Biology (timezone 2)

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 16	17 - 30	31 - 44	45 - 56	57 - 68	69 - 81	82 - 100

Standard level

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

Higher Level Internal assessment

Component grade boundaries

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

General comments

Most schools used appropriate investigations of a good standard. A problem persists however in some schools that are setting investigations for assessment that give too much guidance or insufficient latitude.

In most schools the criteria are being applied rigorously but in a few schools the teachers seem to be ignoring the descriptors of the different aspects. In these cases the work had to be marked down.

Ethics

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

The IB does not wish to inhibit investigations but it does want to stimulate a responsible attitude towards experimentation on animals. Any proposed experimentation involving animals, including humans, should result in a discussion between teacher and student based on its ethical implications and how to refine the experiment to alleviate any harm or distress to the animal; to reduce the numbers of animals involved; or to ultimately replace the use of animals by using cells, plants or computer simulations; any call for human volunteers in experiments must be accompanied by a consent form. Investigations on human subjects must not place the volunteers at risk. Moderators are reporting investigations that are quite inappropriate for example the effect of smoking or alcohol on heart rate.

These rules equally apply to those student-designed investigations that are not intended to be followed through in a practical session. Some teachers and students 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 internetsites that will help here. Exposing them to caffeine, alcohol or energy drinks is not appropriate

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

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

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

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

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

Clerical procedure

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

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

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

Only a few teachers are not designing practical programmes with sufficient numbers of hours, however, some are overestimating 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 include students whose work is incomplete or transfer students where a substantial part of their work has been marked by another teacher.

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

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

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

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

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

The use of ICT in the areas of **1** Data logging, **2** Graph plotting software and **3** Spreadsheets is good.

The use of data logging in investigations now seems quite well established. In many schools the students (and teachers) seem to be at ease with their systems and they are being used more often in student-designed investigations.

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

Trivial, simplistic investigations that do not generate sufficient data to permit adequate assessment of data processing were sometimes used for assessment. Students are

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sometimes missing quite obvious conventional points (e.g. indicating uncertainties in their data) as well as limiting their processing to the calculation of a mean. Teachers are also missing these points and marking over generously. Occasionally moderators are surprised to find teachers point out the errors to their students and still give full marks.

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

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

Some schools need to make better use of databases and simulations to fulfil the ICT requirement. Simulations are also a weakness because what some teachers are calling simulations are often just animations.

Literature sources are not always 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 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	c; c; c = 6	c; n; c = 4

	their raw data and which variables to plot or process the data in a particular way.		
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

Candidate performance against each criterion

Design

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

· All students used the same design for a catalase lab leading the moderator to question how much guidance was provided.

· Although the independent variable was manipulated, the cell respiration was essentially the college board AP biolab with no independent changes to the protocol.

· In this same lab all of the students in the sample have the exact same research question. They all are comparing the fermentation of lactose, sucrose and fructose. The same issue is present with the reaction time lab. All of the students in the sample have done almost the exact same Design.

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

For example, if enzyme activity is the theme to be assessed for the criterion Design, there are a whole range of enzymes to choose from, enzymes from different sources, different substrates, different potential inhibitors, different limiting factors and different methods for determining the rates of reaction. When a moderator is confronted with a whole class that is investigating the same enzyme, from the same source, using the same independent variable and using the same method to determine its activity, then it is not surprising that excessive guidance might be suspected. The same problem has been observed in all the classic themes for Design such as transpiration, osmosis, photosynthesis, fermentation, surface area to volume ratio and bacterial growth.

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

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

The three categories of variable 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 often too simplistic. For example, the range of values of the independent variable was insufficient to establish a trend; the number of repeats was insufficient to permit statistical analysis. Testing the effect of pH on an enzyme using an acidic environment, a neutral environment and a basic environment will not establish an optimal pH.

Standard protocols will, no doubt, be used by the students when they design their investigations. We are not expecting them to re-invent the wheel. These standard protocols however must be 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, this is legitimate but 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. Why stick to the traditional potato? Try carrots, yams, cassava, apple sweet potato.

The two point discrimination test for touch receptors on the skin continues to be frequently used. All too often this ends up as a repeat of a text book classic when it is possible to give it a more original or personal approach. For example, 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 their own designs through. 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 (for example °C not °F and 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 not always clear whether they are referring to volume, mass or concentration.

Data Collection and Presentation (DCP)

A consistent problem relayed by 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 could be seen as collusion. Teachers who provide the students with a pre-formatted data table can expect their students to be moderated down.

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

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

- Data (raw or processed) that is inadequately presented (for example with superficial titles)
- Units missing in the table column headings (note: decimal units should be used)
- No uncertainties given in the column headings of tables of data collected using measuring instruments.
- Inconsistent decimal places in tables
- The decimal places did not correspond to the precision of measurements
- The absence of associated qualitative observations where they are valuable. For example an ecological field investigation is incomplete without some kind of description of the site used. This appears to be a common problem.
- Raw data plotted in graphs that do not actually reveal anything (Note: raw data can be plotted to derive maxima, minima, optimarates, intercepts or to reveal correlations)
- Raw data plotted when the mean should have been calculated and plotted (often the mean is actually calculated and then ignored by the student when plotting graphs)
- The absence of statistical treatment of the data when it was possible
- When statistical treatment is applied with no consideration of its appropriateness. For example calculating standard deviations when there were only 2 or 3 measurements
- No presentation of uncertainties in graphical data either by using trend lines or error bars or uncertainty ranges on the axes.
- The error bars, when used, were not explained.
- A majority are putting a linear line of best fit even when the data is clearly S-shaped or has some other non-linear pattern.

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

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

Conclusion and Evaluation (CE)

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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 always possible to evaluate the method.

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

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

Suggested modifications were sometimes superficial and yet marked over generously.

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

Manipulative skills

Evidence on the 4/PSOW forms indicates that students are being exposed to a sufficient range of investigations. This ensures that the manipulative skills can be assessed correctly. However, a large number of moderators notice that some schools are attributing 6/6 for the whole sample for this criterion. There is no discrimination between the candidates.

