November 2016 subject reports

Biology

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 14	15 - 25	26 - 37	38 - 51	52 - 64	65 - 77	78 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 14	15 - 28	29 - 40	41 - 50	51 - 62	63 - 74	75 - 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

Schools presented a very large range of inventive and original investigations; like last May, this was a huge positive move and teachers should be congratulated on the efforts that they made to achieve this. Many pieces of work were a real pleasure to read.

Overall, most of the work was suitable.

Some of the investigations presented were classic experiments that represented a low input from the candidate. Some were even the investigations specified in the programme with no modification. Invariably these investigations failed to show any indication of the source material.

Consideration of safety and ethics were frequently lacking (this concerned field work, work with microbes, animals and human volunteers).

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

Very few databases, simulations or hybrids were presented. Those involving modelling were very rare. This is most likely because their inclusion in the internal assessment component is new. Their numbers may grow in future sessions. New material is being posted on the OCC including some exemplars that concern these approaches.

There were more cases of students carrying out group work than in the May session. Given that the internally assessed investigation has to be the product of an individual student, this excludes most group work. It will be virtually impossible for students to cover the personal engagement and exploration criteria completely independently (as they must do) and still arrive at a shared protocol that would allow them to collect data so similar that it would be possible to pool it.

If it is an environmental investigation, students could certainly refer to measurements taken by other students and, sometimes, for example in fieldwork, it may be appropriate to pool some data but without similar sampling designs it would be difficult to completely pool data.

Students must have their own individual protocol, which can, for instance, be decided on by conducting trials to ascertain the most appropriate values for an independent variable. It would be possible for separate students in the same class to be working on similar experiments, on rates of reaction of enzymes for example but they would need to be working independently on significantly different system.

Candidate performance against each criterion

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

Evaluation was the weakest criterion for many. This criterion is difficult for many students and it does discriminate between the candidates but many just seemed to hurriedly finish off the investigation. This could be the effect of it being carried out mostly in the second year when there are other deadlines.

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 indication of personal significance at all.

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

Personal input is evident in the persistence in collecting data but also in the research for the background and when establishing the scientific context of the conclusion, in the exploration and in the choice of methods of analysis. Once again, this was clearly evidenced by many candidates. For others it seemed (after 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 in water have an effect on cell respiration in yeast?” should have included the name of the sugar used (presumably sucrose). 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 could affect 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 were missing. For example, human physiology studies with limited data sets and poorly controlled variables.

One particular technical error was encountered. Some students were using agar cubes to test the activity of proteases (bromelain and trypsin). Agar is a polysaccharide not a protein.

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 (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 more fully addressed in a large number of investigations.

There were some microbiological methods being carried out that were very inappropriate for a school environment. Incubating microbial plates at 37°C is unacceptable due to the risk of inadvertently culturing human pathogens.

There were some potentially dangerous practices in physiological investigations, for example, the use of blood samples and urine samples.

The use of consent forms with human volunteers was not systematic. This is an essential ethical practice. The exposure to animals to conditions that are not part of their natural environment is to be discouraged, for example exposing ants to different levels of alcohol.

The environmental impact and safety for fieldwork was often ignored.

It is not sufficient to identify potential areas where safety is an issue, there needs to be an indication of how the issue is to be avoided.

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)
- 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 candidates 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 produces 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 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 programme like Excel is useful but can lead to candidates 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.

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 candidates' 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. A scientific context is needed for a full discussion and this was frequently superficial or absent. For weaker candidates that conclusion was just a description of the results.

Similar to the previous syllabus, the evaluation of methodology is still a challenge to most candidates. The consideration of the strengths was often 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
- 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)

The responses to the communication criterion were 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 and 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 would not only save space but also improve comparisons.
- Squashed graphs so the distribution of the data is difficult to judge.
- Bibliography, footnotes, endnotes or in-text citation missing.
- Inefficient data tables headers. The art of designing data tables needs to be taught. A hand drawn sketch of the table layout should be carried out in rough first.

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 the species name and it ought to be presented in italics e.g. *Mus musculus*).

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.

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 each 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, focusing research questions, safety ethics and environmental impact, use of statistical programmes 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. These have been updated in the light of the material received in the first examination session.
- The Communication statement "The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation" is more likely to be met by a report of about 6 to 12 pages.
- A sensible stance in relation to presentation with regard to font size and margin width should be held, to ensure that good communication skills are demonstrated.
- In the same way, 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.

Further comments

The vast majority of the schools provided the appropriate material. Scanning presented a problem where the teacher had annotated a pdf version of the candidate's work using the .pdf comments function (bubbles). When the work is presented to the examiner, these comments do not expand. Therefore, this method of annotating should be avoided where possible (an IBIS news item was posted to all schools).

Teachers who physically annotated the candidate's work before uploading, used the Microsoft Word comments function or writing on a pdf as a comment box visible directly on the page, 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.

Similar to submissions in previous years (on the previous syllabus), 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 reasoning behind the teacher's marks.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 14	15 - 18	19 - 23	24 - 29	30 - 34	35 - 40

General comments

The mean mark for this paper was 25.5. It was considerably lower for Spanish and German, where the mean was 19.

