Biology – Timezone 2

Overall grade boundaries

To protect the integrity of the examinations, increasing use is being made of timezone variants of examination papers. By using variants of the same examination paper candidates in one part of the world will not always be taking the same examination paper as candidates in other parts of the world. A rigorous process is applied to ensure that the papers are comparable in terms of difficulty and syllabus coverage, and measures are taken to guarantee that the same grading standards are applied to candidates' scripts for the different versions of the Examinations papers. For the May 2017 session, the IB has produced timezone variants of Biology SL/HL Papers 1, 2 and 3.

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 26	27 - 39	40 - 52	53 - 66	67 - 80	81 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 13	14 - 23	24 - 35	36 - 47	48 - 60	61 - 73	74 - 100

Internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 3	4 - 6	7 - 10	11 - 13	14 - 16	17 - 19	20 - 24

The range and suitability of the work submitted

Many schools presented a very large range of inventive and original investigations. Like last May, many pieces of work were a real pleasure to read. Nevertheless, the moderators reported that there appeared to be a greater reliance on classic investigations, some of which are prescribed in the core, of the program with little or no attempt to modify them.

Overall, most of the work was of a suitable standard.

Consideration of safety and ethics were frequently lacking particularly in work with microbes.

There were some trivial investigations that were not of the appropriate level for the IB biology course.

Once again, very few databases, simulations or hybrids were presented. Those involving modelling were also very rare. The situation for database work is worrying. Some candidates are simply taking published papers, copying processed data and even repeating the findings of the researchers. Not only is this an ethical problem, it is not using primary source material. New material is being posted on the OCC including some exemplars that concern these approaches. We hope that they may clarify their use and how they are marked.

The vast majority of the schools provided the appropriate material. Nevertheless, there remain problems.

Teachers who physically annotated the candidate's work before uploading, or used the Microsoft Word comments function to annotate electronically submitted work were most helpful. Examiners found it less helpful when comments were made at the beginning or the end of the work. It was not immediately obvious what the teacher was referring to.

A major problem encountered was teachers who did not annotate or comment on work at all (i.e. an unmarked, "clean" copy of the candidate's work was uploaded). This made it difficult to follow the motive behind the teacher's marks and if possible support the teacher.

The samples should now be completely anonymous. Moderators were still finding candidate names, teachers names, school names and other forms of identification on the uploaded material.

Some of the material was scanned upside down before it was uploaded. This problem can be resolved but it is irritating.

Overall more schools had their marks adjusted this time than in May 2016.

Candidate performance against each criterion

The application of the assessment criteria by teachers was generally good, though often overgenerous, sometimes very generous. Therefore, more rigor is necessary when applying the final mark. Teachers were only occasionally considered too severe.

Evaluation still was the weakest criterion for many. This criterion is difficult and it does discriminate between the candidates. For many moderators analysis was also a criterion that needed more attention. Many candidates were happy to leave the processing at the level of calculating means.

Personal engagement (PE)

Some form of personal significance was expressed in most cases. While most were clearly inspired by an observation or an issue, many were contrived (for example, "I have always been interested in…"), or there was no expression of personal significance at all.

The originality of the exploration was mostly acceptable and sometimes exceptional. There were, however, too many cases of classic investigations being used with little or no attempt to modify.

Personal input is evident in the persistence to collect data but also in the research for the background and when establishing the scientific context of the conclusion, in following through the investigation and in the choice of methods of analysis. Once again, this was clearly evidenced in many candidates. For others it seemed, after a good start with an interesting research question, they failed to follow through.

Personal input can be reflected at the simplest level by having completed the investigation, but those following classic experiments, with no sign of application, cannot expect to score highly. There must be some indication that there is a commitment to the investigation.

When marking this criterion, teachers should look out for the following:
- A statement of purpose
- The relationship with the real world
- The originality of the design of the method (choice of materials and methods)
- The difficulty of collecting data (evidence of tenacity)
- The quality of the observations made
- The care in the selection of techniques to process the data
- The reflections on the quality of the data
- The type of material referred to in the background or in the discussion of the results
- The depth of understanding of the limitations in the investigation
- The reflections on the improvement and extension of the investigation.

Marking this criterion requires a holistic approach and it will overlap with components of other criteria.

Exploration (EX)

The research question lacked sufficient focus for many. Scientific names were not always used and the range of the independent variable was not given. For example, a candidate whose question read, "How will different amounts of sugar have an effect on cell respiration in yeast used in bread making?" should have considered including the sugar used (was it sucrose, as was assumed?). The word "amount" could have been made more specific by substituting with "mass", or "volume" or "moles". The range of sucrose concentrations to be

used should be indicated. A research question can also include how the measurements will be taken by introducing the dependent variable.

The requirements for the background are that it needs to be focused and contain relevant information. There were many cases of superficial or irrelevant material. The independent variable needs to be justified. The dependent variable needs to be explained. The discussion of controlled variables is needed to demonstrate that the student appreciates the other factors that may impact on the experiment. Controls need to be considered more frequently.

The methods were either written in prose or recipe style. Both were acceptable. Where the method was not clear it affected both the Exploration and Communication criteria. The weaker submissions tended to be from candidates who investigated a topic in which causal relationships are difficult to confirm and a large number of controls are missing. For example, human physiology studies with limited data sets and poorly controlled variables.

The moderators frequently found the candidates' understanding of concentration to be weak. A serial dilution of a molar solution of sucrose would sometimes result in the stock solution being identified as 100% sucrose.

When marking this component of the criterion teachers should look out for the following:
- The protocol for collecting the data
- The range and intervals of the independent variable
- The selection of measuring instruments (where relevant)
- Techniques to ensure adequate control of variables (fair testing)
- The use of control experiments
- The quantity of data collected, given the nature of the system investigated
- The type of data collected
- Provision for qualitative observations

Safety, ethics and environmental impact needed to be addressed in a large number of investigations. It is true that some investigations may not have any issues in these areas but there were plenty that did and yet the candidates showed no evidence of concern. It is not sufficient to identify potential areas where safety is an issue, there needs to be an indication of how the issue is avoided.

There were some microbiological methods being carried out that were very inappropriate for a school environment.

The following guidelines should be applied:
- Only culture strains of microbes known to be non-pathogenic. For example, students should not culture from hands or swabs of door handles.
- Do not test for antibiotic resistance. There are enough antibiotic resistant strains circulating in the environment without more being selected for.
- Apply strict rules of hygiene and aseptic techniques.
- Do not culture microbes at 37°C. Incubation should be carried out below 30°C.
- Always label cultured plates so they can be clearly identified and never open them for inspection.
- Do not tape all the way round a Petri dish, this encourages anaerobic conditions.

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- Never assume that what is growing in the culture is the strain that was inoculated, even if non-pathogenic strains have been used.
- Always sterilise used cultures and dispose of the cultures using local health and safety regulations.

There were some potentially dangerous practices in investigations, for example, the use of fecal samples.

In addition to microbial hazards there seemed to be a shocking disregard for safety in some schools that can only be attributed to teacher ignorance. One example was found of a candidate employing potassium cyanide as an enzyme inhibitor.

The use of consent forms with human volunteers is not systematic. This is an essential ethical practice.

The environmental impact and safety for fieldwork was often ignored.

When assessing safety, ethics and environmental issues, teachers should look for the following:
- Evidence of a risk assessment
- An appreciation of the safe handling of chemicals or equipment (e.g. the use of protective clothing and eye protection)
- Consideration of basic hygiene
- The application of the IB animal experimentation policy
- A reasonable consumption of materials
- The use of consent forms in human physiology experimentation
- The correct disposal of waste
- Attempts to minimise the impact of the investigation on field sites.

Analysis (A)

The presentation of raw data was generally accurate but qualitative observations were missing from many submissions. Qualitative observations are expected to accompany the raw data. Their impact will depend upon the nature of the investigation, for example, fieldwork should always have a site description which could take the form of maps, sketches or photographs with annotations. A number of examiners commented on the fact that qualitative observations had frequently been ignored.

Raw data from data logging may be expressed as a graphical readout. It should be accompanied by the necessary information such as units and degrees of precision (if relevant) in the axis titles. A candidate should only present a representative sample of the raw data, for example, when large amounts of data have been collected using data logging. A representative graphical readout revealing how data is derived is acceptable. In this way the derived data becomes the raw data.