ICT coverage

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

Graph plotting using software was perhaps the easiest and most widespread for schools to apply. However the signs are that the students **still need to be taught the correct conventions of graphing.** There is still a tendency to use bar charts for everything amongst the weakest students, perhaps because it is the default setting of MS Excel. Bar charts are appropriate for data in categories but not for continuous variables where there are enough data points to establish a trend. Legends (keys) are not always necessary and students do not seem to know how to de-select them. When they are needed the students often have difficulty labelling them appropriately – students often present the different curves as "series 1" and "series 2" When the students used scatter plot, a trend line was not always used when it was appropriate. Note: joining the points dot-to-dot may be appropriate where the trend cannot be predicted. This can happen for series of measurements taken in field work.

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

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

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

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

The Group 4 Project

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

Recommendations and guidance for the teaching of future candidates

- Share the criteria with the students and explain them.

- Read feedback from the previous session and act upon it.

- Consult the Online Curriculum Centre (OCC) for teacher support material (TSM)

- Apply the internal assessment criteria rigorously.

- Give the students experience in identifying independent, dependent and controlled variables.

- Ensure that the open-ended theme that you set has enough scope to provide a variety of research questions for the whole class.

- Guide students away from repeating classic investigations or working on the same research question when they design their own investigations.

- Counsel the students on the safety issues, ethics and feasibility of the investigations they design.

- Be sure that investigations used for assessment produce <u>sufficient</u> quantitative data.

- Encourage the students to make additional qualitative observations about their experiment. It is good practice for them to keep a log book.

- Ensure that the investigations have the potential to generate sufficient data for substantial processing.

- Teach the students that plotting graphs of raw data is insufficient if nothing can be derived from them.

- Encourage the students to carry out research into the background literature both before starting an investigation and once the results are complete.

- Do not use simulations for assessment. Simulations used in conjunction with hands-on investigations producing "real data" are however to be encouraged.

- Do not use the Group 4 Project for assessment of D, DCP CE or MS. Only use it for Personal Skills. Inappropriate use will be sanctioned.

- Make sure that you are using the most up-to-date version of the 4/PSOW form (available from the Handbook of Procedures on the OCC).

- Check to be sure that all the parts of the 4PSOW form are completed correctly.

- Complete one 4/IA form signed by all the teachers for your school's sample and cross moderation between colleagues is essential.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 15	16 - 21	22 - 26	27 - 30	31 - 35	36 - 40

General comments

Of the teachers who responded on the G2 forms, 88% thought that the level of difficulty was appropriate, 85% thought that it was of a similar standard or slightly easier or more difficult than last year's paper. Some G2 forms indicated that some questions were far too simple such as Q4, Q8 Q 15, Q 16 and Q 22. 55% thought the clarity of wording was good. 82% thought the presentation of the paper was good.

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

Question 1
Some concern was expressed about this question by a few teachers as it was not indicated what was represented by error bars: range, standard deviation or any other indicator of variation. Nonetheless, the error bars clearly indicated that the data is most variable at 20 C. Further, for at least for 20 C, it is not the case that 'measurements at each temperature are very similar to each other.

Question 11
This question caused concern from three teachers due to the ambiguity of the term 'different' polypeptides-as in different with respect to one another or different with respect to the original DNA sequence. In such cases of ambiguous interpretation, students should be advised to read all possible answers. Choice D could then be recognized as unequivocally correct.

Question 13
Three teachers expressed concern over this question suggesting that it is not possible to rule out codominance. Codominance would be indicated as a third colour in the pedigree and all offspring of the first generation parents would need to be represented by the intermediate phenotype.

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Question 14

Two teachers expressed concern over this question arguing that both B and C could be correct. It is agreed that ruling out answer C is based on the subtleties of language as the data does not support the statement that definitively neither parent has the allele. C would only be correct if the statement said 'if neither parent has the allele'.

Question 16

Five teachers expressed concern over this question. They argued that the wording was confusing. However, looking at the statistics for the question, 85% of students answered this question correctly, suggesting that the students did not have difficulty with the question.

Question 17

Three teachers expressed concern over this question. Platyhelminthes having only one opening to their digestive tract is a distinguishing feature of most classes and can be arrived at through eliminating the other answers. Answer C was the most commonly chosen incorrect answer. Teachers are encouraged to review the distinction between radial symmetry and bilateral symmetry with their students.

Question 20

 Three teachers expressed concern over this question. A number chose answer A, suggesting that these students do not understand the concept of the myogenic origin of the heart beat. The role of adrenaline is required, so students should have been able to rule out response C.

Question 21

Four teachers objected to the wording of the question. 92.5% of students answered correctly so the wording did not appear to affect student performance.

Question 38

Eight teachers objected to this question. Student performance on the question was poor with only 30% answering it correctly. The choice of incorrect response was spread between responses A, B and C.   Students should have been easily able to rule out A and B as clonal selection is a clear part of the outcome. If students understand the clonal selection process correctly, then they would know that injection with an attenuated virus would result in polyclonal antibodies.

Question 39

Two teachers objected to the use of the term osmotic potential. 74% of students answered correctly. Knowledge of the meaning of the term can be inferred from the question.

Recommendations and guidance for the teaching of future candidates

Students should be encouraged to read all responses before choosing an answer. Students need clarification around the myogenic nature of the heart beat. They need to understand that it does not extend to changing heart rate. Students should work with models or images to help them understand the meaning of 5' to 3' directionality in replication. Students need clarification of the concept of clonal selection and polyclonal antibodies

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Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 8	9 - 17	18 - 28	29 - 38	39 - 48	49 - 58	59 - 72

General comments

Nearly 90% of teachers who submitted comments on G2 forms considered that the paper was of an appropriate standard, with the other teachers mostly considering it to be too difficult. Of the teachers who were able to compare the paper with that of last year, 50% thought that it was of a similar standard and the other 26% that it was a little more difficult and 12% thought it was a little easier. 55% thought the clarity of wording was good, with almost all the others thinking that it was satisfactory. More than four fifths of teachers reported that the presentation of the paper was good and all the other teachers judged it to have been satisfactory.