The feedback from centres indicates that teachers were satisfied with the paper difficulty and scope of the paper. Most of the 26 teachers answering the G2 report believed the difficulty of

the examination was appropriate. Compared to last year, most believed it was of similar standard or a little more difficult. The suitability of the paper with regard to clarity and presentation in general was considered good. Most teachers agreed that the examination paper was suitable in terms of accessibility and cultural/religious/ethic bias/gender and ethnicity.

Most questions had a high discriminating index, showing that good candidates answered the questions well. The questions had a full range of difficulty indices, showing there were questions accessible for all levels.

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

Candidates did not know how muscles exert force and had trouble understanding the evidence of evolution provided by the vertebrate limb. Candidates also found it difficult to understand the function of auxin.

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

Candidates appeared to be well prepared in cell structure, the effect of neonicotinoids on bees and Mendelian ratios.

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

Questions 1 and 2

These were very easy, so most candidates answered correctly.

Questions 3 and 4

Although these were not too easy, candidates answered them well and they discriminated well too. Good candidates were able to answer them well and weaker candidates answered them badly.

Question 5

There were some complaints in the G2s about the content of this question not being in the guide. This is not true as in section 2.1 of the guide it clearly states in the Skill section that students should “Identify biochemicals such as sugars, lipids or amino acids from molecular diagrams”. In the guidance it further clarifies that “students should be able to recognize from molecular diagrams that triglycerides, phospholipids and steroids are lipids”. Therefore the molecular diagram of a steroid should easily be detected as a lipid.

Question 8

This question is totally valid, as it was testing knowledge on enzymes and the effect of temperature on metabolic activity rate. Candidates should be able to explain the patterns or trends in graphs. Most enzymes have an optimal temperature around 45°C and above this they begin to become denatured. A fever would cause the enzymes to work at their maximum, making them be overactive. The body uses this mechanism to fight pathogens to stop the spread of infection. Unfortunately, the question seemed to be misleading for some good candidates who went for the wrong answer D (spread of infection).

Question 9

This question had the highest discriminating factor.

Question 11

There was a complaint in the G2s about the fact that Chernobyl was not in the guide. It is an Application in section 3.4: “Consequences of radiation after nuclear bombing of Hiroshima and accident at Chernobyl”. It is therefore not surprising that candidates found this question easy.

Question 15

There was an unfounded complaint that the formation of peat is not in the guide. In 4.3 it clearly says that “peat forms when organic matter is not fully decomposed because of acidic and/or anaerobic conditions in waterlogged soils”.

Question 16

Despite a complaint in the G2s, this question turned out to be easy for most candidates, as they recognized that the increased combustion of fossil fuels would directly increase the concentration of carbon dioxide, which would increase the greenhouse effect thus indirectly increasing the average global temperature.

Question 18

There were several complaints about this question. It was a good discriminator, which shows it was not hard for capable candidates. The question asked about the “major contributor” to antibiotic resistance. In topic 5.2, the NOS statement is: “Use theories to explain natural phenomena—the theory of evolution by natural selection can explain the development of antibiotic resistance in bacteria”. One of the understandings reads: “Mutation, meiosis and sexual reproduction cause variation between individuals in a species. Natural selection increases the frequency of characteristics that make individuals better adapted and decreases the frequency of other characteristics leading to changes within the species”. Mutations in bacterial species have always occurred but only after the use of antibiotics was there a huge rise in antibiotic resistant strains, as the environment favoured the reproduction of antibiotic resistant bacteria.

Question 20

This question was clearly too difficult and not a good discriminator. Although fructose does cross the intestinal epithelium through facilitated diffusion, candidates could have been confused by the co-transport mechanisms of glucose in the villus and that made them answer D (active transport).

Question 21

Although this question seems very easy, it confused candidates. The pressure in the aorta is highest during the ventricular systole, when the atrioventricular valves are closed and the semilunar valves are open. Some candidates erroneously believed the pressure in the aorta was greater during diastole.

Question 23

This was a very good discriminator. Good candidates correctly answered the conditions for inspiration, while weaker candidates answered that the contraction of the diaphragm (this is correct) along with an increase in the pressure in the thorax (this is incorrect) caused inspiration.

Question 26

The complaint in the G2s is that what is in guidance should not be tested but the guidance gives an idea of what will be tested. Section 7.3 states: “names of the tRNA binding sites are expected as well as their roles”. Students should therefore know where the amino acids attach to the tRNA molecule. There were also complaints about the way the molecule of tRNA was presented. This question was easy as answers A, B and D showed similar structures, so candidates could guess the correct answer was C. As a result, this question was easy for most candidates.

Question 27

The comment in the G2s mentioned that the 5’cap and the 3’poly-A tail are not specified in the guide but candidates are meant to understand the modification of mRNA after transcription and, furthermore, knowledge of the 5’cap and the 3’poly-A tail was not essential to answer the question. Alternatives I and II are correct answers, so the only possible answer to the question was D. This question was well answered by most candidates and it had a high discrimination index, showing the alternative III did not confuse candidates.

Question 32

Excess irrigation can cause salinity in the soil. It causes increased rates of leakage and groundwater recharge causing the water table to rise. Rising water tables can bring salts into the plant root zone which affects both plant growth and soil structure. The salt remains behind in the soil when water is taken up by plants or lost to evaporation. The question did not focus on this but on the adaptations of plants to saline soils as stated in section 9.1 of the guide. Most candidates answered the question correctly, although weaker candidates chose B.

