Q7(a), superficial outlines of homeostasis often led to only 1 or 2 marks of credit. In part (b), description of how body temperature is maintained was frequently limited to the role of sweat release for cooling and shivering for warming. Finally, in part (c), as they explained the need for a ventilation system, many candidates failed to include any reference to respiration in body cells and the role of the bloodstream. Explanations of how the lungs are ventilated were generally the better half of the question.

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

Section A

Generally, the successful candidates could extract information from the variety of data that was presented. This included correlating the geographical map with the bar graph and the table of contents with the distribution graph. Most consistent achievement was seen in Q2(a) where students knew differences between plant and animal cells and in Q2(b) where simple diffusion across membranes was understood. Question 3, devoted entirely to DNA and RNA, was frequently well answered. In part b, sometimes despite dreadful diagrams, some candidates gained the maximum of 3 marks. This occurred because of a generous mark scheme for part b. In Q4(a) many candidates knew that global warming might cause loss of habitat for organisms in arctic ecosystems.

Section B

Many candidates provided better structured answers than in previous years.

In Q5(a), monosaccharides, disaccharides, and polysaccharides were usually mentioned as the types of carbohydrates found in living organisms and appropriate examples were given.

For stronger candidates, Q6(a), describing stem cell characteristics and use, was an easy source of at least 4 of 6 available marks. In Q6(b), a few scripts had beautiful outlines of the inheritance of hemophilia. Also, stronger candidates did well on Q6(c), explaining the use of karyotyping in genetics. Their answers addressed both the construction of karyotypes and their purpose. Sometimes the number of details provided exceeded the maximum of 8 marks.

In Q7(a), well prepared candidates not only accurately defined homeostasis but also embellished their answers with an appropriate examples and reference to maintenance through negative feedback and hormonal/nervous control. In Q7(b), strong answers for how body temperature is maintained included the role of the hypothalamus in monitoring and the effects of vasodilation and constriction of skin arterioles . Finally, well prepared candidates knew the specifics of how ventilation occurs in their answers for Q7(c). The workings of the internal and external intercostals muscles and the diaphragm during inhalation and exhalation were thoroughly explained.

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

Section A

Questions 1 and 4 involved more analysis and explanation and students struggled; questions 2 and 3 involved more raw knowledge which was easier.

Question 1

1(a) Most answers were correct, although some gave the highest overall number in winter.

1(b) Many candidates recognized the more even distribution of dolphins in summer than in winter and that more dolphins congregated near Cape Hatteras in winter than in summer. Some candidates just quoted data. Instead of saying “many” dolphins they would state a number and let the reader interpret the meaning.

1(c) By far, the most common answer identified seasonal variation in food supply or water temperature. Some candidates did not earn the mark because they had no reference to season. In 1(b) candidates had been asked to compare the distribution of dolphins in summer and winter and in 1(c) they were asked to suggest one reason for the differences in distribution. It was expected that some reference to seasonality would accompany any answer in 1(c).

1(d) Candidates frequently gained a mark by answering that as dolphin mass increases their LCT_w drops or vice versa. However, once again, some candidates simply quoted numbers from the data without ever generalizing a relationship between mass and LCT_w. A few candidates correctly answered that dolphins above 185 kg had no change in LCT_w with increasing body mass. Uncertainty due to small amount of data was never answered. This was a link to IA investigations and exposed a lack of critical thinking.

1(e) Candidates usually gained only 1 of the 2 available marks by stating that the hypothesis was supported because water temperature affects metabolic rate or that dolphins will avoid areas with water below their LCT_w. However, some candidates didn’t understand the command term evaluate and others did not understand the meaning of LCT_w.

1(f) Some strong candidates were able to gain both marks in one sentence by stating that dolphins may migrate further north to cooler water/suitable temperatures. Another common answer was that dolphin distribution became spread out. However, most candidates gained only 1 of the 2 available marks.