Processing the data varied. Most candidates managed the basics, for example, means and standard deviations. Nevertheless, there were still candidates who tried to apply standard deviation to a sample size that was too small ($n<5$).

Several were using significance tests from t-test to ANOVA. Although good, they need to be appropriately applied and there needs to be sufficient explanation for the processing to be followed. The use of programmes, such as Microsoft Excel, which produce a statistic, such as a p-value or a correlation coefficient, is fine but the candidate needs to know what the value actually represents.

>30 is considered a large sample,

15-30 a small sample,

5-15 a very small sample,

<5 is usually considered too small a sample to apply tests like the t-test.

Rates and proportions were not always calculated where they were appropriate.

Basic measurement uncertainties were presented but not discussed. Candidates are expected to appreciate the limitations of their instruments and, where they may have a choice, to select the appropriate one. In biology, the biggest issue for uncertainties is in the variation in the biological material (expressed as standard deviations, standard error or max-min range). Error bars showing variation were frequently used on graphs but their significance, or even what they represented, was often absent. In some cases, the error bars were incorrectly placed or they had no bearing on what had been calculated.

The interpretation of the data was sometimes well presented after each set of data. Sometimes it was mixed in with the conclusion. The use of statistics may have been satisfactory but were not always well interpreted. As with calculators, the use of a program like Excel is useful but can lead to accepting values without truly understanding them. Huge mistakes can result from this (for example, confusing the t-statistic with the p-value), leading to an erroneous conclusion. Often the interpretation was handicapped by the limited degree of data processing.

Evaluation (EV)

This was the weakest criterion for many. It is a difficult skill but many candidates just seemed to hurriedly finish off the report. Schools may need to consider the impact of the deadlines for each subject, theory of knowledge and extended essays on the candidate's workload.

Conclusions were not always supported by the data and explanations were missing. The candidates did not always refer back to their research question at this point. Some candidates were rather overoptimistic in their conclusions. Clearly the data did not fully support it but they would aim to put a positive spin on it. A scientific context is needed for a full discussion and this was frequently superficial or absent. For weaker candidates, the conclusion was just a description of the results.

The evaluation of methodology is still a challenge to most candidates. The consideration of the strengths was frequently missed. Weaknesses were often restricted to practical details or sloppy manipulation and the level impact on the conclusion was often not discussed.

Proposed improvements were sometimes unrealistic and often too vague. Extensions were often missed or illogical, not following on from the investigation.

When assessing evaluation, teachers should look for the following:
- A discussion of the strengths – this might be quite general or it might refer to specific parts that worked well or data that was consistent.
- Discussion of the reliability or the data.
- Identified weaknesses in the method and materials.
- The evaluation of the relative impact of a weakness on the conclusion.

Communication (C)

Communication was generally good. Those who communicated well were candidates who had already scored highly in the other criteria.

The most common problems in the work were:
- The use of whole pages for titles. This is not necessary.
- Whole pages for a list of contents. This is not necessary at all.
- Blank data tables presented at the end of the method section (unnecessary).
- Repetitive tables, when one would do.
- Tables split over two pages or with a title on one page and the table or graph on the next.
- Multiple graphs drawn when they could have been combined, this not only saves space but it also improves comparisons.
- Squashed graphs so the distribution of the data is difficult to judge.
- Bibliography, footnotes, endnotes or in-text citation missing.
- References with an incomplete format.
- Inefficient data tables headers. The art of designing data tables needs to be taught. A hand drawn sketch of the table layout should be considered first.
- Scientific nomenclature was not always used and the formats were not always respected.

For graphs that result from data logging that are used to derive a value (e.g. a rate) one example can be presented to explain the processing then the rates derived can be organised in a table.

The format for the citations, when they were presented, was mostly correct.

Format of scientific names was sometimes incorrect (small case letter for species name and it ought to be presented in italics).

Units were occasionally missing and use of non-metric units did occur sporadically.

Measurement uncertainties were occasionally missing.

The numbers of decimal places were sometimes irregular or they did not correspond to the precision of the data.

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In general, the reports were of a suitable length.

There were no automatic penalties for reports that were slightly longer, as long as the reports remained relevant and concise.

Recommendations for the teaching of future candidates

- Present the criteria to the candidates early on in the course and use them for the assessment of practical work.
- Explain the expectations of each component of each criterion.
- Ensure that the candidate's work has some original purpose. It should not be the repeat of a classic investigation.
- Teachers should add comments throughout the work (rather than at the beginning or end).
- Apply the criteria more rigorously.
- Counsel the candidates on the feasibility of the investigation, focussing research questions, safety ethics and environmental impact, use of statistical programs and the use of citations.
- Teach candidates how to design tables and draw graphs.
- Consider the global context of the candidate's entire IB workload when scheduling the individual investigation in the scheme of work.
- Teachers should visit the OCC to see examples of individual investigations that are considered adequate (teacher support material). These have been updated in the light of the material received in the first examination session.
- Graphs should not be reduced to such a size that they become uninformative, simply to stay within the page limit.
- Candidates should not add on appendices in addition to a write up of about 12 pages and should not send in excessive quantities of raw data from data loggers (although showing an example of how raw data have been processed will be needed).
- Reams of extra work should not be submitted. Teachers marking the work should annotate it if they judge the processed results to be a true reflection of the raw data from, for example, a data logger.
- Full calculations are not expected to be shown, examples will suffice and a worked example from a calculation carried out on a spreadsheet or a programmable calculator will not be expected. However screen shots should be considered.
- Teachers should ensure that the work is anonymous. The candidate name, the school name, and the session numbers must all be removed before scanning and uploading.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 13	14 - 17	18 - 22	23 - 28	29 - 33	34 - 40

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General comments

A total of 251 teachers answered the G2 form. Nearly 54% of the teachers felt that the level of difficulty of this paper was appropriate. The others thought it was too difficult. When comparing the paper to last year's, 26% of teachers thought the standard was similar; 43% believed it was more difficult and 27% believed it was much more difficult. Over 67% of the teachers felt that the clarity of the wording was good to excellent. The proportions were higher for the presentation of the paper (72%), with even a few teachers finding it excellent.

This paper performed really well, as the discrimination indices of most questions were high, this means that good candidates performed well in the question and weaker candidates did not perform well.

There were some complaints that many questions were assessing objective 3 skills. This is exactly what was intended as the guide specifically states that objective 3 will now be tested in paper 1. This paper is gradually moving away from factual recall and definitions to more elaborated and thinking questions. This type of question has already successfully been included in the specimen paper and in other sessions. The paper turned out to be more interesting and challenging. The grades were evenly spread, making it easier to discriminate. The fact that the exam was more difficult was resolved in grade award where the boundaries were set accordingly taking this into account.

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

The questions that were answered least successfully were on peat formation, cladograms and oxygen debt.

The areas of the programme and examination in which candidates appeared well prepared
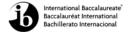
In this paper the questions that were answered most successfully were on the differences between alleles and genes and on the structure of cells seen under the electron micrograph.

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

Comments are included on the questions that proved to be controversial or where candidates did very well.

Question 1

This question proved to be quite easy for candidates and it had a high discrimination index. There were some complaints about the detail expected on the cell theory.

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The question was about the giant algae and according to the guide the reason why it is an exception to the cell theory is because it is a very large cell. Of the possible answers, the only one that could fit is the fact that they lack subdivisions into separate cells.

Question 2

This question was too easy so it was not a good discriminator; good candidates and weaker candidates both were able to distinguish the nucleus of the cell.

Question 3

A good discriminator, where only the capable candidates recognized the function of the vesicles in pancreatic exocrine cells. This topic appears in section 1.2 where candidates are supposed to study the structure and function of organelles within exocrine gland cells of the pancreas. In section 1.4 they had to study exocytosis through vesicles.

Question 5

Although there were many comments on the G2 forms about this question, it really proved to be too easy and a good discriminator.

Students should be able to identify biochemicals such as sugars, lipids or amino acids from molecular diagrams and they should recognize from molecular diagrams that steroids are lipids. What was being asked was not to show that this lipid was a steroid, but that this steroid was a lipid. The answer needed to be deduced, as it was testing objective 3 skills. The first answer that could be discarded was D, as there are no nitrogen atoms in this molecule. The presence of carbon rings and of OH groups is not correct as these can be found in glucose molecules, therefore the only possible answer was B.