Question 34

This question unfortunately confused some candidates. Auxin is a hormone, and as such it cannot detect light direction, as it is not a pigment.

Question 36

In general this question was answered well and had a high discrimination index. Some concern was expressed in the G2 comments that German candidates may have had some trouble with the translation of “directional”.

Question 38

Many candidates wrongly thought that both flexor and extensor muscles are needed for a skeletal muscle to exert force.

Question 39

This question comes straight from the guide. In section 11.3 it says “The length of the loop of Henle is positively correlated with the need for water conservation in animals”.

Recommendations and guidance for the teaching of future candidates

Make sure the new guide is addressed rather than the former guide.

Use different sources to teach students, for example original papers from scientific journals.

No marks are taken off for wrong answers therefore candidates should attempt to answer all questions.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 10	11 - 13	14 - 17	18 - 20	21 - 24	25 - 30

General comments

The average mean mark for this paper was 15. It was lower for Spanish where the mean was 13 and higher for German with a mean of 17. This was the first session in Japanese, with a mean of 12.

The feedback from centres indicates that teachers were satisfied with the paper difficulty and scope of the paper. Most of the 30 teachers answering the G2 report believed the difficulty of the examination was appropriate. Compared to last year, most believed it was of similar standard or a little more difficult. Most teachers agreed that the examination paper was suitable in terms of accessibility and cultural/religious/ethic bias/gender and ethnicity.

This paper had most questions with a high discriminating index, showing that good candidates answered the questions well. The questions also had a full range of difficulty indices, showing there were questions accessible for all levels, although none of the questions were too easy.

Most questions had a high discriminating index, showing that good candidates answered the questions well. The questions had a full range of difficulty indices, showing there were questions accessible for all levels.

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

Candidates found the structure of a steroid difficult; most believed it was a carbohydrate. Most did not know the products of aerobic and anaerobic respiration or the significance of a diploid number of chromosomes. They did not know about the development of melanistic insects in polluted areas. In general evolution was not well understood. Many candidates had no idea about the use of a surfactant.

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

Candidates had no trouble with the question on somatic cell transfer and on food chain.

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

Questions 1 and 2

These had a very high discrimination index and most candidates answered correctly.

Question 3

Although not too easy, candidates answered this question well and it discriminated well too.

Question 5

There was a complaint in the G2s about the quality of the micrograph of the onion root tip. Many candidates wrongly believed the cell was in prophase. This is impossible, as it is clearly seen that there is no nuclear membrane and the chromosomes are aligned in the equator.

Question 7

There were some complaints in the G2s about this content of this question not being in the guide. This is not true as in section 2.1 of the guide it clearly states in the Skill section that students should “Identify biochemicals such as sugars, lipids or amino acids from molecular diagrams”. In the guidance it further clarifies that “students should be able to recognize from molecular diagrams that triglycerides, phospholipids and steroids are lipids”. Therefore the molecular diagram of a steroid should easily be detected as a lipid.

Question 9

This question is totally valid, as it was testing knowledge on enzymes and the effect of temperature on metabolic activity rate. Students should be able to explain the patterns or trends in graphs. Most enzymes have an optimal temperature around 45°C and above this they begin to become denatured. A fever would cause the enzymes to work at their maximum, making them be overactive. The body uses this mechanism to fight pathogens to stop the spread of infection. Unfortunately, the question seemed to be misleading for some good candidates who went for the wrong answer D (spread of infection).

Question 12

There was an issue with the Spanish translation of ATP, but both options are accepted in different books and it really did not affect the answer.

Question 15

There was a complaint in the G2s that prokaryotes have plasmids and linear DNA. This is true, but what is not true is that eukaryotes have only one linear chromosome; therefore the only possible answer was B.

Question 21

There were several complaints about this question. It was a good discriminator, which shows it was not hard for capable candidates. The question asked about the “major contributor” to antibiotic resistance. In topic 5.2, the NOS statement is: “Use theories to explain natural phenomena—the theory of evolution by natural selection can explain the development of antibiotic resistance in bacteria”. One of the understandings reads: “Mutation, meiosis and sexual reproduction cause variation between individuals in a species. Natural selection increases the frequency of characteristics that make individuals better adapted and decreases the frequency of other characteristics leading to changes within the species”. Mutations in bacterial species have always occurred but only after the use of antibiotics was there a huge rise in antibiotic resistant strains, as the environment favoured the reproduction of antibiotic resistant bacteria.

Question 23

This question did not aim at the students knowing the species of birds, it was testing their knowledge of the binomial system of nomenclature.

Question 24

This question was clearly too difficult and not a good discriminator. Although fructose does cross the intestinal epithelium through facilitated diffusion, candidates could have been confused by the co-transport mechanisms of glucose in the villus and that made them answer D (active transport).

Question 25

Although this question seems very easy, it confused candidates. The pressure in the aorta is highest during the ventricular systole, when the atrioventricular valves are closed and the semilunar valves are open. Some candidates erroneously believed the pressure in the aorta was greater during diastole.