1(g) Basically, this question asked how research would benefit from international cooperation. Candidates simply had to mention that data can be collected over a larger area or more data could be collected and shared. Many candidates misread the question and described how international cooperation would benefit the conservation of dolphins or environmental protection or even end global warming. Such inappropriate answers lost what should have been an easy mark.

Question 2

2(a) Most candidates knew structural differences between plant and animal cells. Answers usually mentioned that chloroplasts and cell walls exist in plant cells but not animal cells. That plants have chlorophyll and animal cells do not was unacceptable since chlorophyll is not a structure. Unless the wording was careless, some shocking misconceptions were revealed when candidates wrote that “plant cells have cell walls while animal cells have cell membranes” or that “plant cells have chloroplasts while animal cells have mitochondria.”

2(b) An easy 2 marks were gained my many candidates who mentioned that membranes are permeable/porous to allow diffusion and that diffusion is movement of particles from high to low concentration. Many candidates stated that diffusion happens without the need for energy instead of without the need for ATP.

2(c) Most candidates stated that active transport goes against the concentration gradient and requires ATP. Unfortunately, some candidates thought protein pumps produce/provide ATP and some confused change in the shape of protein pumps with exocytosis and endocytosis. Though candidates did give the example of the sodium potassium pump, they did not mention that protein pumps are specific for the solute/molecule they transport.

Question 3

3(a) Most candidates had no problem identifying the phosphate group and deoxyribose in a diagram of a DNA nucleotide.

3(b) Although many drawings were dreadful in appearance, at least three marking points could be found to earn maximum credit. Surprisingly, the nucleotide diagram that appeared in the previous question was not used by many candidates as the first nucleotide in their DNA drawings which eventually had to show four nucleotides arranged in a double strand connected through two bases.

3(c) Astute candidates who spotted the word “nucleotide” in the question earned an easy two marks by stating that RNA nucleotides contain ribose and uracil whereas DNA contains deoxyribose and thymine. Those candidates who thought in terms of a helix talked about single and double strand molecules without earning any mark. In this question, names were expected rather than letters to identify the nitrogenous bases.

Question 4

4(a) Most candidates performed well here, but a significant number of candidates lacked the appropriate vocabulary (habitat, competition, and extinction). Some poor answers focused on the effect of warming on the environment rather than the organisms in the arctic. Others focused only on the problems posed for polar bears. Answers that did not earn credit were release/increase in greenhouse gases, rising water levels, and references to animals "dying out" which was vague.

4(b) Given the pivotal position of evolution in biology, it is disturbing that so many definitions missed the mark. Candidates who did well were familiar with the Teacher's notes in the Biology syllabus (p. 66) which accompany A.S. 5.4.1. The concept of change in the heritable characteristics of a population was often expanded to include adaptation through natural selection. Others candidates expanded their answer with the idea of species arising from pre-existing species. Candidates who performed poorly did not specify change in terms of heritable/genetic characteristics. Many weak answers stressed mutation rather than natural selection as the basis for adaptation.

4(c) Among all candidates as a group, every marking point for the question about the promotion of variation in a species through sexual reproduction was eventually awarded. However, most candidates could only produce one or two creditable ideas in their answers. Most common was the involvement of two parents leading to new genetic combinations which cause variation in offspring. Many candidates mentioned crossing-over and/or random orientation during meiosis. A few candidates mentioned random fertilization. Some weak answers talked about interbreeding of different species because the candidates misread the question and overlooked "in a species." Also, many candidates talked about the genes of an organism or adaptation of an organism when the discussion should have been on a species or population. Finally, some candidates mixed up meiosis with mitosis while other made irrelevant comparisons to asexual reproduction.

Section B

Question 5

5(a) Well answered except for the absence of understanding about the prefixes: mono-, di-, and poly- when preceding the word saccharide.