There was an error in the translation into Spanish, of Question 1g so an additional marking point was added for the Spanish papers to compensate for this.

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

There were no areas of the programme or examination that proved difficult for all candidates. In comparison to previous years, students were able to score well on most sections of the paper. Question 1a, 1c, 1f and 4a. were almost universally answered correctly.

There appear to be some gaps in students' conceptual understanding of the role of the pituitary hormones in the menstrual cycle, the details of the structure of the placenta, endocytosis and exocytosis, the role of water in the light dependent reactions, the effect of acid on enzyme function and the mechanism of sex determination in humans.

In data based questions, there is still some tendency for students to give descriptive responses to 'compare' and 'distinguish questions.

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

There was evidence of good preparation across a wide range of topics, with some candidates reaching very high overall scores. Almost all candidates showed at least reasonable data analysis skills in Question 1 and knowledge of genetics. In Section B prokaryote cell structure and glycolysis were mostly very well known.

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May 2013 subject reports

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

Question 1

This was well answered by most candidates.

a) Most were able to describe the overall trend

b) Most candidates successfully compared the two groups, though weaker candidates gave descriptive answers without using comparative terms

c) This was another question that was effectively answered though students tended to give descriptive answers

d) This question tended to differentiate in terms of preparation as better prepared candidates drew in a discussion of type 2 diabetes, reduced glycogen levels, higher blood sugar and sugar in the urine

e) Most believed that the data supported the conclusion that a difference existed. The lower mean and the lack of overlap was noted by most.

f) Answers were roughly split between both sugars suggesting that students had difficulty making the link that higher rates of uptake suggest higher rates of use.

g) Better prepared candidates could make the link between sugar levels, cell respiration and higher levels of cell division. A greater number of candidates indicated that pancreatic cancer was related to cell division rates.

h) Prepared candidates were able to draw in the link to fructose and type 2 diabetes. Fewer acknowledged that the link between cancer and fructose was difficult to establish. Most were able to summarize the data but fewer were able to make a link to health effects.

Question 2

a) i) Most wrote the correct genotype, though there were a surprising number that did not follow notation conventions such as writing HFhf or using linkage notation.
ii) The majority of students could answer this question. Where students were not answering correctly, it was due to a lack of conceptual understanding of segregation; i.e., writing gametes as HH or ff for example.
iii) This question was most commonly answered correctly.

b) i) Approximately half of students answered this correctly. A number did not recognize the condition for determining a female was the absence of the Y chromosome rather than the presence of the X chromosome.
ii) This was more commonly answered correctly than i). Here a common misunderstanding was that nondisjunction could only be present if additional chromosomes were present rather than if one were missing.

Question 3

a) Many students were able to state examples of conditions that led to increases in mortality. Better prepared candidates identified emigration as a cause of population decrease

b) A surprising number could not correctly link the events of meiosis to the correct phase indicating a lack of understanding of the necessary sequence of events. Many did not recognize that the second stage of meiosis also resulted in an increase of variety.

Question 4
a) Most students knew the correct definition of active site.
b) Better prepared candidates got full marks discussing induced fit. Chemical compatibility was discussed more rarely. Students had surprising difficulty describing the relationship between the shape of the substrate and the shape of the active site.
c) This question differentiated performance well. Many stated that acids denature enzymes. Better prepared candidates mentioned increased activity for enzymes with an optimum pH that was acidic. Better prepared candidates also referenced the altered shape of the active site.

Question 5
Overall, candidates performed very well on this question.
a) The diagram in 5a was well drawn by most. A number of students included eukaryotic structures in their drawings. Flagella were often drawn too short in relation to the overall length of the cell. Pilli were often poorly drawn being shown not connected to the cell. The diameter of ribosomes was often too large in relation to the rest of cell structures.
b) Many were able to outline transcription successfully. Some confused transcription with replication. A number referred to helicase as the enzyme responsible for separating and unwinding the helix.
c) Most scored well on part c of the question. An area of misunderstanding surrounds what happens upon second exposure to the antigen. It should be noted that antibodies are produced more rapidly and to a higher level.

Question 6
This was a popular question among candidates.
a) For part a, many did not earn full marks and this appeared to be due to a lack of knowledge of this part of the syllabus.
b) For b, many candidates easily earned the marks for parts d, e and f requiring them to identify examples of organisms that occupy the various trophic levels of organisms. A number lost marks due to poorly constructed diagrams especially in relation to the bars not being drawn proportionately. Few correctly indicated the correct units for productivity of the various trophic levels. Part c was generally well done. Most used the term homeostasis and negative feedback in their answers. A number have a misconception regarding vasodilation and vasoconstriction as they are writing that arterioles move toward and away from the skin surface. Few discussed the role of the hypothalamus in regulated body temperature.

Question 7
This was a popular question.
a) 7a, few completely related hydrogen bonding to surface tension. In discussing solvent properties, a number neglected to draw in that water performed best at dissolving polar substances. When discussing adhesion, students should have referenced the polarity of molecules.
b) In part b, many referenced the role of xylem. Many used terminology correctly in this section making reference to transpiration pull, cohesion, adhesion and the transpiration stream. The stages of water uptake that occur in the root was covered in less detail and with less accuracy in general.
c) Part c was in general poorly done as the question required students to discuss the role of water. The details of photolysis were often excluded as were the correct details of

chemiosmosis.

Question 8

Question 8 was the least popular question.

a) In part a, few discussed exocytosis and endocytosis. The distinction between simple diffusion and passive diffusion was often confused. Reference to aquaporins was rare. Discussion of osmosis was generally well done.

b) In part b, the knowledge of students was adequate. The challenge for this question was structuring the response to address the demands of the question as the events within the ovary had to be linked to the events within the uterus. The role of estrogen in developing the uterine lining was well known as was the role of progesterone in maintaining the lining. They were also reasonably successful in discussing the role of LH. Students were less commonly successful with discussing the specific actions of FSH and the regulation of hormone levels.

c) Answers to part c were adequate, though it was common for the use of terminology to be poor. Most candidates were able to identify the placenta as a disc shaped structure embedded in the uterine wall that was connected to the mother via the umbilical cord. Most showed adequate understanding of the types of material exchanged within the placenta. Fewer showed adequate comprehension of the mechanism of materials exchange between the mother and the fetus. Few adequately described the structure of the placental villi or the relationship between maternal and fetal blood flow.