Question 28

This was a very good discriminator. Good candidates correctly answered the conditions for inspiration, while weaker candidates answered that the contraction of the diaphragm (this is correct) along with an increase in the pressure in the thorax (this is incorrect) caused inspiration.

Recommendations and guidance for the teaching of future candidates

There were some complaints about the time candidates have for each question. 1.5 minutes per question is a reasonable amount of time to answer these questions. Teachers can train candidates using past papers.

Another complaint was that only objective 1 was tackled in this paper. This is not the case for this exam, as there is a balance between the three objectives. There are questions requiring memory, but most questions expected analysis from candidates.

Teachers should make sure the new guide is used rather than the previous one.

Use different sources to teach students, for example original papers from scientific journals.

No marks are taken off for wrong answers. Candidates should attempt to answer all questions.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 8	9 - 16	17 - 24	25 - 33	34 - 43	44 - 52	53 - 72

General comments

Thank you to the teachers who submitted G2 forms. Most of the responses thought that the paper was of an appropriate difficulty, with 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. It should be remembered that this is the first examination using the new syllabus, so the comparison is pleasing. Most respondents thought that the clarity and presentation of the paper was at least fair.

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

The feedback from centres indicates that teachers were satisfied with the paper difficulty and scope of the paper.

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

Identification of nuclei in electron micrographs.

Differences between the composition of blood in the renal artery and vein.

Synthesis of organic compounds containing nitrogen and phosphorus.

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

Sex-linkage

DNA replication

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

Section A

Question 1: Data based question on ecology of corals

(a) Most candidates were able to select the correct curve, read off the two figures and do a simple subtraction to get the answer.

(b) Nearly all candidates got the idea that as ocean temperature rises coral cover falls. Many also made the point that in the periods of falling or constant temperature the coral cover did not change. A few candidates pointed out that there is no proof from the graph that temperature is affecting coral cover even if they are correlated.

(c) This was also well answered by most candidates, though a few thought that the greenhouse effect could occur in water as well as in the atmosphere. There was also confusion about the mechanism of the greenhouse effect from the weakest candidates.

(d) Almost all candidates either suggested a variable that could more easily be controlled in the laboratory or mentioned control variables in general.

(e) This was well answered too. Most candidates decided that the experimental data supported the observed data because of the greater percentage of dead corals at higher temperature. A few did not accept that there was support because of the difference between the temperature increases – this argument was also accepted.

(f)(i) About half of candidates scored the mark here. The others mostly did not make it clear that calcification decreased with decreasing pH in all three species.

(ii) A wide range of answers was given here, but any answer below 7.9 was accepted.

(iii) The only verdict accepted here was that the effect will not be the same in all the species, but this had to be backed up with at least one argument based on the data. Perhaps because the data was complicated, with three independent variables (pH, temperature and species), many candidates struggled to give such an argument clearly enough.

(g) A wide variety of animals was suggested. Phyla containing species that have external parts made of calcium carbonate or particular species within these phyla were accepted. Vague answers such as sea shells or shellfish were not accepted.

(h) This question was based principally on an application in part 4.4 of the program. About half of candidates were able to explain how carbon dioxide dissolves to form an acid in ocean water and that rises in atmospheric carbon dioxide from fossil fuel burning are increasing this process. Other candidates mostly stated that pollution was the cause, sometimes mentioning a named pollutant. A common answer that was not accepted was that burning of fossil fuels to generate power in boats causes the acidification.

(i) There were some interesting answers here. A wide range of arguments was accepted and they could be phrased in many different ways. The weakest answers tended not to get beyond the idea that coral reefs are ecologically important.

Question 2: Structure of intestine epithelium and control of the cell cycle

(a)(i) Nearly all candidates were able to label microvilli, but to get the mark a nucleus also had to be labelled and about half of candidates got this wrong, mostly labelling vesicles in the goblet cell as a nucleus.

(ii) In retrospect, this question should probably not have been included in the exam, as goblet cells are not mentioned in the program and in 6.1 the skill of identifying tissue layers in the intestine wall does not extend to identification of individual cell types. Marks were therefore awarded generously and all that was expected was that candidates deduce from the obvious vesicles in the goblet cell that secretion is taking place. It was not necessary to state secretion of mucus.

(iii) This was answered correctly by a small minority of candidates. The main pitfall was to think that the area with vesicles is the entire cell, so no nucleus is present and cell division is impossible, whereas there is indeed a nucleus visible in the cell, but it is in interphase so the cell is not about to divide. The alternative argument that the cell is differentiated and therefore non-dividing was also accepted.

(b) Better prepared candidates keyed into the role of cyclins in the control of the cell cycle and many of these had impressive knowledge of this new topic in the program.

Question 3: Metabolism and enzymes

(a) The first row of this table was considered to be too ambiguous. Water is split, which could be regarded as catabolic, but ADP is phosphorylated and that is arguably anabolic. For this reason and to be fair to all candidates, the first line on the table was not marked and the two marks available were awarded for correctly stating which part of metabolism the light-independent reactions and glycolysis are in.

(b) There was tendency for candidates to write about enzyme activity and not answer the question by outlining the importance of enzymes to metabolic processes. There were some excellent answers that included ideas of enzyme specificity and end product inhibition.