5(b) Candidates who did well understood that hydrolysis falls within the context of digestion rather than thinking that hydrolysis is synonymous with digestion. Their answers began with the notion that only small molecules can diffuse and be absorbed into the bloodstream and that hydrolysis is a step in the digestive process. Often those candidates went on to describe that hydrolysis requires water and gave examples of how polysaccharides or proteins are hydrolyzed to named sub-units. Even among stronger responses, lipid hydrolysis was not mentioned very often nor was the idea that hydrolysis is aided by enzymes. This question was an interesting link between Topic 3.2 and Topic 6.1

5(c) The best answers started out with the sun as the ultimate source of energy and how light energy is converted to chemical energy through photosynthesis by autotrophs/plants. This led naturally to how energy passes from one tropic level to the next. By including that energy transfer is only about 10% efficient and that it is not recycled, candidates gained the max of 8 marks. Some candidates included pyramids of energy. Less commonly mentioned was the loss of energy through metabolic heat or that decomposers obtain energy from waste products, dead bodies/leaf litter. Only the rare candidate mentioned how energy flow is measured in energy per unit area/volume per unit time.

Question 6

6(a) Many candidates knew that stem cells retain the capacity to divide and can differentiate into different tissues. It was frequently mentioned that stem cells can replace damaged cells and form a variety of tissues. Candidates knew about medical applications for stem cells such as in treatment for leukemia and for growing skin to help burn victims.

6(b) Many candidates showed excellent knowledge about sex linked inheritance, using hemophilia as their example. Although many candidates gained the max of 5 marks, the importance of the X chromosome in sex-linked conditions was not always understood. There was a lack of understanding of "carrier" vs "affected." A few candidates gained marks with annotated Punnet Squares. For those who failed this question, there was an inability to explain the genetics of inheritance and the inaccurate choice of sickle cell anemia as the example. Some regarded alleles as chromosomes. There appears to be weakness in the learning of Topic 4 among more than a few candidates.

6(c) There were many strong answers to this question. The technique and the uses of karyotypes were well stated. Collectively, candidates answered all the marking points. Some candidates failed to point out the obvious e.g. XY is male and XX is female. Some candidates referred to Down syndrome as inherited on chromosome 23. Others did not use the term chromosome for the abnormality and referred to genes instead. As mentioned earlier in this report, karyotyping was confused with a variety of other laboratory procedures from DNA fingerprinting to gel electrophoresis.

Question 7

On question 7, candidates tended to score either high or low for the whole question. It was unfortunate that some did not read the whole question before beginning to answer it, as part (a) asking about homeostasis was followed by part (b) how body temperature is maintained. Candidates who answered (a) very thoroughly wasted time repeating themselves in (b). They may have been unconsciously drawn to the body temperature example of (b) when answering (a).

7(a) Most candidates could give an example of homeostasis, even though many of their definitions for homeostasis were incomplete. Errors included forgetting to mention "internal" and "within limits." The best answers included the concept of negative feedback and control through nerves and hormones

7(b) The majority of candidates had good knowledge of how sweating helps to control body temperature. They knew that sweat is released by the skin to cool an overheated body. In addition, some mentioned that heat removal occurs through evaporation of sweat. Since shivering, increased metabolism, and hair erection were all parts of one marking point, candidates were awarded a mark regardless of how many of these ideas were given. A common major misunderstanding involved the role of blood vessels. Too many suggested that blood vessels either moved closer or away from the skin surface for cooling or heating. Many candidates did not understand vasodilation and vasoconstriction of arterioles. Furthermore, terminology was restricted to blood vessels, veins or capillaries. Only the rare candidate used the term arteriole. Other pertinent ideas often missed included normal body in degrees °C or °F, distribution of heat by the

blood, and the importance of the hypothalamus with its thermoreceptors in monitoring body temperature and effecting needed responses.

7(c) Many candidates showed surprising command of the details in explaining the mechanism of ventilation. That understanding coupled with knowing the need for O_2 absorption and CO_2 removal was enough to gain most of the available marks. However, there were flaws. For example, the diaphragm was referred to as getting flattened or dome shaped with no reference to contraction or relaxation. The idea of the thoracic cavity increasing or decreasing was replaced with lungs increasing or decreasing with no reference to pressure. A number of candidates traced the respiratory system from mouth to alveoli. Some even included diagrams. All this was irrelevant since the mechanism of ventilation was not being addressed. The high surface area of the alveoli-capillary interface was not often mentioned nor was the high concentration gradient of O_2 in the alveoli and the importance of blood to deliver O_2 to respiring cells.