Question 6

Teachers were concerned that candidates would not be able to answer this question as the ornithine cycle is not in the guide. This question had a very high discrimination index and did not prove to be too hard as 2/3 of the candidate went for the correct answer. The ornithine cycle did not need to be known in order to answer the question. Only catabolism, anabolism and metabolism were required. Only a few chose B, catabolism. This is incorrect, as it is clear that CO_2 is entering the cycle, therefore making a larger molecule (citrulline) from ornithine. The overall reaction needs to be metabolism.

Questions 7 and 8

These questions were very easy and discriminated well.

Question 9

This question had quite a good discrimination index. The loss of secondary structure (as well as tertiary) is related to the denaturation of proteins. Hydrogen bonds are weak, therefore lost quite easily when a protein is heated.

Question 10

This question presented most G2 comments. This is strange, especially when the discrimination index was one of the highest of the exam and 60% of the candidates had it right. Considering that this was a multiple completion question, the outcome was very good.

Candidates know that only plants do photosynthesis, therefore know that fungi do not produce oxygen. As the leaf is yellow, we know the cells have less chlorophyll, therefore the plant is producing less oxygen. The photograph still shows the leaf is shiny, therefore we can assume the waxy cuticle is still there, thus avoiding of water loss. Anyway, if there were leaf damage, there would be fewer stomata, which would mean a decrease in water loss, so the only possible answer is B.

Question 11

Although teachers complained that this was a tricky question, this question was easy for candidates. Only a few were confused by the direction of the movement, but in the stem, it clearly states that the arrows show the movement of mRNA (from right to left), therefore the tRNA exiting the E site has to be on the far left (answer A).

Question 12

Most candidates chose the correct answer.

Question 13

This was an excellent discriminator. Good candidates were able to determine which advance in technology allowed Calvin to perform his lollipop experiment. What was being tested is in the nature of science section of 8.3.

Question 14

Despite the complaints, this question is perfectly suitable for this test as it is specifically stated in understandings of section 8.2 of the guide.

Question 16

This question was too easy, as most candidates marked the correct answer.

Question 17

This question was a very good discriminator.

Question 18

Some teachers mentioned that none of the answers are correct. According to these teachers the individual labelled X would have a 0.66 chance of being a carrier, as the symbol is white so the individual does not have cystic fibrosis. This is correct if you only consider those individuals who are non-CF. If all individuals are considered, then the answer is 0.50. As there

was no option of 0.66, candidates had to assume that all individuals should be considered. The question asks: *what the probability is of X being a carrier?* not stating whether he/she has or does not have cystic fibrosis, therefore the CF individuals should be considered in the answer.

Question 19

Most candidates had this question right and it had a very good discrimination index. It is clear that candidates can perform a dihybrid cross.

Question 20

Although some teachers criticized this question, it is perfectly fair. It discriminated very well.

Question 21

It is a shame that some candidates still believe that genetically modified crops can increase mutations in organisms that consume them. It is agreed that option B candidates could be favoured by this question, but the topic tested is in section 3.5.

Question 22

This question was fair as 4.1 mentions testing for association between two species using the chi-squared test with data obtained by quadrat sampling.

Question 23

This question comes straight from the guide in topic 4.3. Nevertheless many candidates failed to realize that acidic conditions favour the production of peat.

Question 25

Some teachers complained that this question was unfair. The question turned out to be a bad discriminator, probably because the question was too ambitious and therefore too difficult. Many good candidates went for answer B instead of A. The fact is that the change in song duration is too small to be considered adaptive radiation. This is more for large changes in structures used for different functions, such as Darwin's finch beaks or the pentadactyl limb. A change in song duration is similar to a change in bird dialect.

Question 26

Organisms are classified into different genera when there are enough differences between them. The cladogram shows Procyon and Bassariscus belonged to the same genus and then split. This means that the number of splits is not related to the genus in which an organism is placed. Unfortunately this was the answer chosen by many capable students, therefore this question turned out to be a very bad discriminator.

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Question 27

This question discriminated very well. Most candidates realized that both bryophyta and filicinophyta release spores.

Question 28

This question was too easy so most candidates had it right. The scale showing 1m is clear enough to show that these plants were not small nor had small flowers.

Question 29

Although most candidates got the right answer, there were some candidates that confused the section of an artery with a small intestine. Both are expected in the guide. The villi are clearly not present in this cross section.

Question 32

The wording of this question could have been clearer, as obviously the villi are part of the small intestine.

Question 33

This question had a relatively low discrimination. Some teachers complained that what was being tested was mathematics. This is not true, as the candidates did not have to calculate the total percentage. The reason why more than 100% of the bacteria present resistance to antibiotics is due to the fact that some bacteria are resistant to more than one antibiotic. It is true that if people do not take the antibiotic as prescribed the resistance could be increased, but this is not the best possible answer.

Question 34

Many candidates wrongly believed that epinephrine keeping the ventilation rate high increased oxygen consumption. Although it is true that epinephrine enables intensified respiration, this does not explain keeping the oxygen consumption high.

Question 35

This question discriminated very well. Good candidates were able to identify that myelin is essential for saltatory impulses. The word "saltatory" appears in the guide in section 6.5.

Question 36

Although this question was very difficult, it discriminated really well. Some candidates were confused by answer D, as the answer fits exactly but for post-synaptic neurons. Some teachers complained about the wording of the question. The question asked for the "drug action", this meant how the chemicals work in drugs used to treat schizophrenia.

Question 37

This question was in general well answered, as candidates recognized the action of calcium in muscle contraction.

Question 38

Although the presentation of the information was quite novel, candidates were able to answer this question without problems. This question was too easy, as most candidates answered it well.

Question 39

A good discriminator.

Question 40

Although it was an easy question it discriminated very well.

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 - 46	47 - 56	57 - 72

General comments

84% of teachers responded that the paper was of the appropriate level of difficulty with 58% of respondents indicating that it was the same level of difficulty as last May's paper while 30% responded that it appeared to be more difficult than last year's paper. There was general agreement that the paper was clearly worded, well presented and suitable in terms of accessibility to diverse learners.

In G2 forms, a number of teachers mistakenly presumed that for definitions will not appear on the exam. The exam is structured to include a balance of objective 1,2 and 3 questions so some objective 1 questions will always be included.

A number of teachers expressed concern regarding the inclusion of the question 8c) on the exam. The question is justified by the content of section 7.2 of the syllabus. The question is worded in such a way that it could be broadly interpreted and answered drawing together a range of information from the syllabus. In general, well prepared candidates answered this question well.

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

Students muddled the definition of osmolarity with the concept of osmosis.

Writing accurate details regarding the regulation of gene expression.

Interpreting images of electrophoresis gels.

Explaining the shape of the competitive inhibitor graph.

Explaining evolution in an unfamiliar context.

Correctly representing the position and type of atoms around a peptide bond.

Providing the details of the cell cycle outside of mitosis.

Correctly drawing the stages of crossing over.

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

The competition between substrates and inhibitors for the active site in competitive inhibition.

The role of ATP Synthase.

The features of arthropods.

Negative and positive feedback in relation to menstrual hormones.

Antibody production.

The flow of energy within a food web.

Hormone control of the menstrual cycle

Spermatogenesis

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

Question 1

a): This was an easy graph to read and almost all took accurate readings and gave the correct answer.

b): Most achieved 1 mark here but few recognised the significance of the error bars. Many wrote about the difference between the values for L4 and L6 as being significant.

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c): Many achieved the maximum 2 marks by correctly interpreting the data, although some did not gain marks by using vague terms such as the size of the roots.

d)(i): Some candidates did not understand the instruction compare and contrast and simply listed what happened in the stem base for the control and then for NPA-treated cuttings. Students need to be taught how to make effective comparisons.

d)(ii): Many answers just repeat data without drawing conclusions mpc was rarely found in answers and some described auxin being transported from the stem base to the leaves.

e): mpa and mpc very rarely seem in answers. Very few candidates achieved more than 2 out of the 3 possible marks. Many students misinterpreted this question and discussed the role of auxin in tropism.

f)(i): generally answered correctly.

f)(ii): mpa was not seen in answers; mpb was most commonly achieved with a relatively small number recognising a lag in the peaks.

Many candidates referred only to light and dark bands without showing recognition that these responded to the level of transcription of the GH3 gene.

f)(iii): Some gave vague answers but failed to state whether or not the conclusion was supported.

Question 2

a): Many correct answers. Candidates generally showed good understanding of enzyme action and the effect of competitive inhibitors. A few believed that the active site was found on the substrate.