Recommendations and guidance for the teaching of future candidates

There are a number of areas where teachers may want to focus their teaching to clarify concepts:

· The role of the Y chromosome in determining sex

· The process of non-disjunction such that students can recognize other examples other than trisomy 21

· The range of mechanisms plants use to store energy

· The mechanism of vasodilation and vasoconstriction

· The role of photolysis in the overall process of the light dependent reactions

· The specific actions of FSH

· The materials exchange mechanism within the placenta

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 12	13 - 17	18 - 22	23 - 26	27 - 31	32 - 40

General comments

Nearly 93% of the 134 teachers responding on G2 forms felt that the level of difficulty of this paper was appropriate, the others thinking almost equally that that it had been too easy or too difficult. When comparing the paper to last year's, approximately 61% of teachers thought the standard similar with slightly more thinking it was much easier or a little easier than a little more difficult. Nearly 74% of teachers felt that the clarity of the wording was good and 26% only satisfactory, whereas this proportion reached 82% and 18% respectively about the presentation of the paper. None thought that the clarity and the presentation of the paper was poor.

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

Questions requiring a good understanding of concepts and proper use of terminology were challenging for many. Basically, although candidates do well at objective level 1 questions, they have more and more difficulty as the level increases; this applies to both syllabus coverage and data based questions. Generally, candidates seemed to have difficulty giving complete definitions, using appropriate terminology and interpreting graphs. They were often able to read the graphs, but had difficulty making valid and/or detailed comparisons; many candidates are still stating numerical values without interpreting the relationship between the data, therefore not gaining marks. It was not uncommon for candidates to confuse the concepts difference and percent difference. Option D seems the area of the programme where candidates have the most difficulty, and their answers to question D3 were mainly irrelevant.

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

Most candidates seemed to know which two options they were prepared for and answered them thoroughly. They were able to handle data based questions relatively well, although some of their answers could have been clearer and more comprehensive. A large number of candidates displayed a good knowledge of basic factual information, demonstrated mainly by their answers to short questions and the incorporation of basic facts into the last question for options E, F and H. They seemed to be best prepared for Option H, as there were many good, detailed answers.

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

Option D - Evolution

Question 1
Many candidates had difficulty to relate to the means when comparing the tools. References to photographs, if any, remained too vague to earn any mark in most cases. The vast majority of candidates ignored the approximate date of extinction of *H. robustus*.

Question 2
Most candidates had difficulty providing a complete definition for gene pool. The conditions for the application of the Hardy-Weinberg law and the differences between allopatric and sympatric speciation were well known. Most candidates knew something about sickle cell

anemia, but had difficulty expressing it clearly; defining "balanced" and "polymorphism" was difficult, as well as using the concepts of alleles and genotypes. Although many mentioned that people homozygous for sickle cell anemia have an advantage for resisting malaria, most had missed the important idea of heterozygote advantage that enables both alleles to be in equilibrium.

Question 3

The worst question for the whole paper. Many answered about variations in DNA, confused bases with amino acids, and generally produced very vague, unorganized and sometimes irrelevant answers. The relationship between mutation and protein structure was not understood. A few valid discussion elements were seen though.

Option E - Neurobiology and behaviour

Question 1

Generally well done, although some answers were a bit unclear.

Question 2

Pinna, eardrum and brain structures (c) were well known. Although most had an idea of the process of hearing, they were not not very successful in E2a (ii) because they could not outline the roles for all three of cilia, hair cells and cochlear fluid. Most candidates knew vaguely what contralateral processing was about, but couldn't outline how it works properly, sometimes writing very confused and incorrect answers. For E2d, most candidates gained one mark for writing that the pupil constricts when a bright light is shone in the eyes, but didn't get much more; most ignored the mechanism or located it in the medulla oblongata, which is incorrect (the reflex pathway is located in the anterior part of the brain stem; although the medulla is the posterior part of the brain stem, the oversimplification of locating the pathway in the medulla, or stating that the autonomic nervous system is controlled by the medulla because other parts of the brain are not in the syllabus is incorrect); most missed the discussion element and confused probability and certainty of brain death.

Question 3

There was a wide range of answers, some very confused, others very good. Many answers lacked specific terminology, such as presynaptic and postsynaptic membrane, included incorrect mechanisms (e.g. cocaine blocking the receptors and implying that cocaine caused dopamine release) and concentrated on the general effects of cocaine addiction instead of the effects on the brain.

Option F - Microbes and biotechnology

Question 1

Most had 55° and 30 (or 29.4) litres for (a) and (b). Many confused between the independent and dependent variables and/or were distracted by the only data point at 80°; they stated a reversed relationship in (d) (e.g. "the higher the flow rate, the lower the temperature"); their answer to the previous question (c) was influenced by this, but some managed to get the two marks there anyways. For (e), some read the question as relating to the graph and the chulli purifier, others read it as a theoretical question (F.6.4); among the latter, some confused pasteurization and sterilization; the markscheme allowed for both perspectives and most candidates gained some marks.

Question 2

Question (a) was a simple factual question, but many read it as outline how RNA could be used to produce DNA with reverse transcriptase, which was not the case. Others gained only

the mark for RNA/DNA, and a few gained the two marks adding that it could be single or double stranded. Most knew about Gram staining, but some confused the characteristics between Gram$^+$ and Gram$^-$. Most answered (c) and (d) correctly, although some could not recognize the heterocyst.

Question 3

This was probably the most successful third question of the whole paper, perhaps because it was based on factual information, but also because candidates were able to incorporate precise details and present the process in a logical order. Most candidates, obviously well prepared, gained many if not all the marks for this, but some irrelevant answers were also seen.