Question 4: Variation, natural selection and speciation

(a) Mutation was regarded by the examining team as an essential answer here and many gave it. The other answer could have been meiosis, random fertilization or sexual reproduction. It

could be argued that only mutation adds to the variation in a gene pool and that the other processes merely make new combinations out of what is already in the pool, but this argument was not seen in candidates' answers.

(b) This was another part of the exam where candidates did not always answer the question. The whole answer was expected to focus the importance of variation, in evolution by natural selection. Variation is of course a *sine qua non* of natural selection, but to score well it was necessary to explain the reasons for this.

(c) There were some clear and informative accounts of how speciation occurs. The main error was to imply that lack of interbreeding is a consequence of speciation, rather than a pre-requisite for speciation to be able to occur.

Question 5: Sex-linkage

(a) Nearly all candidates correctly deduced that the allele for hypophosphatemia is dominant. Any logical explanation of how the pedigree proves this was accepted. The main problem candidates seemed to have was in explaining their argument unambiguously enough for it to make complete sense.

(b) About half of candidates gave the correct genotype using the conventional notation of upper case X to indicate the sex chromosome, with a superscript letter for the allele.

Section B

Almost all candidates chose question 7 and roughly equal numbers answered 6 and 8 as their other question.

Question 6: Gas exchange and blood circulation

(a) This question elicited some interesting and perceptive answers, with evidence of detailed knowledge of the double circulation. Many candidates made the point that oxygenated and deoxygenated blood are kept separate, but fewer knew that the different systolic pressure are needed in the pulmonary and systemic circulations.

(b) This was not a high scoring question. Many candidates wanted to describe adaptations of alveoli for gas exchange rather than things that happen. The examining team considered the capillaries to be part of the alveolus, so blood flow to maintain concentration gradients was relevant. Many candidates forgot to mention pressure and volume changes during inspiration and expiration.

(c) Few candidates gained all three marks here, despite relatively easy points being available for the differences in oxygen, carbon dioxide, urea and glucose concentrations. Given that urine can be hypotonic or hypertonic, water and solute concentrations can be higher or lower in the renal vein than artery, but candidates seemed unaware of this.

Question 7: Phloem transport, flowering and DNA replication

(a) Answers here ranged from authoritative accounts of translocation in phloem, to brief and inaccurate general comments on transport in plants.

(b) Almost all candidates knew some of the details of sexual reproduction in flowers. Pollination and seed dispersal were described by many candidates, but the details of fertilization were often muddled and meiosis was rarely mentioned.

(c) This is now a familiar question in IB Biology exams and well-prepared candidates did not have any difficulty in achieving high scores. In some answers there were signs of memory failures and significant details were incorrect. The best answers explained both the 'what' and the 'why' of DNA replication.

Question 8: Energy in photosynthesis and food chains, and use of minerals in biosynthesis

(a) Most candidates realized that they were being asked about the light dependent reactions of photosynthesis and there were some first rate answers. Some candidates used the approach that they would explain everything they knew about photosynthesis in case it was relevant. This can give high scores for the part question, but makes the award of a quality mark less likely.

(b) This was not well known. Shrewd candidates scored two marks by giving examples of biochemicals containing nitrogen and phosphorus, but few were able to extend their answer by saying anything else relevant about synthesis of compounds containing these elements.

(c) This was a question of two parts: how energy flows through ecosystems and how it is used by organisms. Most candidates concentrated on the former and said little or nothing about the latter. Scores were therefore modest.

Recommendations and guidance for the teaching of future candidates

Candidates should be encouraged to think carefully about a question and phrase their answer so that it refers specifically to it. The aim in this new biology program is for candidates to develop a thorough understanding of the topics they have studied and not merely learn facts by rote. Questions will tend to test understanding, and candidates' scores will be low unless they genuinely answer the question.

Candidates are strongly advised to write the whole of each section A answer inside the box provided. Whilst examiners will make every effort to find and read parts of answers that stray outside the box, extending answers in this way is a breach of the instructions at the start of the exam.

Where diagrams are included in an answer to a section B question, they should be annotated rather than merely labelled, and it should be clear how the diagram forms part of the answer. A series of labelled diagram at the end an answer rarely results in the awarding of additional marks.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 14	15 - 19	20 - 23	24 - 29	30 - 34	35 - 50

General comments

Thank you to the teachers who submitted G2 forms. Most of the responses thought that the paper was of an appropriate difficulty. 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. It should be remembered that this is the first examination using the new syllabus, so the comparison is pleasing. Most respondents thought that the clarity of the paper and the presentation were at least fair.

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

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

Question 1 had sections which were fairly straightforward but still tricky for less prepared candidates.
The data analysis sections proved difficult for many. Many did not compare but just restated numbers or just restated the headings from tables. It was quite obvious that some topics had not been taught in several centres (control of cell cycle, the distinctions between domains and also cladograms). The functions of the capillaries and the uses of mineral ions were poorly understood.

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

Understanding of command terms was generally sound. Extended responses were of a higher standard than in previous years. Candidates generally confined their answers to the spaces provided, with concise responses and there was far less use of extra pages.

Section A

Simple calculations of mass differences using data in table.