Some candidates did not link the increase in reaction rate to the increase in substrate concentration.

b)(i): Many correct answers.

b)(ii): Many correctly linked ATP synthase to ATP production, achieving marking point c. Some referred to the movement of protons through the membrane without stating that this movement took place through ATP synthase so they did not achieve a second point.

Question 3

a): A few missed the term 'outline' in the question and simply stated cohesive and adhesive properties without describing how this helped to move water in a plant. There were however many good explanations and correct answers.

b): Many had no idea of the meaning of osmolarity with many candidates describing osmosis. Less than 50% gave a correct description.

c) and d): many correct answers.

Question 4

a): Those who understood the terms detritivore and saprotroph scored well, however this was only about 50% of candidates.

b): There were a large number of students who did not answer this correctly.

Question 5

a): many correct answers though many referred to an example of a disease caused by a mutation rather than a general type of mutation.

b)(i): many correct answers.

b)(ii): Students showed the ability to outline the principles of evolution by natural selection but struggled to relate it to this particular example. That selection pressures are the source of mutation is a misconception that many students failed to identify. Some answers gave general statements instead of dealing with the particular example of head lice.

Section B

Question 6
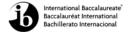
Question 6 was the question attempted most frequently.

a): Many good and accurate diagrams showed the formation of a dipeptide. Even the weakest answers were aware that a condensation reaction resulted in water being produced so often achieved this one mark.

b): Many clear answers gained full marks. Weaker answers referred to bonds forming between tRNA rather than the amino acids they carry and the E site being where the polypeptide leaves the ribosome. A, P and E sites were not always correctly identified as being on the large subunit of the ribosome.

c): Many showed a good understanding of antibody production and outlined the steps of this process clearly.

Question 7

a): Some good descriptions of reproductive isolation although many failed to give an example of geographic isolation. Weaker candidates showed lack of understanding of the term population and referred to different species being unable to reproduce.

Some also gave examples of reproductive isolation in plants although the question specifies animal populations.

b): Many showed good knowledge of the stages in spermatogenesis but the sequence of events was not always clearly described. Many still achieved full marks for this.

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Few mentioned the role of Leydig cells (marking point g). Weaker candidates who muddled up the sequence of events often still achieved the mark for the role of Sertoli cells.

c): Many good answers showing good knowledge of the sequence of events in the menstrual cycle. Common mistakes included: Stating the ovaries secrete estrogen rather than specifying secretion by the follicles. Confusion about the role of estrogen and FSH and how positive feedback works. Stating that estrogen has positive feedback on the ovary leading to increased estrogen production. Falling estrogen and progesterone levels leads to menstruation.

Question 8

a): Very few gave the definition of mitosis needed for marking point a. Some candidates only described the stages of mitosis and these stages were often given in detail. Those who included interphase and cytokinesis achieved good marks here.

b): Candidates frequently achieved marks for labelling diagrams. Diagrams were seldom clear enough to achieve marking points c and e.

c): The weakest students misunderstood the question, discussed dominant and recessive alleles and presented punnet squares explaining inheritance patterns. There was little evidence of clear understanding of the control of gene expression. Those accounts that did score marks tended to be very confused and required considerable re-reading in order to find the points needed for marks. Marking points a and b and k were not seen in answers. The role of nucleosomes and DNA methylation were the most commonly achieved marks. Post transcriptional splicing was sometimes described but frequently candidates failed to link this to the regulation of gene expression.

Recommendations and guidance for the teaching of future candidates

Drawing must be clear and correctly annotated.

Teach the accurate details of crossing over.

Advise students to use language carefully such as length of roots rather than size of roots.

The topic of domains as a level of classification need to be taught.

The question addressing the distinction between selection pressure and mutation is recommended to be used as a teaching tool.

Further Comments

Some candidates are still writing outside the designated space. It is important to write 'continued'. The student should then continue on the extra pages clearly indicating the

number of the question. It is not advised to carry on writing on the same page outside of the box.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 18	19 - 24	25 - 30	31 - 36	37 - 45

General comments

A total of 9840 scripts were received in English, 653 in Spanish, 200 in French, and 291 in German, for a total of 10984. Comments on G2 forms were received from 251 teachers (243 in English, 2 in French, 6 in Spanish and 0 in German). Out of these teachers, 2 felt that the level of difficulty of this paper was too easy, 238 appropriate, and 11 too difficult. When comparing the difficulty of the paper to last year's, 17 thought it was easier, 175 of a similar standard, 46 a little more difficult, 3 much more difficult, and 10 did not answer. About the clarity of the wording, 32 judged it to be excellent, 100 very good, 81 good, 34 fair, 3 poor and 0 very poor. As for the presentation, 45 though it to be excellent, 98 very good, 77 good, 31 fair, 0 poor, and 0 very poor.

There was a very negligible number of candidates omitting to answer Section A and/or answering more than one option in Section B, a major improvement compared to last May session in which Section A was omitted by an alarming number of candidates. The majority of respondents chose option D, closely followed by option C, a lower number option A, and only a small number option B.

Candidates not answering Section A were mainly in Spanish; it is also among this cohort that option B was more chosen, sometimes displaying very good answers. In general, the Spanish scripts appeared to be more completely answered than many in the past, with fewer blanks and answers more focussed on the command terms, although some misread the terms, such as giving explanations when descriptions of the data were required. The biological knowledge was variable, from outstanding to very weak. From answers to Section A, some appeared to have little experience with experimental set-ups.

The answers of candidates writing in French differed mainly from the other language cohorts by attempts to provide explanations and display knowledge in questions for which this was not required by the command terms; although the knowledge demonstrated was sometimes excellent, this effort was generally worthless in questions for which candidates should have focused on interpreting data or distinguishing elements instead.

The biological knowledge of those writing in German showed major gaps for higher level candidates, who sometimes left some answers blank; they seemed to lack a basic

understanding of ecological concepts and definitions, as well as a basic knowledge of the action of hormones. Section A caused many problems as candidates had difficulty interpreting the graphs correctly as well as understanding basic scientific methodology. The conclusions based on the graphs were often inverted, i.e. the cause was seen as the effect. For both options C and D some students used the data based questions often as the basis for answering other unrelated questions.

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

Areas of the programme

It should be reminded to teachers that Section A of this paper is meant to address applications and skills, including those covered by the practical programme. A weak practical programme usually translates into weaker candidate performance in skill oriented questions as the candidates only focus on the theoretical knowledge relating to them. Although many good option B papers were seen, it seemed that many candidates were not well prepared for that option, perhaps choosing it despite that it was not the one which was covered in class.

Areas of the examination

Many candidates have difficulty reading questions accurately and answering precisely in the terms used in the question. Candidates' answers were often too superficial for HL biology. Weaker candidates did not seem to be able to use the information provided in the question stems to support their answers. Action verbs such as *outline*, *distinguish* and *describe* were often confused with *explain* and many candidates were side-tracked, for example, by trying to explain data when they had to discuss pros and cons of the information provided. Many tend to concentrate on only one aspect in questions requiring many. Many also do not seem to have a sense of hierarchy or categorization of biological structures, not making any difference between cells, tissues, parts, structures, etc. This is true irrespective of whether candidates were learners of English as an additional language or not. In English, a variation of this applies to some words, which have a specific meaning and should not be used indifferently: *species* refers to a group or organisms, not individuals; *affect* has a different logical meaning than *effect* or *infect*.

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

The candidates appeared well prepared for most questions simply requiring memory and reading data, that is, level one objective. They seemed to be slightly more prepared to deal with questions relating to human physiology, but sometimes did not include sufficient details in their answers.

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

Section A

Question 1

a): The majority of candidates mentioned *meristem*, but there were also some irrelevant answers and a limited number of blank answers. Some gave *root apex* which did not apply to this case.

b): Most candidates could describe the relationship correctly, but many did not mention the outlier at low diameters and/or the little variation at highest diameters.

c): Many candidates provided a definition of directional selection, but it was sometimes expressed with difficulty; many wrote that one of the extremes is favoured, but did not specify that they meant extreme phenotype, trait or characteristic. Many also referred to galls only, instead of flies.