Option G - Ecology and conservation

Question 1

Most candidates did well, but some limited their comparisons or did not compare similar elements in (c). Most figured out that the project would not succeed in the long term, but some had a certain difficulty to use the data properly to demonstrate it.

Question 2

Most candidates managed questions (a) to (d) relatively well. Some candidates confused between methods to estimate the size of the population in (b) with methods to estimate the population structure, which was not answering the question; also some suggested quadrats, which is not appropriate for fish. A few candidates confused extinct with endangered species in (d). Question (e) turned out to be difficult for most candidates who did not know what the Simpson Index was used for or did not use it for a comparison.

Question 3

This question was relatively easy for the majority of candidates who used either DDT or mercury as example. Many answers nevertheless lacked detail needed for the "named example", and there were many other only partially correct statements. Candidates could describe the process in broad strokes, but failed to be able to explain it well in detail.

Option H - Further human physiology

Question 1

Answers to questions (a) to (c) were relatively good. Candidates were not very clear about the symptoms of asthma and the use of the units in (d), but nevertheless many gained some marks. They were not able to relate the description of the units in the background information to the physiological effects of asthma. Some have the misconception that the bronchioles contract as muscles, or that asthma is due to a problem with gas exchange. Many thought that people breathe out less than they breathe in, and so asthma sufferers had a less efficient gas exchange. Question (e) turned out to be a giveaway, but a few candidates confused cause and effect and did not gain the mark.

Question 2

This part was relatively easy for the candidates, but some missed some marks due to incorrect answers or lack of detail. We have seen non-hormone peptides in (a), no mention of stomach in (b), no enzymes in (c), and short cuts, inappropriate terminology (e.g. protein instead of globin) or misconceptions (e.g. heme is the bile pigment) in (d).

Question 3

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Most candidates demonstrated a sound understanding of this topic and scored high for this question, but many did not distinguish between the events of the cardiac cycle and the mechanisms that control the heartbeat, including everything in their answer and perhaps losing precious time. Many answers incorporated the same unnecessary details, probably learned from the same manual. Sometimes the weaker candidates only described the events on one side of the heart and did not refer to pressure, systole or diastole. There was also sometimes some confusion about the opening and closing of the valves.

Recommendations for the teaching of future candidates

Interpreting data

- Provide more practice interpreting all types of graphs or data at a high level of complexity;

- practise careful reading and absorption of the information in the "stem" in data based questions; time needs to be spent on reading all the data carefully and ensuring candidates are aware of what is being shown and therefore what conclusions can be drawn from the data;

- candidates should be reminded that they will not gain marks in data based questions by simply quoting values and leaving the conclusion to the reader; there must be a statement or comparative adjective showing that the relationship between pieces of data has been understood (e.g. E1(b): "Fed sand goby ate 8.0 mg and starved 9.6 mg, whereas fed black goby ate 4.2 mg and starved 8.9 mg" : no mark; "both foraged more after starvation" : one mark; "black goby increased the amount more than sand goby": another mark);

- candidates should look beyond whether values are higher or lower; they should also focus on the degree of change and the relation between sets of data;

- although this may not always be required to gain a mark, it is always a good practice to indicate units and refer to them when dealing with quantitative answers.

Syllabus coverage

- Many of the concepts run together and build on each other. A holistic approach with a focus on appropriate terminology is essential to score well in this paper. It is fine to memorize information taken from diverse manuals, but candidates should nevertheless be aware that there are further levels of questions for which textual answers cannot be found in manuals and that they must use their knowledge and skills to build them;

- encourage candidates to memorize definitions including all necessary elements. This attention to detail is important in one mark questions where often candidates will not gain the mark for an incomplete definition.

- some answers are often too superficial for HL; candidates must be aware of the details that make the HL syllabus different from the core to be able to incorporate them in their answers.

- Reinforce command terms throughout the two-year programme. Use the command terms in homework, tests and exams to make candidates familiar with the question styles so that they understand what is required of them when they are asked;

- candidates should also be familiar with other terms or symbols often used in examination papers (e.g. "named example" means that the candidates have to write the name of an organism or the common name of the species corresponding to the example they are providing; "/" announces the units that are used);

- Candidates must be taught to read the questions carefully to understand what is being asked exactly; although similar key words as past examination papers or sections in

manuals may be used, the scope of questions in a new paper may be different and what some candidates may have learned by rote may not apply entirely;

· practise writing extended answers; the best answers to options' third question were written by candidates who had clear knowledge and were able to write a plan or brief notes on what they considered to be the key points in the question; the answer will flow as one point leads to another and steps involved when explaining processes will come up in a logical order; it was especially the case for Options E, F, G and H in this paper;

· use the terms or wording from the question rather than trying to substitute it with words of a different meaning or taking short cuts;

· very few candidates used diagrams to enhance their answers; candidates may find that well-labelled, clear diagrams help when their explanations are weak, although they should not constitute the only part of the answer.

· Examination papers are scanned and only boxes containing answers are visible to be marked on screen by examiners; although the scanning process produces very high quality images, there is always a possible loss of definition and parts of answers may be cut off if they are outside the printed box; to prevent any accidental overlooks candidates must ensure that they write clearly preferably in black inside the boxes and that their writing does not show overleaf;

· candidates can continue writing in the answer booklets provided; when they do so, they should be aware that it is often, but not necessarily, a sign of a not very well planned answer that may be off target and/or contains repetitive and/or irrelevant material; they should nevertheless indicate clearly that the answer continues in the booklet; using an answer booklet to add only a few words should be avoided if these words can fit inside the box.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 11	12 - 16	17 - 20	21 - 23	24 - 26	27 - 30

General comments

Of the 97 G2 forms received, 97% of teachers believed this exam was at the appropriate level of difficulty. 58% believed it was of a similar standard to last year's paper with 20% viewing it as being more difficult and 12% as being a little easier. 62% believed the clarity of wording on the paper was good and 86% responded that the presentation of the paper was good.