Recommendations for the teaching of future candidates.

- Candidates must always remember that relevant accurate detailed information will inevitably earns marks.
- Work on data based questions, particularly the interpretation of data, is most important. For example, candidates need more practice in evaluation of an hypothesis for given data. There is a large bank of questions available now from the accumulation of many years of IB exams.
- Candidates must read questions carefully and should look for KEY words. (Maybe key words should be underlined.) After completing their answer, candidates should re-read the question to ensure that their answer is really what the questions was asking.
- While practising exam papers from previous years is vital to the success of the candidates, there were occasions in Section B where a similar question had come up in a previous year and instead of reading the exact question in the current paper, the 'prepared' answer for the previous year's paper was used.
- Teachers need to see mark schemes so they know the level of response that is expected among candidates and then teach to that level so that candidates can earn maximum marks on a question. Candidates should learn to plan extended answers.
- Where it applies, candidates need to know correct sequences. This can be achieved by learning through point form.
- It is recommended that candidates prepare their own probable exam questions on various topics and develop accompanying markschemes. This style of active learning, coupled with peer review, can be a powerful learning strategy.
- Candidates must know how to respond to each of the command terms. These need to be constantly reinforced. This is particularly true for: discuss, explain, outline, compare , distinguish and evaluate. (For 'compare' questions, a table format is often an efficient answering method. The tables should describe what is present or absent for each item. In this May 2012 exam, candidates would say what structures were present in a plant cell but not that those structures were absent in an animal cell, there marks could not be awarded.)

- On exams, candidates should not repeat the question. Weak candidates that write too much often repeat the question and extend from the designated answer box to additional pages without gaining marks.
- Candidates should look at the number of marks available in a question and try to write more distinct relevant ideas than marks available.
- When choosing essay questions in section B, candidates should choose a question in which they can answer all parts reasonably well rather than another question where only one part can be answered well.
- Further attention should be given to terminology. This is especially true in genetics where terms such as recessive, dominant, carrier, affected, sex-linked and autosomal should be clearly known. When outlining a sex-linked condition, homozygous and heterozygous should be used and annotations must show carrier, normal and person with the condition. Elsewhere, energy is not synonymous with ATP or hydrolysis with digestion. In evolution, population and species are distinct. In general, correct use of key terms will help candidates improve clarity/avoid vagueness
- When drawing a diagram (such as DNA) candidates should be taught to fully label their diagrams, especially when asked to do so in the question! Drawings should be large and neatly drawn.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 15	16 - 19	20 - 24	25 - 28	29 - 36

General comments

Of the G2 forms submitted, 61% thought that the paper was of a similar standard to that of last year, and 96% of respondents thought that the level of difficulty of the paper was appropriate.

Suitability of the question paper in terms of clarity of wording was judged to be good by 56% and satisfactory by 42%. In the overall presentation of the paper 69% thought that it was good, while 30% thought that it was satisfactory.

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

The standard of performance showed a wide spread, but generally candidates demonstrated reasonable achievement, and there were also some very good answers seen. It seems that in centres where all the candidates attempt the same options, the standard of responses tend to be slightly better than when the candidates have more flexibility of choice. Pleasingly, the majority of candidates followed the rubric of the

paper and only attempted the required two options. However, it seems that in some cases, only the data response questions were being answered with the rest of the option being left unanswered, which is a little worrying.

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

Candidates seemed to have limited ability to respond to details accurately, and they were often weak in their responses to the command terms “evaluate”, “discuss” and “explain”. The commonest problem, which resulted in lack of credit for answers, was the inability of candidates to carry out these commands, with the majority of candidates listing things or processes without any further justification of the point being made.