The interpretation of tables and graphs in question 1 seems better done than in some past exams.

Drawing of food web and identification of competing organisms based on provided research information. However a significant number of candidates either forgot to put arrows on lines, or had them pointing in the wrong direction.

Recognition of mitosis from a word description.

Determination of haploid number.

Section B

Basic structural knowledge of arteries and veins in relation to their physiology.

Knowledge of gas exchange over alveoli.

Energy movement through trophic levels.

Drawing a labelled pyramid of energy diagram.

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

Question 1

(a) Few candidates failed to gain the mark for the simple calculations.

(b) Most gained the marks. Weaker candidates did not progress from the stem of the question, repeating “mean temperature difference” instead of saying that the temperature increased or decreased. In the data table the dams were just described arbitrarily as “high” or “low”, so answers describing a linear relationship between height and temperature difference were incorrect.

(c) Many candidates were well prepared with an understanding of statistics; weak answers missed the fact that the “trend line” (needed in the answer) was very shallow. Strong answers recognised scatter issues; quite a few underperformed.

(d) Many missed the fact that both flooding and tree felling were in the stem and also ignored the word “analyse”.

(e) Unfortunately there were no prizes for the best drawings. Many candidates, especially from South American centres reversed the arrows or forgot to put arrowheads. The arrows must show the direction of the energy flow.

(g) Few candidates stated a clear criterion, even with the clarification given in the stem. Weaker candidates hung on to the mayflies and temperature differences. There were very few clear discussions.

Question 2

(a) A surprising number saw this as a prokaryotic cell. There were a few wild guesses such as "eukaryotic as it has 80s ribosomes".

(b) (i) either correct or wildly wrong.

(ii) This had obviously not been covered in a large number of centres. The cell cycle was reasonably well known, but its control was a mystery to most candidates. Although cyclins are neither enzymes nor hormones their description as thus was not penalised. There were several G2 comments to the effect that 4 marks seemed too many for this question.

Question 3

(a) Some very fuzzy ideas about metabolism, with some definitions more akin to digestion being offered. It is defined in section 2.1 of the guide.

(b) Thank you to all the teachers who commented on this question. Knowledge of the light dependent and light independent stages of photosynthesis are not required at SL. There is also some debate as to whether the light dependent stage should be classified as catabolic (photolysis) or anabolic (formation of ATP and NADPH). It was expected however that the terms *anabolic* and *catabolic* were known (section 2.1) and that respiration was catabolic and photosynthesis was anabolic. The question was marked as fairly as possible; where a candidate knew that photosynthesis is an anabolic process, credit was given.

(c) Unfortunately only the better candidates read past the word 'respiration' and answered the question, with weaker ones just describing anaerobic and aerobic respiration.

Question 4

(b) and (c) Candidates misread the stems. (b) was about why mules cannot reproduce, so there should have been no reference to horses or donkeys) and (c) was about horses and donkeys, so mules should not have been included, except for the fact that they are the infertile offspring.

(d) Perhaps the fact that that the mule was born at a university confused some candidates, who answered in terms of genetic manipulation etc. Few were able to state 'non-disjunction'.

Question 5

(a) Again another 'new' area of the syllabus that had not been taught. The vast majority of candidates either scored zero or did not attempt the question. There were several G2 comments that the level of knowledge expected was not clear. This appears in section 5.3 of the syllabus.

(b) Similarly cladistics had not been taught either, but appears in syllabus section 5.4.

Section B

For the first time in the November examinations there was a choice of one out of two questions, instead of three as in the past.

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.

Question 6: Physiology

(a) Even although the stem mentioned “tissues”, a surprising number of candidates seem to think that capillaries only exist in the alveoli and villi. Many used the word “materials” from the stem, not developing it to say which “materials” were exchanged.

(b) Most candidates had a good knowledge of the circulatory system, but many got bogged down with too detailed descriptions of the systems, rather than the structures and functions of the arteries and veins. Some treated the question as a compare and contrast, using a table, which often meant that explanations were lacking. The reasons for muscle and elastic tissue in arteries was not so well understood.

(c) Generally quite well answered, but many failed to recognise that it was not a duplication of (a). The two types of pneumocytes were often confused.

Question 7: Energy flow and nutrients

(a) This was generally answered well, but few stated that the chemical energy was stored as sugars and how the plant uses those sugars. A surprising number of, albeit weaker, candidates still think that the energy is recycled in the end.

(b) Very few good answers here; only a few saw the soil nutrients as components of amino acids/proteins and/or components of nucleotides/nucleic acids. Most just stated that they were released by saprotrophs.

(c) Some pyramids were triangles; stepped ones were rarely to scale, but figures indicating 10% transfer were often provided. Credit was not given for any names other than producer, primary consumer etc., as this was an easy question for most.

Recommendations and guidance for the teaching of future candidates

This was the first November 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 cyclins, domains or cladograms. 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 faint 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.

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, 2b (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 quality mark in section B.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 15	16 - 22	23 - 28	29 - 35	36 - 45

General comments

Although the very first sitting of examinations for the new syllabus was in May, this was the first one for the November session. Despite the high numbers of candidates and a new type of examination paper, comments on G2 forms were received from only 26 teachers. Of these teachers, most felt that the level of difficulty of this paper was appropriate. When comparing the difficulty of the paper to last year’s, the majority thought it was of a similar standard or a little more difficult. For clarity of wording and presentation, most felt it to be at least good.