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

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

Question 1

Some concern was expressed about this question by a few teachers as it was not indicated what was represented by error bars: range, standard deviation or any other indicator of variation. Nonetheless, the error bars clearly indicated that the data is most variable at 20 C. Further, for at least for 20 C, it is not the case that 'measurements at each temperature are very similar to each other.

Question 9

Two teachers expressed concern over this question believing that recognizing the structure of a nucleotide was beyond the SL syllabus requirements. This is not the case. 72% of students did answer this question correctly.

Question 13

This question caused concern from three teachers due to the ambiguity of the term 'different' polypeptides-as in different with respect to one another or different with respect to the original DNA sequence. In such cases of ambiguous interpretation, students should be advised to read all possible answers. Choice D could then be recognized as unequivocally correct.

Question 16

Three teachers expressed concern over this question suggesting that it is not possible to rule out codominance. Codominance would be indicated as a third colour in the pedigree and all offspring of the first generation parents would need to be represented by the intermediate phenotype.

Question 18

A number of teachers expressed concern over this question, primarily concerned about an expectation of knowledge of clams. However, from the context of the question, students should have been able to determine that eating decaying matter rather than rotting decaying matter indicates that the clam is a detritivore.

Question 19

Five teachers expressed concern over this question, primarily over the use of the term 'regained'. Answer C is the only reasonable answer to the question of how an ecosystem maintains energy supply for food chains.

Question 25

There was some concern over the wording of this question. 86% of respondents got the correct answer so the wording was not a detriment to students.

Recommendations and guidance for the teaching of future candidates

There is no question that stands out as having been difficult for students but as for HLP1, students should be encouraged to read all responses before choosing an answer.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7

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Mark range: 0 - 5   6 - 11   12 - 18   19 - 24   25 - 31   32 - 37   38 - 50

General comments

According to the general comments, the exam was straight forward to answer, and of a similar standard to previous exam papers. Spanish scripts showed a much lower understanding than the English scripts. There was an error in the translation into Spanish, of Question 1g so an additional marking point was added for the Spanish papers to compensate for this.

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

There were few areas of the programme or examination that proved difficult for all candidates.

Question 1
g) question g was a question that needed not only proper knowledge, but some further skills to relate sugar uptake with pancreatic cancer. This same concept is applied to the marking point **d** in 1h. No student was able to say that...” there was no clear evidence that fructose causes pancreatic cancer”, on the contrary many clearly stated the opposite,...” that there was clear evidence that fructose causes pancreatic cancer”

Question 2
a) i) Some difficulties were observed in the way candidates answered this question. The word **both** suggested, led to confusion, and it was also used in the wrong place.
ii) The concept of allele is still poorly understood by many students.
b) Many students have difficulties in the way they show a sex linked trait.

Question 3
a) The concept of Natural selection seems to be memorized by many students, instead of having it internalized, and that is the reason why they always score some mark, but while answering we can find strong errors such as “...competition between species” or “...adapted by developing new characteristics according to the different environments”. Too many Lamarckian answers were observed.

Question 4
b) Again, memory works against scoring marks for this answer, because candidates sometimes explained the function of its surface area for volume and vice versa.

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

There was evidence of good preparation across a wide range of topics, with some candidates reaching very high overall scores. Many English candidates scored way higher than 40. Almost all candidates showed at least reasonable data analysis skills in Question 1 and section B scored well in all those candidates that proved that they have studied.

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There was a general consensus that this year, students seemed to be better prepared to draw conclusions from the graphs and identify the correct trends.

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

Question 1
a) Some of students did not receive the mark, for not mentioning the time
b) In some cases, comparisons were not properly done, for which they did not receive the mark. Some of the marks were awarded even if comparisons were made in different sentences.
c) The most common answer was for the first marking point, with few candidates gaining a further mark.
d) Students who did not score the mark usually failed to do so because they mentioned diabetes alone without referring to diabetes two. Others did not receive the mark for mentioning low insulin sensitivity, repeating information supplied by the question.
e) Confusions between wider range and higher uptake were made. Many students thought glucose uptake was higher due to the larger range. Also, some commented that since the units were arbitrary no conclusion could be drawn.
f) Glucose was among the most common wrong answers.
g) All examiners found this question very hard for students. Some said that none of the students managed to get this question right of all the scripts they marked. It was noticed that students could not link the production of ribose to nucleic acid synthesis and cancer occurrence. Even the students who achieved high scores in the whole script could not get this part correct. There was much confusion about how fructose could cause pancreatic cancer as most candidates linked this to insulin sensitivity rather than increased sugars would cause increase cell division. Poor ability to distinguish between correlation and causation when interpreting data. There was a mistake in the translation of the question, in the Spanish scripts, so we have been forced to add another marking point to compensate for this error. As the question was now "Suggest what sugar uptake could be related to pancreatic cancer" m.p.**a** was added to the markscheme for Spanish examiners only. This was the only mark scored by most of the Spanish candidates.
h) was not answered well by many of the candidates. Sometimes it turned difficult to award the second marking point because obesity was mentioned in reference to increase in fructose, but not always clearly correlated with the increase in triglycerides.

Question 2
a) i) Some did not receive a mark for mentioning "both" for the codominant allele in the homozygous genotype
ii) Many of the candidates did not receive the mark for making reference to the blood groups instead of correctly identifying the alleles. Some put the correct letters and symbols but placed them next to each other so implying it was a genotype and lost the mark.
b) Many candidates drew a correct Punnett Square, for which they scored two marks but failed to show the genotype of the mother clearly. Some failed to use appropriate sex-linkage allele symbols. Many simply used uppercase & lowercase, yet did not use X and Y symbols. Y was also wrongly associated with a gene in many cases.

Question 3

a)   Most of the candidates obtained both marks. Expanding habitat was hardly mentioned.

b)   Many candidates failed to receive points because they often wrongly implied the following: "..competition between species ", "survival of the fittest species"

Question 4

a)   Candidates scored marks for a good working, but did not measure correctly, so failed to obtain the second mark. This question seemed to cause some confusion with candidates measuring the picture rather than the scale bar. Also, many wrote down very large magnifications without thinking about plausibility.

b)   Confusing answers led to interpret that many candidates do not clearly understand this topic, writing wrong memorized concepts instead.