They also frequently fail to give complete comparisons where questions require them to distinguish or compare, often giving only half the argument. This does not gain any marks.

Questions that ask for a drawing continue to be especially poorly done, and a large proportion of candidates did not even attempt to respond. The requirements for labelling or drawing and labelling diagrams are clearly stated in the appropriate areas of the syllabus, and it is surprising that this continues to be an area of weakness.

A number of examiners expressed concern about the apparent lack of basic knowledge of core aspects of the syllabus, suggesting poor preparation of students for the examination. Options D and E produced some of the weakest responses in this respect, with many candidates leaving blank spaces for fairly simple answers. Option B also seems to present difficulties for some candidates.

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

For the most part candidates were able to read the data and answer the associated questions, the majority gaining at least half marks on the data response elements of each option. Many were able to make some attempt at interpreting trends in the data given, although only the stronger candidates were able to make complete comparisons or draw valid conclusions from the information supplied.

Responses to the different options seemed fairly similar, so the paper appears to have been well-balanced amongst the options.

The level of subject knowledge was good for many centres, and it appeared that candidates had again been well prepared in options A and G. Candidates appear to have found the material more accessible and in general had fewer problems in understanding what was required of them. Option C was also generally well done.

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

Option A: Human nutrition and health

Question 1

(a) Most candidates gave the correct answer.

(b) The majority were able to identify the correct group of individuals.

(c) Most candidates could state that more females than males had iron deficiency anaemia, but many did not state that there was only a very small difference between males and females for B12 deficiency and folic acid deficiency.

(d) Many candidates gained the two marks, but there were a lot of vague answers which did not gain credit. Students do need to try and be specific when suggesting possible answers.

Question 2

(a) This was mainly well answered, but candidates needed to be precise in their points. The connection between preventing obesity by increasing bulk in the stomach is an obvious example of the need for complete statements.

(b) There were many irrelevant answers to this question and students seemed very unsure about the nature of vitamins and minerals. Some thought that vitamins are ions, and did not know the difference between inorganic and organic.

(c) This was the least well answered part of the option, with many students dwelling on detail of the genetics of PKU, when the question was about the effect of diet. No credit was given for such answers. Also, many thought that infants are born with the symptoms of PKU, which is not the case.

Question 3

(a) This was a “distinguish” question and so answers needed to give a comparison of the two types of milk. Many candidates failed to do this. However there were some excellent responses, with many giving the correct compositions of the two types.

(b) The benefits of breastfeeding appear to be well understood, with some many candidates gaining the three marks.

Option B: Physiology of exercise

Question 1

(a) This was generally correctly answered.

(b) (i) Comparative statements were needed in this part of the question, and many gained two marks. However, the fact that sprinters and hurdlers both had about 26% of other injuries was not commonly mentioned.

(ii) Many candidates did not appreciate that the pattern of injuries in hurdlers closely matched that seen in sprinters.

(c) This was a “discuss” question which was not well answered. The benefits of warm-up routines in preventing injuries was the important question, there is a lot of disagreement about such benefits, which candidates would have gained credit for saying. References to psychological effects were not accepted as this does not relate to prevention of injuries.

Question 2

(a) Many candidates gained one mark for identifying the type of joints, but few were able to accurately state the range of movements in each. Again, comparative answers were required.

(b) It seems that many candidates did not understand what was meant by “distribution of blood flow”. Many were commenting on the speed of flow, and few seemed to know that blood flow to the brain remains unchanged during exercise, or that flow to the abdominal organs is reduced.

(c) There were few accurate answers to this question, and not many students seem to know that EPO is naturally produced by the kidneys to stimulate red blood cell production. Some stronger candidates did suggest that its use has ethical implications, which is a valid point in a question asking students to evaluate its use.

Question 3

(a) The diagram of a sarcomere was very poorly drawn on the whole, with many bearing little resemblance to what was required. Those who did attempt a diagram often managed to gain a mark for showing Z lines, but little else. Quite a large number of candidates left this part of the option blank.