Question 2

a): Most candidates could read the graph (some quoting the data values unnecessarily), but many had difficulty realizing that there was no effect with fructose or did not state it.

b): Most candidates were able to bring at least one discussion argument, but there were many answers focusing on the data only, which is of rats, rather than recommendations for humans. Many candidates used a different terminology than the one used in the question, often inferring information that was not provided, such as *balanced diet*.

c): A large number of candidates could state the tissue producing leptin and its target, but there was a noticeable proportion providing irrelevant answers. Some simply misread the question for c)(ii), giving appetite as the answer.

Question 3

a): A large number of candidates could state *xylem*, but some provided irrelevant answers such as *root*, which is not a tissue, or *phloem*, which was incorrect.

b): This question relating to practical 7 turned out to be difficult for most candidates who predicted an increase instead of a decrease in pressure and, although transpiration was often mentioned as a reason, could not explain clearly what was occurring in the tube in terms of water and air volume. Some candidates have even explained mechanisms that would result in a pressure decrease, but stated that the pressure would increase. Many seemed to be trying to explain pressure changes in the actual transpiration pull.

c): This question relates to practical 7 from the syllabus and candidates were expected to draw from the experiments they had designed. Candidates generally performed very poorly on this question, providing very vague statements on how to vary either humidity or temperature and sometimes even only stating that the humidity or the temperature should be

varied, with no further details. A large number of candidates treated *or* as being *and*, and suggested methods for both humidity and temperature. Most did not take into account how to control other variables and how to compare with the control setup.

Section B, option A: Neurobiology and behaviour

Question 4

a)(i): Many candidates could identify both structures, but some only one and a few, neither.

(ii): Most candidates could give both parts.

(iii): Many candidates correctly answered *spina bifida*.

b): Some candidates compared the brains of the rat and human, instead of the cerebral cortex. Otherwise, most candidates had no problem here.

Question 5

a): In spite of the graphs that were given, some candidates were unable to explain the problem of red-green colour blindness; they struggled with distinguishing the red/green cone cells as opposed to the wavelengths absorbed.

b): A large number of candidates ignored the wording of the question, about distinguishing sounds of different wavelengths, and wrote answers explaining sound conduction, as in past papers. Most nevertheless included a sufficient number of elements, but many lacked details about the relation between cilia length and specific vibration wavelength; cilia are also often confused with hair cells.

Question 6

a): Most candidates were able to provide sufficient elements and figured out that concentration of dopamine increased within the synapse.

b): Some candidates had notions of the relationship to memory and learning, but very few were able to give details.

c): The vast majority of candidates could outline the structure of a reflex arc, but there are a few who missed or confused some elements.

d): Most were able to state the correct receptor.

Question 7

a): Most candidates stated the correct range or averaged it to 17.5 mm. Some stated 17 or 20 mm as their answer, incorrect for this type of graph.

b): Most candidates were able to clearly explain the ratio between energy exerted and energy return, but few could suggest other reasons.

Question 8

Many candidates explained fMRI and lesion studies although some gave somewhat vague descriptions of *animal experiments*. In some cases, the method was not fully explained although most described quite well what could be learned in each method. There were a few irrelevant answers, such as those relating to the pupil reflex or Pavlov's experiments.

Option B: Biotechnology and Bioinformatics

Question 9

a): Most candidates stated a correct answer, but some gave *air* or *oxygen* (which was already provided as compressed air); some stated *medium*, which was too vague.

b): Most correctly stated *temperature* or *oxygen* as the answer.

c): There was some confusion here, starting with poor comparisons between the two methods. Some gave good answers for one but only partial or incomplete in the other.

d): Most candidates focussed on controlling the TPS activity but many did not mention using genetic modifications. Some simply mentioned removing the product as soon as it was produced, but nothing of the method.

Question 10

a): Not all candidates were able to answer this fully, giving an incomplete distinction between two but not all three conditions.

b): Most were able to provide a correct suggestion.

c): Some candidates do not have a clear understanding of the difference between physical and/or chemical treatments and bioremediation of polluting factors.

Question 11

Most candidates had a fairly complete understanding of the process, although some missed naming a specific marker and target gene.

Question 12

a): Most candidates had a general idea of how genetic sequences could indicate a predisposition for a genetic disease, but were unable to express it fully. Many gave an example, such as BRCA, and a technique but little else.

b): Some candidates knew the use of phosphorescent labelling, but many appeared to be guessing about marking cancer cells.

Question 13

a): Many candidates had difficulty explaining the reading frames; some knew there were three reading frames on each strand but were unable to explain them.

b): Most were able to state that start codons could help identifying open reading frames.

c): This was answered quite well by many candidates, with many complete answers. Knockout organisms were the least well explained.

Option C: Ecology and conservation

Question 14

a): Most candidates were able to state there was a reduction in insect species diversity, but some referred to numbers of insects instead of species.

b): Most candidates realized that *S. geminiata* was a biological control, but had difficulty coming up with other possible effects.

c): Not all candidates were able to clearly define a keystone species although most seemed to be aware their removal could cause a major change.

Question 15

a): Most candidates correctly stated either symbiosis or mutualism as an answer but some stated commensalism or left it blank.

b): The majority of candidates stated *producer*, but some used inappropriate expressions, such as *trophic level 1*.

c): The majority stated *indicator species*. Others didn't have a clue.

d): Many candidates provided very complete explanations. Some have little idea of what causes eutrophication and are more aware of its effects.

e): Most candidates gave a good description of top-down factors, but there were also some were very vague answers.

Question 16

a): Well answered by most candidates.

b): Most candidates described the theory of island biogeography in detail without referring to the case of the plastic rafts.

c): Most candidates showed an understanding of bio magnification, but many did not understand the relationship between the toxins released by the plastics and the plastics themselves.

d): Most answers included introducing alien species, but not all could give a second valid concern.

e): Although many provided very clear answers, some candidates did not seem to know of DDT, not even that it is an insecticide, nor of its role in the control of malaria.

Question 17

Most candidates knew the general climatic difference between tropical rainforest and taiga. Many included details about nutrient stores and flows to various degrees. Some answers included very detailed and clear Gersmehl diagrams, which sometimes helped in clarifying answers, although they were not required, whereas other answers remained very vague.

Option D: Human physiology

Question 18

Most candidates knew that a calorimetric method should be used, but it was difficult for many of them to provide precise answers. The latter lacked details about the mass of water used and the calculation of the temperature difference. A large number omitted to take the mass of food into account. Some were able to give the formula but did not clearly identify the terms used, and did not specify whether the mass was that of the water or the food. A few answers suggested a food analysis instead, not distinguishing between the skills of determining the energy and the nutritional content from the syllabus.

Question 19

a): This is a very good example of a question in which an opportunity to display a better performance was missed by most candidates who ignored the command term (in this case *discuss*). Most candidates noticed that all heart features were smaller in anorexia patients. A very large number concluded this as sufficient evidence and instead of using the obvious presence of overlapping error bars on the graph and the statement of the number of patients in the question as discussion elements, engaged into explaining the cause and the nature of anorexia, which was irrelevant here, and, for some, into quoting a long list of values.

b)(i): Most candidates provided one difference between the two traces, mainly about the T wave. Some did not focus on the trace, as required, but provided a description of the heart events, which was the object of the next question.

(ii): Most candidates could outline the sequence of heart events corresponding to the graph.

(iii): Many candidates were able to describe the use of a defibrillator, but some candidates seemed not to have understood *medical response* and failed to answer the question by describing the use of pacemakers.

(iv): Many candidates could state a range of 7.35 to 7.45, but there was a certain number of imprecise or irrelevant answers.

(v): Most candidates could provide a sequential explanation, but there were some answers containing inaccuracies; many wrote *hypothalamus* instead of *medulla*. Others gave a generalized answer without sufficient details.

Question 20

Most candidates could outline some steps of a *V. cholerae* infection, but many answers lacked details, including the production of a toxin and where the ions were pumped into.

Question 21

Most could describe most elements of the mechanism, but many erroneously mentioned that erythrocytes, not hemoglobin, were split into heme and globin. The question was focusing on the breakdown of erythrocytes, not the future usage of the products issued from it as in past papers. Many candidates mentioned the latter, at the same time providing insufficient details about the mechanism itself.

Question 22

Most candidates were able to explain the role of receptors for both hormones, some in great detail, but there were also answers lacking elements or confusing steroid with protein hormones. There is a limited but noticeable number of candidates providing answers about the different roles of named hormones, which was not under the scope of this question.