Question 5

a)   Clear answers were given by most of the students that had the knowledge.

b)   Some students got confused with other biological techniques, making reference to PCR for example, apart from explaining correctly some steps in gene transfer. There was often no mention of reverse transcriptase.

c)   Most of the students scored marks for this answer, some of them confused the graphs of temperature and pH with the one of substrate concentration, consequently their explanations were incorrect. A number of students incorrectly wrote that the enzyme denatures once it reaches its optimal temperature or pH, so marks were not awarded.

Question 6

Question 6 was the most popular to answer.

a)   The major confusions were found when explaining the functions of the Golgi Apparatus and the rough endoplasmic reticulum. Some candidates did not make any reference to proteins when explaining the function of the Golgi, for which they did not receive the mark.

b)   Marks were not awarded generally for incomplete answers. E.g. Not mentioning one of the end products of anaerobic respiration, either CO_2 or ethanol or in products of aerobic respiration, water was often omitted. The comparisons were sometimes difficult to spot, given that they did not use a chart or did not follow a proper order. Finally some candidates simply failed to compare, explaining only one type of cell respiration.

c)   There were quite a few students who gave very good descriptions of gas exchange and even respiration in some cases, and the properties of the alveoli that made them well adapted for gas exchange. Unfortunately the question was 'Explain the mechanism of ventilation in the lungs in order to promote gas exchange for cell respiration' Many candidates did not read the question correctly. Some candidates even gave more detail of aerobic respiration here than they did in part b. Among the most common errors found were to say that "...inspiration brings oxygen into the lungs" and that "...expiration releases CO_2" In some of the answers there was no differentiation between external and internal intercostals muscles. Some candidates   referred to changes in the lung volume, instead of thoracic volume.

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Question 7
a) This question scored badly.
b) The pyramids of energy were not always shown in the correct energy proportions for each step. As in many of the text books this error is also found, we decided to accept it and award the corresponding mark. Many of the marks were awarded for correctly drawn and clearly labelled pyramids.
c) Among the most common errors were to mention dilation of arteries capillaries or veins instead of arterioles and shivering was not always associated to heat production. The concept of evaporation was not always mentioned. Few were able to account for the role of the hypothalamus.

Recommendations for the teaching of future candidates

In general for all questions, a lot of candidates had the right ideas but lacked enough detail in their answers to gain the marking points. They also need to be taught to check over their work to make sure they are not making careless mistakes or contradicting themselves.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 13	14 - 18	19 - 22	23 - 27	28 - 36

General comments

Nearly 97% of the 117 teachers responding on G2 forms felt that the level of difficulty of this paper was appropriate. The others were split equally between too easy and too difficult. When comparing the paper to last year's, most teachers (81%) thought the standard similar with the others again being almost equally split between a little easier and a little more difficult. All teachers felt that the clarity of the wording was good or satisfactory in a ratio of almost 3:1, whereas this proportion reached 4:1 about the presentation of the paper, with one single teacher thinking that the presentation was poor.

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

Writing complete and accurate definitions proved to be difficult for many candidates. Candidates often did not gain credit because they confused the tasks they were required to perform by the command terms, such as *explain* when they should describe data. Reading graphs accurately, interpreting them using the data and evaluating their significance was also difficult for many, although showing a slight improvement, regardless of the options chosen. Many candidates were unable to express their answers using appropriate terminology, neglected to include details that could have refined their answers (*e.g.* mention of 'fast-food' for high calorie/fatty foods. Briefly, these candidates limited themselves to the repetition of what they learned from manuals, with a range of ability to do so.

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

Most candidates seemed to know which two options they were prepared for and answered them thoroughly.

A large number of candidates displayed a comprehensive knowledge of factual information, demonstrated mainly by their answers to the last question in each option for which many gained all the available marks, especially in options E and G. Most knew of the causes of obesity and the risks of too much Ultra Violet radiation.

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

Option A – Human Nutrition and Health

Question 1

a) In a. almost every candidate gave the correct answers of Affar and Tigray. In b, even although the question was about mothers, many wrote about the sons, but also correctly commented on the large range. In c most were able to comment that the hypothesis was not supported as there was no clear relationship. In d many noted that there was no data about the sex of the mothers' other children or the age of the mothers. In e many did not relate back to the stem and remember that it was about Ethiopia, resulting in some nebulous answers about 'lack of essential nutrients ' etc.

There were some comments on the D2 forms that the x axis was confusing. This did not seem to be the case.

Question 2

Most were able to give and use the syllabus definitions of nutrient and essential and non-essential amino acids. However the word 'supplementing' was missed by many in b who missed talking about iodised salt , and described a non -specific IDD (Iodine deficiency disease), so lacked the detail needed. In c the students usually gained the mark for contributing to obesity, but the expected health comparison with saturated fats was lacking. Some complicated matters by trying to write at length about cis and trans fats.

Question 3

In a, although the stem asked for a comparison as a source of ENERGY, many tried to write about vitamins and minerals etc. In b, apart from some imprecise answers about 'fat food' most were able to score two marks here. Some failed to score both marks by giving too similar answers e.g. sedentary occupations and too much car travel would be in the same marking point. Most of the correct answers gave antibodies or stronger bond as the correct answer.

Option B – Physiology of Exercise

Question 1

Almost all could state 50% for a. In b, the command term was <u>state</u>, but many tried to <u>explain</u> at length, usually on extension sheets. In c i and ii most were able to obtain 1 mark, with only the better candidates obtaining both. Many were able to obtain the mark in d for stating that there was no mention of the sex of the swimmers or comparison of fitness.

Question 2

In a, the better candidates were able to state that the fibre was (partially) contracted as there was a narrow/reduced light band between the Z lines; b was not well answered, with few considering the duration of ATP regeneration by creatine phosphate or the time taken to build up lactic acid. Better candidates could explain the role of ATP in muscle contraction.