(b) This was also not well answered. It is a challenging topic, and proved to be a good discriminator for the more able candidates. It is obviously an area which students find difficult to understand. Very few could accurately describe the sequence of events in skeletal muscle contraction.

Option C: Cells and energy

Question 1

(a) This was mainly answered correctly with the correct units being given.

(b) Most candidates stated the process of respiration.

(c) (i) Many gained a mark for saying that release of carbon dioxide decreased as nitrogen addition increased, but few quoted any data from the graph to support their statement, so did not gain a second mark.

(ii) There were few correct answers here, but stronger candidates did suggest that there was decreased respiration of organisms resulting in less carbon dioxide production.

(d) Many answers did not compare the two areas in the forest, and those that gained one mark did not utilise the data accurately to gain a second mark.

Question 2

(a) This was answered well by most students, the majority getting two marks for the idea of loss/gain of electrons and loss/gain of oxygen.

(b) Many candidates had no difficulty in outlining the process of glycolysis and most gained three marks. Some of the weaker answers were too vague with few precise statements about the different stages and substances produced.

(c) The understanding of many candidates was a little limited in this question, and their answers were less well presented. Many had the idea of limiting factors, but few could express clearly the way in which light could affect the rate of photosynthesis

Question 3

It would seem that many candidates did not fully understand what was required in this question, and the meaning of the word ”significance” may have misled some students. The question was asking about proteins, but many answered solely in terms of membranes. Those who gained marks did so mainly for referring to the hydrophilic/ hydrophobic nature of amino acids and their ability to affect the tertiary/quarternary/3D structure of proteins.

Option D: Evolution

Question 1

(a) Most candidates answered this correctly.

(b) The majority of candidates estimated the correct percentage, but some gave the figure for melanic forms rather than non-melanic.

(c) i Many answers described the trends rather than comparing them, with a significant number failing to distinguish between melanic and non-melanic forms. Very few answers referred to the sharp decline in *B. betularia* shown for 1987 in the graph.

ii Candidates were required to suggest reasons for the differences in the trends and many gained a mark for the idea of a change from a polluted to a cleaner environment with some suggesting changing selection pressures on the moths.

Question 2

(a) Many candidates could not give an accurate definition of the term species, so few went on to discuss the limitations of such a definition with appropriate examples.

(b) Most answers gained two marks for giving a description of allopatric and sympatric speciation although few defined the process of speciation to begin with. Very few examples of the two types of speciation were given.

Question 3

(a) There were some good answers to this question, with many students quoting the Galapagos finches as an example. On the lighter side, some candidates thought that the question was referring to ways of adapting to radiation, having completely misunderstood the wording.

(b) This was not well done, and many scripts gave muddled, vague answers which showed little understanding of cultural evolution and its importance to humans. Those who gained any marks generally gave good examples of cultural evolution such as language, technology or agriculture.

Option E: Neurobiology and behaviour

Question 1

(a) The correct answer was given by most students with the correct units.

(b) The correct relationship between birth weight and head circumference was given by the majority of candidates, but the answer of "directly proportional" was not accepted.

(c) The data was perhaps more challenging to comprehend than the other options, and many students appeared to find it difficult. Most only gained one mark for making the connection between high levels of cocaine usage and decrease in head circumference in babies.

(d) Many answers were very similar to those given to part c), and few could express their ideas precisely and succinctly. The majority only gained one mark for suggesting that cocaine could cause a smaller head circumference. There were no suggestions that there might be other variables influencing the relationship.

Question 2

(a) Many candidates scored the mark for correctly outlining the difference between innate and learned behaviour.

(b) A surprising number of students were unable to label all four parts of the ear correctly, with the majority gaining only one mark. Few seemed to know the semi-circular canals.

(c) (i) There were some very good answers to this question, the majority did give comparative statements, and gained three marks. A few weaker candidates got the connections between the cells and the bipolar neurons the wrong way round.