Recommendations and guidance for the teaching of future candidates

Preparing for the examination:
- As usually recommended, the use of past papers and markschemes is a valuable tool to prepare candidates for the examination.
- This tool should nevertheless be used with caution, as many candidates tend to memorize answers from past markschemes rather than using it to familiarize themselves to the paper format, question style, expected vocabulary and depth and variety of elements to include in answers. New questions most generally have a different perspective and learning old answers by heart is usually counterproductive.

Syllabus coverage:
- The syllabus has to be covered completely, including understandings, applications and skills.
- Both practical skills and understandings from the core and the AHL are necessary for section A in paper 3 and should therefore be taught together. Teaching should aim for a comprehensive knowledge of the subject and application of concepts and principles in a wide variety of contexts.
- A variety of practical examples, data and graphic presentations should be incorporated to the teaching of various topics.
- It is important to undertake the required practicals. It appeared, based on their specific answers to questions relating to them, that some of the candidates had not in

fact undertaken these in class. This seems to be true for the transpiration experiment and the use of a calorimeter.

- Teaching of all understandings should be at objective level 3, when applicable.
- Teachers and candidates are encouraged to use multiple sources of reference.

Reading and writing skills:

- Many candidates could have reached a better performance in this examination paper by reading into the questions more carefully.
- Candidates should be aware that command terms have sometimes a different meaning than they think and should familiarize themselves with them during their course. Teachers should use them throughout the course for their exercises and internal tests.
- Teach the vocabulary of biology as candidates need to use subject-specific vocabulary in their answers. Teachers may choose to build up a glossary of terms used in the programme.

Examination techniques:

- Candidates have a five-minute period before being able to start writing when they are handed paper 3. They should be aware of this and use this period to carefully read the questions and start mentally planning their answers.
- Many answers could contain more elements. Developing the habit of taking a little time to lay down and organize an answer's core elements would improve answers and prevent omitting important ideas. Coach candidates on how to structure answers. They should take time to consider what is relevant to the answer of the question and leave out what is irrelevant. Encourage candidates to highlight or underline the keywords in the question and plan their answers.
- It is unnecessary to repeat the question or stem in the answer box; this uses up time and space needed to answer. As can be seen from available markschemes, marking is based on facts and accuracy rather than on style.
- The number of marks indicated in the right margin of the question paper is often an indication of the expected details and number elements for a complete answer. Any "outline" question should never be answered by one word.
- Bring a ruler or a square to the exam. This could help measure values on graphs with the required precision.
- For diagrams, like the Gersmehl diagrams in this paper, respecting proportions makes a difference and care should be taken when drawing arrows of different thickness and circles of different sizes. In all cases, all drawings should be well annotated and labelled carefully.
- Most candidates write within the prescribed boxes. All candidates should nevertheless be reminded that examiners view only scanned parts of the papers on screen at a time and anything outside the boxes or not referenced could inadvertently be ignored; answers should be fully legible following the scanning process (although high quality equipment is used, there is always a loss of detail resulting from scanning; especially small and tight handwriting or poor writing instruments often cause problems).
- Most candidates also make a sensible use of continuation answer booklets. The best candidates usually give a sufficient number of elements in the space provided and

very few gain additional marks from answers which extend into a continuation booklet. An indication that an answer is continued should nevertheless be made in the main booklet whenever a continuation booklet is used.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 9	10 - 12	13 - 16	17 - 20	21 - 24	25 - 30

General comments

Out of a total of 190 teachers who answered the G2 form, nearly 60% of the teachers felt that the level of difficulty of this paper was appropriate. The others thought it was too difficult. When comparing the paper to last year's, 24% of teachers thought the standard was similar; 42% believed it was more difficult and 23% believed it was much more difficult. Only 5% believed it was a little easier. Over 60% of the teachers felt that the clarity of the wording was good to excellent. The proportions were higher for the presentation of the paper (72%), with many teachers finding it excellent (20%).

This paper performed really well, as the discrimination index of most questions was high, this means that good candidates performed well in the question and weaker candidates did not perform well.

There were some complaints that many questions were assessing objective 3 skills. This is exactly what was intended as the guide specifically states that objective 3 will now be tested in paper 1. This paper is gradually moving away from factual recall and definitions to more elaborated and thinking questions. This type of question has already successfully been included in the specimen paper and in other sessions. The paper turned out to be more interesting and challenging, although more time consuming. The grades were evenly spread, making it easier to discriminate. The fact that the exam was more difficult was resolved in grade award where the boundaries were set accordingly taking this into account.

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

The questions that were answered least successfully were on peat formation and on the effect of drugs on neurons in schizophrenia.

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

The questions that were answered least successfully were on causation and correlation in smoking and probability of survival and on the difference between an allele and a gene.

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

Comments are included on the questions that proved to be controversial or where candidates did very well.

Question 1

This question proved to be quite easy for candidates and it had a high discrimination index. There were some complaints about the detail expected on the cell theory.

The question is about the giant algae and according to the guide the reason why it is an exception to the cell theory is because is a very large cell, and of the answers given, the only one that could fit is the fact that they lack subdivisions into separate cells.

Question 2

This question was too easy so it was not a good discriminator; good candidates and weaker candidates both were able to distinguish the nucleus of the cell.

Question 3

A very good discriminator, where only the capable candidates recognized the role of cholesterol in animal cells.

Question 4

This question had a very high discrimination index.

Question 5

Although there were some comments on the G2 forms about this question, it really proved to be too easy and therefore not a good discriminator, as most candidates had it right. It is good to know that although most candidates know about the correlation between smoking and cancer, they mostly went for the correct answer of what this graph was showing.

Question 6

Teachers complained about this question. The guide states that only the ring forms of D-ribose, alpha–D-glucose and beta-D-glucose are expected in drawings. Students should be able to recognize from molecular diagrams that triglycerides, phospholipids and steroids are

lipids. Proteins or parts of polypeptides should be recognized from molecular diagrams showing amino acids linked by peptide bonds.

Question 7

Teachers were concerned that candidates would not be able to answer this question as the ornithine cycle is not in the guide. This question had a very high discrimination index and did not prove to be too hard as 2/3 of the candidate went for the correct answer. The ornithine cycle did not need to be known in order to answer the question. Only catabolism, anabolism and metabolism were required. Only a few chose B, catabolism. This is incorrect, as it is clear that CO_2 is entering the cycle, therefore making a larger molecule (citrulline) from ornithine. The overall reaction needs to be metabolism.

Questions 8 and 9

These questions were not easy and discriminated well.

Question 10

This question had the highest discrimination index of all the exam. This means good candidates answered it well while weaker candidates did not. Weak candidates went for answer C, that says that lactate is formed during aerobic respiration. This is clearly lack of knowledge.

Question 12

This question presented most G2 comments. Considering that this was a multiple completion question, the outcome was very good.

Candidates know that only plants do photosynthesis, therefore know that fungi do not produce oxygen. As the leaf is yellow, we know the cells have less chlorophyll, therefore the plant is producing less oxygen through photosynthesis. If there is less photosynthesis there is less use of water. We appreciate that candidates in SL have not studied transpiration, but knowledge on this topic is not needed to answer this question.

Question 14

Despite the complaints, this question is perfectly suitable for this test as it is specifically stated in understandings of section 3.3 of the guide. The sister chromatids do result from the replication of DNA before meiosis, but this is not visible even under the microscope. Sister chromatids can only be visualized at the end of Prophase I.

Question 15

This question was very difficult but discriminated well.

Question 16

Some teachers suggested that none of the answers are correct. The individual labelled X would have a 0.66 chance of being a carrier, as the symbol is white so the individual does not have cystic fibrosis. This is correct if you only consider those individuals who are non-CF. If all individuals are considered, then the answer is 0.50. As there was no option of 0.66, candidates had to assume that all individuals should be considered. The questions asks what the probability is of X being a carrier, not stating whether he/she has or does not have cystic fibrosis, therefore the CF individuals should be considered in the answer.

Question 18

This question comes straight from the guide in topic 4.3. Nevertheless, many candidates failed to realize that acidic conditions favour the production of peat.

Question 20

Some teachers complained that this question was unfair. The question turned out to be a bad discriminator, probably because the question was too ambitious and therefore too difficult. Many good candidates went for answer B instead of A. The fact is that the change is too small to be considered adaptive radiation. This is more for large changes in structures used for different functions, such as Darwin's finch beaks or the pentadactyl limb. A change in song duration is similar to a change in bird dialect.