Question 3

In 3a, a disappointing number could list cartilage and synovial fluid as the answers. However most knew the connection between stroke volume and cardiac output in b. In c most knew that the oxygen consumption of the brain is relatively stable, but the concept of oxygen debt was poorly understood.

Option C –Cells and Energy

Question 1

Nearly all were able to give 3.2 as the answer to a. In b most were able to state that all had a peak at about 450nm and A emits the most and C the least. Few achieved the mark in c as they failed to state that the fluorescence falls after it rises, and in d many realised that it could be used to identify the stage of ripening 0f the bananas.

Question 2

In a naming a protein and its use should have been an easy mark. Unfortunately it was very poorly answered. In b most knew the function of enzymes and their reduction of the activation energy. However, only the better candidates gained the other marks by correctly putting them into the context of pathways. In c the production of Acetyl CoA from the link reaction was well understood. Unfortunately its destiny was less well known.

Question 3

Part a and b posed no trouble for the well prepared candidates. In c marks were lost due to imprecise answers which did not mention that the cristae are on the inner membrane.

Option D - Evolution

Question 1

Most were able to gain the marks on parts a and b by correct reading of the graphs. In c many lost marks by not using clear expressions such as 'average of', or 'range of'. Many weaker candidates just quoted numbers without explaining their significance. Most were able to gain some marks in d for saying that they ate termites as both the pattern and the means of the angles were similar.

Question 2

Naming the radioisotopes proved surprisingly difficult for many, but most were able to list two anatomical structures and outline the possible influence of a change of diet.

Question 3

Many did not know the aims of Miller and Urey's experiments in a, with a surprising number not knowing the difference between organic and inorganic. The catalytic and self-replicating properties of RNA were quite well known in b. The discussions of the definition of 'species' were very varied, with very few gaining all three points.

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Option E - Neurobiology and behaviour

Question 1

Most were able to state in a that the total volume was greatest at 6 months. In b most were able to gain a mark for spotting that there is no clear trend in the inner layer but a decrease in the outer. Few gained the second mark. There were many correct statements, but few correct comparisons. In c most were able to state that the volume of neurons remains the same and that the synapse density in outer, but not inner decreases with age. In d most were able to gain the mark for loss of synapses, but not neurons but only the more astute candidates could link it back to the introduction and talk about smell perception.

Question 2

Better students gained the mark for bipolar cells in a. Contralateral processing in b was not well known or explained, with many thinking that the images cross/are focused at the optic chiasma and that all the images from the left eye go to the right side of the brain. In c many lost the mark as they incorrectly labeled the pinna and in d, even although it said in the stem, many forgot to name the hair cells and the fact that it is the cochlear fluid that moves. There were comments on the G2 forms that 1 mark for a high level of complexity was meagre. However the command term was 'outline' and the space provided for the answer should have suggested that one precise sentence was required.

Question 3

Most were able to define *stimulus* in ai, but few were able to give excite and inhibit as the two effects in aii. In b most could define taxis. Most of those who did not failed to mention movement. In c the genetic components and the effects of social pressure were well known. Many knew that the cause was linked to dopamine, but did not explain in sufficient detail.

Option F - Microbes and biotechnology

Question 1

Most were able to give 55 C as the highest temperature in a but few were able to calculate 30 litres in b. There was a lot of discussing in c, but few got straight to the point that 80 C is a good temperature as it is free of bacteria, but it could be undertaken at much lower temperatures which would have been much more energy efficient. In d very few candidates were able to state that the slower the flow rate the lower the temperature needed. In e most were able to say that it was effective in removing bacteria, but few were able to spot that there was no information on how contaminated the water was beforehand or how effective it would be in removing other bacteria.

Question 2

Most of the well prepared candidates knew about the varied structural features among viruses in a, could explain how the gram stain is used in b and that most attempts at gene therapy have been unsuccessful, although it could potentially correct a (genetic) defect.

Question 3

Most gained the mark in a for anaerobic or boggy ground, with some being vague with for example 'humid' or 'damp'. Also most were able to state extreme habitat features for Archea. Good candidates scored both marks in c, with weaker ones mentioning that the food dries out, but not that water is withdrawn from the microorganisms, thus killing them.

Option G - Ecology and conservation

Question 1

There were some comments on the G2 forms that said that these graphs were confusing. In fact the vast majority of candidates gained all three marks on parts a and b. In c there were often very wordy answers that did not get to the point, not being proper comparisons. Only the better candidates were able to narrow it down to the fact that the feeding in adults and instars is similar without predators, but there is more feeding on grass by adults with predators. In c many could correctly suggest a reason why the feeding differs. Some misinterpreted e, not spotting that grasses would benefit as more time would be spent eating the bushes.

Question 2

Most of the better candidates could explain the niche concept. Weaker candidates who attempted this part complicated matters by trying to write at length on fundamental and realised niches. Better prepared candidates scored both marks in b, with weaker candidates losing marks by talking about losing individuals, rather than species. Candidates should be dissuaded from using the words in the stem which result in vague statements like 'one species is excluded', without really explaining what exclusion is.

Part c caused several comments from teachers as they were quite correct that it could be construed as a HL question. The markscheme was constructed to incorporate the SL coverage (AS G.3.5), while still allowing for a HL answer (from AS G.4.2) resulting in many students achieving the mark. However a significant number did not mention a named species as instructed, so immediately lost the mark.

Most knew what the Simpson index measures in b, but not that it is used to compare two communities, or the same community at different times.

Question 3

The better prepared candidates could distinguish clearly between gross and net production in a with the weaker ones talking about energy, rather than organic matter. Several teachers suggested that 3 marks in part b was somewhat generous. In reality few achieved all three marks, as they were determined to answer about the greenhouse effect and the ozone layer, which are not biological effects as mentioned in the stem.

Recommendations for the teaching of future candidates

- Practise ordering information into a logical account/ explanation e.g. B2c ATP in Muscle contraction or G2a niche concept.

- Practise how to answer comparison questions without just giving a list or quoting numbers.

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