(ii) This question was not appropriate for a standard level paper, and so was discounted. Marks were awarded in proportion to the total performance by the candidate in this option.

Question 3

(a) This question was generally well answered; the majority of students could accurately define a reflex. Some answers however, did not refer to the rapid nature of the response.

(b) There were few good responses to this question, and it may be because the order of the neurons was different to the usual format. Most managed to give the role of the relay neuron, but in the other two, there were no references to the CNS or to receptors/effectors, with answers being generally very imprecise.

Option F: Microbes and biotechnology

This was not a popular option, attempted by so few candidates that it is difficult to give more than brief comments about the various sections. Those who did attempt it left several parts blank.

Question 1

(a) The correct indicator was generally given.

(b) Those students who answered this mainly gained only one mark for saying that both bacteria and viruses were reduced in number.

(c) This proved to be very difficult for most, with those who attempted it only gaining one mark by mentioning possible cost factors.

(d) Most candidates could refer to algal blooms and eutrophication.

Question 2

All parts of this question seemed to prove difficult. In part (b), understanding of the nitrogen cycle was very poor for those who attempted it, and in (c), the concept of biomass seemed to be an unknown topic whilst some candidates did not know that methane was a fuel.

Question 3

(a)(b) Some candidates seemed to know about somatic and germ line gene therapy, but were not able to express their ideas in the answer. They also seemed rather confused about the ethics of their use. Those who did attempt this question could mainly give a named example in part b).

Option G: Ecology and conservation

Question1

Careful reading of the question stem should have made this a reasonably easy question, and many candidates grasped the key ideas behind the data response section some however seem not to understand or be able to use the concept of biomagnification.

(a) Both parts were mainly well done, although a number of candidates gave tank 6 in part (ii).

(b) This part had some answers where the analysis was superficial, with few gaining more than one mark.

(c) Many answers did not make the connection between Daphnia feeding on the algae and the smaller concentrations of mercury in the increased population of algae, which had been caused by higher phosphorus levels.

Question 2

(a) Few could draw an accurate pyramid of energy. Many scored two marks for the correct trophic levels and their associated energy values, but the proportions of the bars was generally totally out of scale. Each bar was expected to be no more than one quarter of the one below it.

(b) This proved to be another weak area, as not many candidates could define biomass correctly. Many did not refer to dry mass, and also often wrote about a single organism. The concept of biomass needs to be in terms of a group of organisms.

Question 3

(a) This question revealed much confusion about CFCs, with some dubious chemistry being offered by many. A significant number of scripts muddled ozone deterioration with global warming, often calling CFCs greenhouse gases. However, stronger candidates were able to gain maximum marks in this part.

(b) The idea of distribution of animals seemed to present difficulty to many students, and answers tended to be vague and simplistic. Although polar bears were frequently given as an example, few made the connection between external temperature, an animal's metabolic rate and it's ability to survive in different environments.

Many students had the idea of competition between animals for space and food, but again, many responses were inadequate, and often repetitive.

Recommendations and guidance for the teaching of future candidates

- Candidates need to learn the meaning of command words when answering questions, in particular evaluate, discuss, suggest and explain.
- Teachers can support candidates by highlighting the importance of responding with complete statements to questions asking them to compare or distinguish. Also, students must learn to explain things in a sequenced and orderly manner.
- Teachers should draw students' attention to the key definitions relevant to their option, and encourage familiarity with them in preparation for the examination.
- Teachers should remind candidates to read the data response questions very carefully and thoroughly, as they often contain important information that can help them with their answers. Students should be made aware that whilst their own knowledge and understanding is often asked for, sometimes key points may be found within the text provided. The laboratory programme (IA) is an effective way to develop data analysis interpretation skills.
- Teachers should stress the need for good quality drawings (with labels) of those structures outlined in the syllabus for their particular options, and provide students with the opportunities to practice this skill whenever possible.
- Candidates should be encouraged to familiarize themselves with the syllabus, so that they are aware of the coverage of topics in preparation for sitting the examination papers.