Question 22

Organisms are classified into different genera when there are enough differences between them. The cladogram shows Procyon and Bassariscus belonged to the same genus and then split. This means that the number of splits is not related to the genus in which an organism is placed. Unfortunately, this was the answer chosen by many capable students, therefore this question turned out to be a very bad discriminator.

Question 24

Teachers complained about this question. The final product of amylase activity of starch is not glucose but maltose and maltodextrins. The table does not give the final product produced by the enzymes but the final product absorbed.

Question 25

This question discriminated very well. Good candidates realized the pressure decreases in the atria as the ventricle fills up (answer D). Because the volume of the atrium does slightly increase when the left ventricle contracts we have accepted answer B too.

Question 27

This question had a relatively low discrimination. Some teachers complained that what was being tested was mathematics. This is not true as the candidates did not have to calculate the total percentage. The reason why more than 100% of the bacteria present resistance to

antibiotics is due to the fact that some bacteria are resistant to more than one antibiotic. It is true that if people do not take the antibiotic as prescribed the resistance could be increased, but this is not the best possible answer.

Question 28

This question discriminated really well. Weaker candidates answered that gas exchange occurred in veins surrounding the alveoli, when it is clearly capillaries that surround them.

Question 29

Although this question was hard, it discriminated really well. Some candidates were confused by answer D, as the answer fits exactly but for post-synaptic neurons. Some teachers complained about the wording of the question. The question asked for the "drug action", this meant how the chemicals work in drugs used to treat schizophrenia.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 9	10 - 15	16 - 21	22 - 27	28 - 34	35 - 50

General comments

Thank you to the teachers who submitted G2 forms.77% of the responses thought that the paper was of an appropriate difficulty, with most of the others thinking it too difficult. Almost 50% thought that the paper was of a similar standard to last year's, with almost everyone else saying that it was more difficult. Interestingly about 8% thought that it was much more difficult and another 8% thought that it was easier. In reality the mean mark was about 2.4 lower than last year. However, several other factors have to be taken into consideration.

Many teachers commented, usually positively, that the questions in section B were not as straightforward as in previous years.

About 75 % and 87% respectively said that the clarity and presentation were good to Excellent

There were a few comments that there was too much in the paper for the time limit. Examiners did not report that the candidates seemed to be rushing to answer the last questions.

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

Statistical significance, using electrophoresis, the difference between exocrine and endocrine, analysis of electron micrographs, classification (arthropods), Stargardt's Disease, causes and types of mutation.

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

Punnet grids, Stem cells, greenhouse effect, Melatonin

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

Question 1

a): Considering that all students submitted a piece of work for Independent Assessment, and most included statistical analysis, whether it be t test, λ^2 or Pearsons. Only about 1 in 20 students knew the significance of $p<0.05$. Most were able to score at least one mark in part (ii), although weaker candidates just quoted figures, and scored zero.

b): Many weaker candidates saw the word 'capillary' and went off tangentially to talk about lungs. Most gained a mark for noting that more oxygen could be provided for the muscle tissue, but few thought about the removal of waste.

c): Even though the definition of muscle fatigue was given in the stem, many were unable to give an answer of between 170 and 180 seconds. In the second park, two marks were frequently achieved, but few commented on the increase in frequency in the Epi mice.

d): Many gained the mark for increasing time to fatigue, but few commented on the fact that exercise with water had little or no impact.

e): Many seemed confused by the electrophoresis gel, which they should have been familiar with. Perhaps the mention of the Western blotting was confusing. However, the stem did relate the thickness of band to the amount of protein.

f): weaker students did not realise that a role of proteins in mitochondria was required, and described the function of mitochondria instead. It was a 'suggest' question, so any of the functions of proteins would have sufficed. E.g. enzymes, protein channels etc.

g): many gained two marks for strengths of the data, even though they did not really connect Epi and dark chocolate. For the third mark a limitation had to be given as it was an 'evaluate' question.

Question 2

a): Most knew about the secretion and effects of melatonin, with some weaker students confusing it with melanin.

b)(i): There were some G2 comments about the use of the word 'exocrine'. It is mentioned in section 1.2. Insulin or hormones (endocrine products) were the most common wrong answer. Many weak students thought that 'exocrines' were released. (Digestive) enzymes or any correctly named digestive enzyme scored the mark.

b)(ii): A surprising number of students were unable to identify and give functions for RER (or ribosomes) and mitochondria. There were a few G2 comments saying that II was not clear. Two mitochondria were marked, to suggest that the shape depends on the cutting orientation, and the left one clearly shows the cristae. For mitochondria, aerobic_respiration was expected. Weaker students answered 'the powerhouse of the cell', which is really too vague for an examination of this level.
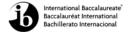
Question 3

a): Those who had been taught about Stargardt's disease (section 1.1) gained two easy marks. There were many accurate descriptions of stem cells, but not related to the question, which scored zero.

b): Many examiners commented that the Punnett grid asked for could not really have been any simpler. Even those scoring zero in part a could gain all 3 marks easily. The majority of students gained three easy marks, but a significant number insisted on making it a sex linked condition, even although it was described as 'autosomal recessive' in the stem. They tended to score zero as the male was not a carrier as stipulated in the stem. In this particular case there was not a mark for a key as long as the letters used fitted the correct convention (i.e. a Capital with its corresponding lower case). Well prepared candidates included this information.

Question 4

Question 4 was in common with HL as it only included questions from the core section.

a): Many examiners commented on how this relatively simple question was answered so badly. Most of the correct answers gave 'radiation; or some type of radiation. In part (ii) many incorrectly gave an example (e.g. sickle cell anaemia) instead of a type of gene mutation such as base substitution. Some of the wrong answers indicated that the students could not distinguish between the effects of a gene mutation, e.g. Sickle cell and a chromosome mutation such as Down Syndrome.

b)(i): The word 'arthropod' (syllabus section 5.3) was either well known or an alien word. Classification had obviously not been taught in many centres and it was also on the previous syllabus. There was a G2 comment that a photo of a louse should have been included. This was considered at paper setting, but it was thought that this would have made the question too easy.

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(ii): Most were able to gain a mark for the better adapted individuals surviving and passing on their alleles to the next generation. The fact that mutations are random, and occurred in the population already and not cause by immersion in shampoo was poorly understood and this was a good discriminator for those heading for the high grades.

Section B

The need for clear communication should be stressed here so that the Quality mark is not compromised. It was good to see more prepared candidates writing some form of plan before starting. This should be encouraged.

Question 5

Proteins. This was the favoured option of the higher grade students

a): About half of those attempting this scored all 3 marks. Common mistakes were adding another Carbon and having the amine group connected to the Carbon through an H not an N,

b): The command term was 'outline'. Many very verbose answers described transcription as well. It should be noted that there is often a mark for a definition as it sets the scene for the rest of the answer. Good answers started with 'Translation is…' There were a few good answers including clear, annotated diagrams.

c): Even although the stem had the word "named" in bold, weaker students blanked it out of their mind and were determined to write a general essay on immunology, which gained few marks. There were a large number of very good answers, which allayed the fears of many G2 comments that it was far too difficult. This question solicited by far the most comments from teachers. There were 4 possible marks for the proteins involved in the clotting process and 6 for the actions of leucocytes. Weak students made sweeping inaccuracies such as 'Lymphocytes and phagocytes are proteins that…'. They are not, they are cells. Marks were for antibodies, immunoglobulins, digestive enzymes in the phagocytes etc. which are proteins.

Question 6

Carbon cycle and photosynthesis

a): It should be noted that the stem asked for structure and function. Most students gained a function mark for storage of glucose/ energy. Few gained any structure marks. Amylose and amylopectin are in syllabus section 2.3.

b): There were several G2 comments concerned about the level of knowledge of the light independent stages of photosynthesis. There were at least 7 marking points available, and most students gained at least half marks. Some answers were not in sufficient depth, for example it was expected that light was absorbed by chlorophyll, not just 'by plants'

c): Several teachers commented that the wording of the question was confusing for some students. This did not seem to be the case as most gained some marks. It required explanations of both the carbon cycle and climate change. Very well prepared students drew

clear diagrams of the carbon cycle and annotated them well. Others drew poor diagrams and hoped for the best, not adding anything. Diagrams, of course, were not expected. Common mistakes were saying that both gases were produced by combustion. Knowledge of the absorption of long wave radiation were better understood than in previous exams, however there were still a large number trying to write about the ozone layer.