There were no reports about candidates omitting to answer section A and/or answering more than one option in section B, a major improvement compared to last May. The majority of respondents chose option C or option D, a lower number option A, and only a small number option B.

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

The level of knowledge shown by candidates was variable, ranging from excellent to weak. In general a large number of candidates struggled to express their answers clearly and concisely and lacked the expected subject-specific vocabulary. It seems that many candidates ignore the scope of some questions and only focus on a few keywords, often repeating expected answers from past papers for which questions were based on a different syllabus and/or on a different perspective. Many candidates have difficulty adjusting their answers to the command terms, especially higher level ones, and/or providing a variety of elements proportional to the mark allocation. Interpreting data and making predictions from data is also difficult for many.

It appears that many candidates had difficulty with basic plant physiology, synapse maintenance, the process of swallowing, explaining the role of hair cells in the cochlea, interpretation of antibiotic sensitivity tests, bioinformatics, the concept of biopharming, the

difference between micro- and macro-plastics, the edge effect, bottom-up and top-down factors, and detailed explanation of the Bohr shift.

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 (although some were not careful about axes and scales). They seemed to deal better with areas of the programme common to both the past and present syllabus and be slightly more prepared to deal with questions relating to human physiology. Some candidates were well prepared for extended questions on biofilms and supply of phosphorus to crops.

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

Section A

Question 1

(a) Most candidates could state that higher concentration of enzyme caused a faster reaction or saw a positive correlation. A surprising number answered in terms of duration of hydrolysis, but most of these did not realize that reaching a plateau meant that the reaction was over.

(b) Most candidates sketched a curve within an acceptable range, but many did not start from zero.

(c) The majority of candidates were able to answer this without difficulty, explaining the effect of lower pH on enzyme activity. A certain number confused denaturation of the enzyme with denaturation of fish protein, showing that they did not pay attention to the question wording.

Question 2

(a) Most candidates recognized the small intestine; parts of the small intestine were not required as they are not covered by the syllabus and are difficult to distinguish between each other.

(b) Many identified correctly the layer of tissue as *epithelium*; candidates are expected to know about the concept of tissue, as specified by the question, and it was therefore incorrect to answer *microvilli* as many others did since these are cell structures.

(c) A good number of candidates could measure correctly the distance between the two black lines on the paper, but some measurements were also outside an acceptable range. Although many of these candidates could calculate a correct answer with the measurement they made, many errors occurred, ranging from shifting decimals incorrectly when converting centimeters into millimeters (it was easier to measure in millimeters to start with), inverting the correct formula they had actually written when calculating, and obtaining an incorrect answer with the correct figures and formula. A certain number did not have a clue about calculating the magnification.

(d) Many drew correctly an arrow going into the epithelium, but too many drew an arrow going all the way through the full length of the villus.

Question 3

(a) Obtaining sap using aphids is part of the syllabus, but, for diverse reasons, many candidates didn't seem to know about this. Among those who knew, there were many very clear and precise answers; others could formulate a correct answer, but it seems that they did not know that aphids were insects and/or what a stylet was, often confusing them with some kind of instrument.

(b) This question required a careful consideration of the stem, drawings and graph and was a good opportunity to demonstrate basic understanding of plant physiology. Some brilliant answers were seen, but most answers were far too vague and even irrelevant, some even discussing germination or implying that sucrose was absorbed by the roots. Few realized the significance of the sugar/amino acid ratio. Although it could be answered only discussing sucrose levels with many valid possibilities, the question required to take the time frame into account in the answer and include sufficient details to explain the changes, not merely describe them.

Section B

Option A: Neurobiology and behaviour

Question 4

(a) Most correctly gave neural pruning as the answer.

(b) Some had difficulty connecting the information to their answer here, but nevertheless managed to demonstrate understanding of the process.

(c) A good number of candidates gave consequences of having many synapses instead of the causes. Most suggested that there was an excess of synapses formed.

Question 5

(a) Most candidates realized fMRI measures blood flow in the brain, indicating activity. Many also knew it is a non-invasive, real-life observation.

(b) Most candidates were able to compare and contrast at least three possibilities of the action of the two drugs on the two areas of the brain. There were a few candidates who didn’t make actual comparisons but simply listed values, which is not sufficient for this type of question.

(c) Many candidates answered correctly in terms of processing visual information, but there were a number who only mentioned receiving visual signals, which was not sufficient.

Question 6

(a) This was generally well answered although some candidates knew little about coordination of involuntary reflexes by the medulla.

(b) There were similar questions in the past and most candidates could give an adequate example. Using terms such as “bird” is considered too vague (as it is a whole class of animals) whereas “dog” is accepted (as the common name of a species). Human examples, such as learning to read or learning a foreign language, were exceptionally accepted for this paper because the question wording did not exclude it.

Question 7

(a) The majority of candidates could label the required parts correctly, although there were an important number who confused the round window with the oval window.

(b) Most candidates knew this well.