Recommendations and guidance for the teaching of future candidates

This was the second May examination under the current specification. Please make sure that the students are aware of differences in the specification when attempting past questions, for example topics that have appeared/disappeared and the fact that there is now only a choice of 1 out of 2 in section B. In addition, teachers should ensure that their schemes have been fully updated as it was obvious that some centres had not taught melatonin, Stargardt's disease or the structure of starch. Candidates should be reminded that answers may be amplified by the use of clear, annotated diagrams. However, poor half-remembered diagrams will not gain anything. Diagrams should be drawn boldly in dark pencil. Very feint diagrams can lead to scanning problems. Overall there seemed to be fewer candidates needing extra pages. Please continue to stress that if they are continuing outside the box, they are almost certainly writing too much. If they do go on to extra pages, then make sure that they state this at the end of their answer in the main text. Many, mainly weaker students seem to fill up the first few lines by restating the stem of the question, thus restricting the number of available lines.

Some candidates do panic when they see question 1. Perhaps they should be encouraged to start on Section B and then go back to question 1. In section B, and in the longer answers in for example 1g) or 4b)(ii), candidates should be encouraged to think of a plan instead of starting to write straight away. For example, "what key words do I need to use?" should be uppermost in their minds. This also enables the answer to flow easily, requiring little or no rereading by the examiner, meaning that the candidate is more likely to gain the Clarity mark in section B. The examiners reported that there was a pleasing increase in the number planning their answers before starting to write.

Perhaps more for the teachers than the students is the fact that there were a few comments to the effect that topic X was not in sufficient depth in the textbook. Teachers should realise the dangers of only using one source of information.

Please remember to submit a G2 form giving your impressions of the examination, whether positive or negative. If you feel unqualified to compare the paper to previous years, then that could be left blank or n/r added.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 8	9 - 12	13 - 16	17 - 21	22 - 25	26 - 35

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

Once again there were many vague answers where students did not answer the question. This is often due to poor exam technique rather than understanding. For example, in the question concerning the use of the pupil reflex to test for brain damage many pupils described the pupil reflex in depth, and others simply described reflex actions without focusing on the effect of brain damage.

Candidates missed marks in long answers due to lack of detail, rephrasing the same idea or repeating the stem of the question. For example, this was noticeable in the question where candidates were asked to explain the use of indicator species to assess the condition of the environment where the question stem was repeated several times in different words.

Identification of structures from photographs was difficult and is something candidates need to practice.

There were many candidates who were handicapped by the failure to answer questions using scientific terms. This happened especially in Spanish scripts.

Definitions of key terms were inconsistent and poor in many cases (e.g. keystone species, indicator species). Understanding of blood pressure, leptin, receptors, parasitic relationships (in food chain), and the consequences of biological control on ecosystems also proved difficult for many candidates.

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

Options C and D were most popular followed by option A. Very few candidates attempted option B.

Overall there was no part of the paper that posed great difficulty to the better candidates and many did well on knowledge based questions like the proton pump, and visual information.

In the questions on the experiments with enzymes and the calorimeter it was very apparent which candidates had carried out experimental work in these fields. Candidates who do not have a strong practical programme to supplement the theory are greatly disadvantaged in the written examination. Those with this experience performed well.

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

Section A

Question 1

a): Most good candidates noted that the oxygen concentration had to be measured before and after the respirometer. Very few mentioned that time was needed to calculate a rate. Weaker students suggested counting the bubbles of gas coming from the fish.

c): Most candidates noted increased temperatures would result in increased oxygen consumption but only a few went on to comment on aerobic respiration as required.

Question 2

The candidates tended to do quite well in this question and many scored full marks despite having no knowledge of keratinase. Weak students stated that temperature and pH should be kept constant in both experiments. This was a question where experience in practical work can be carried over to new and unknown situations.

Question 3

b): This was a fairly easy question but weaker candidates failed to answer what was required and tended to simply repeated the answer to 3 (a) distinguishing between the effect of leptin on each diet. Marks were given for relating leptin injections and appetite suppression. Better candidates noted that results in mice may not necessarily be the same for humans.

c): Many candidates incorrectly wrote that leptin was produced in the hypothalamus and acts on adipose tissue.

Option A

Question 4

The top candidates scored full marks in this question on neurulation and it discriminated well

Question 5

a): Most candidates could outline the function of the autonomic nervous system.

b): Most candidates scored 2 marks for stating that light is shone in the eye and lack of response by the pupil suggests brain damage. Only the better candidates managed to score a third mark. Weaker students simply described the pupil reflex without relating it to brain injury. A common error was to say that a normal response by the pupil indicates there is no brain damage.

Question 6

This question discriminated well. Weaker candidates simply stated the relationship between body mass and brain volume while stronger candidates described the relationship as body mass increases.

Question 7

Generally, poorly answered and only the strongest candidates scored high marks. Many answers were vague such as describing the olfactory stimulus as smell rather than chemicals or stating that the tissue where photoreceptors are found is the eye.

Question 8

The better candidates could differentiate between the left and right sides of the visual field and the left and right eye.

Option B

Few candidates attempted this option, but those who did seemed well prepared. The comments below are based on a small sample of students.

Question 9

In general, most candidates could relate the diagram of a biofilm to emergent properties.

Question 10

The questions on the amylose and amylopectin content of starch question proved quite difficult with many vague answers

Question 11

Many good answers on why golden rice is considered a transgenic organism.
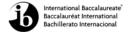
Question 12

In general candidates understood the use of a fermenter but only a few could distinguish between batch and continuous cultures.

Question 13

Variations of this question have been asked in the past so candidates were well prepared to explain how microorganisms can be used in response to pollution incidents such as an oil spill.

Option C

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Question 14

Good discriminator with only the strong candidates scoring full marks. Most candidates noted that in a mixed population the cell volume of both species was lower. Candidates seemed to have understood competitive exclusion well.

Question 15

Generally well answered, even by weaker candidates except (c) which proved difficult. Only a few of the stronger candidates answered tropical rainforest.

Question 16

a): This was difficult to answer from the graph but a large margin of error was accepted in the markscheme allowing most students to obtain the mark.

b): Generally well answered, even weaker candidates could compare and contrast the biomass in the different trophic levels.

c): This question confused many candidates who gave details about parasites rather than the simple answer required.

Question 17

b): Most candidates scored a mark for saying that the fire ant may reduce corn pests but only a few mentioned that they may also reduce the number of beneficial species.

c): Definition of a keystone species was generally weak. Many candidates said that a keystone species was important in an ecosystem but some idea that its importance was disproportionate was required.

Question 18

Most candidates scored some marks for explaining the use of indicator species and better candidates scored full marks. Weak candidates simply repeated the information in the question stem.

Option D

Question 19

The question on proton pumps was a good discriminator with most candidates scored some marks and strong candidates scoring full marks.

Question 20

Nearly all candidates named Kupffer cells though only stronger candidates scored all 3 marks for b) describing the breakdown of erythrocytes. Many answers were vague and stated that erythrocytes rather than hemoglobin were broken down in to heme and globins.

Question 21

Very few candidates could determine the systolic and diastolic pressure from the information in the diagrams. The meaning of systolic and diastolic pressure elicited many vague responses with only good candidates scoring full marks. Few candidates could identify both structures in the diagram. Weaker candidates identified only the nucleus and stronger candidates the intercalated disc.

Question 22

Discriminated well, with most candidates scoring some marks and the best candidates fully describing how food energy could be measured with a calorimeter. Weaker candidates suggested alternative methods of measuring food energy such as reading the information on the packaging. Others had the food burning in the water. It was obvious which students had carried out an experiment of this type.

Recommendations and guidance for the teaching of future candidates

Teachers should focus more clearly on key experiments that shape our understanding of Biology, in particular experiments listed in the guide. The students may not have previously worked with keratin but those with experimental practice knew how to identify the controls and variables and answered the question correctly. Preparation for IA is also preparation for Paper 3 and the students need to be able to transfer their practical skills to new situations.

Students should know how to construct a logical response to a question and to identify specifically what the examiner requires rather that writing all they know about a topic and hoping they have included the answer.

Once again candidates were writing outside the boxes provided and this may not be picked up by the scanner and seen by the examiner. Candidates should be instructed that all answers should fit in the boxes provided. If they do require more space they should write on the extra sheets and never on the script outside the lines within the box.