(c) Most candidates had a vague idea but could nevertheless mention that hair cells transmit impulses through the auditory nerve. Many answers lack precision and most candidates do not distinguish between hair/cilia and the hair cells themselves.

Question 8

On the whole, candidates knew the general effect of anesthetics although not many included sufficient details of their effect on synaptic transmission. As the question clearly asked for general anesthetics, many candidates wasted valuable time describing local anesthetics, although the common action between both types did gain marks.

Option B: Biotechnology and Bioinformatics

Question 9

(a) It was evident that some candidates had never seen Petri dishes with antibiotic sensitivity tests and had no idea of how to interpret the image.

(b) Some candidates understood this clearly and others not at all.

(c) Some candidates had no idea of the difference between the two groups of bacteria and could not predict the result.

Question 10

(a) Most candidates could state that only the cotyledons with the resistance survived but many had difficulty expressing what the marker gene was.

(b) There were many guesses here as to the name of a correct tool.

(c) Most candidates were able to interpret the graph correctly and a large number could also back up their suggestion.

(d) Most candidates had an idea about a gene gun action, but there was confusion about the details of the gene gun action, some stating the DNA was inside the metal, others that the DNA was shot directly into the correct gene.

Question 11

(a) Most candidates gave the example of glucose and diabetes, but some were confused.

(b) There was confusion here between general transgenic organisms and biopharming. Most candidates were able, at best, to give an example and state that it could be recovered from milk (most commonly mentioned).

Question 12

(a) Some candidates could state the correct tool but many only guessed.

(b) This was difficult for most candidates and they struggled to express themselves.

(c) (i) Although some candidates had no idea, many gave the correct sequence.

(ii) A surprising number of candidates said that the DNA coding had to be identical, despite of the table given in the question.

(d) This question caused difficulties, as many answers were very vague, simply mentioning similarities without being able to give details.

(e) Most candidates correctly identified the two genera.

Question 13

There were some outstanding answers here and some very poor. Most candidates knew at least some elements about the general formation of biofilms and some problems associated with their formation, although not all were able to incorporate a sufficient number of elements to their answer.

Option C: Ecology and conservation

Question 14

It was clear that most candidates had a generally correct interpretation of the graph, but many struggled to express themselves and many could not quite answer the focus of the question as to how the data showed the respective niches.

Question 15

(a) Most candidates gave a correct example (although in Spanish this seemed to cause a problem and some candidates gave a process causing pollution instead of an example).

(b) There was confusion here between macro- and microplastics and their effects. Many gave strangling or suffocation on plastic but this only applies to macroplastics.

(c) Many candidates limited themselves to only one element in their answer (wind blowing the pollution across the lake) without considering the number of marks available for the question.

(d) Most candidates provided putting more bins and implement fines as an answer, but many could not suggest more changes and gave more detail to the same points.

Question 16

(a) Most candidates could name one method, but often confused transects with quadrats. Many descriptions were incomplete.

(b) The edge effect is not well understood by most candidates. Many had vague ideas but were unable to express them well. There is an awareness of movement of species and instability, but no clear idea of the effect on diversity, neither at the edge nor in the centre.

(c) Most candidates could compare and contrast the richness and evenness of the two fields, using the data, but there was a certain number who confused the two or had no idea.

Question 17

(a) Many candidates could clearly state two bottom-up factors, but some only guessed or had obviously no idea. There is a relatively small number of candidates (but numerous enough to mention) who alarmingly thought that algal blooms were a species or associated algal blooms with *Zooxanthellae*.

(b) Explaining top-down factors was more problematic. Many candidates clearly stated predation and herbivory as factors, but could not provide a clear explanation. Others stated the same factors as for the bottom-up question.

Question 18

Most candidates had some notion of the importance of and sources of phosphorous for crops as well as of the factors related with its sustainability. Brilliant answers were seen, but some candidates had difficulty expressing this clearly with sufficient detail.

Option D: Human physiology

Question 19

(a) Most candidates could say that the drug was more effective than the placebo and that it was less effective than the change in lifestyle.

(b) Most candidates could provide two risk factors out of the numerous possibilities.

Question 20

(a) (i) Most candidates could label the second messenger correctly.

(ii) Fewer candidates labelled the gene regulatory protein correctly as the figure with straight sides, either within the cytoplasm or the nucleus; many candidates did not pay attention and labelled incorrectly the gene regulatory protein and the steroid hormone complex within the nucleus.

(b) Many candidates stated a correct characteristic, such as “hydrophobic” but failed to complete their answer with a brief account necessary to comply with the command term “outline”.

(c) Most candidates could state two mechanisms of action of peptide and steroid hormones elements, but some had difficulty organizing their answer into a point by point comparison and contrast, as required, while some provided a very clear answer within a table.

Question 21

(a) (i) A large number of candidates could correctly identify cell X as a Kupffer cell, although some identified it incorrectly as a hepatocyte.

(ii) Most candidates' outlines matched the cell they identified, but only functions of Kupffer cells were correct.

(b) Most candidates were able to describe several elements of regulation in the liver, but some limited themselves describing in great detail the regulation of glucose, which is only one element required in this question. Others wasted time describing the liver blood circulation, which was not required, without actually answering the question. This is an example of candidates not focusing on the question wording and elements of the current syllabus, which may differ from both past papers and syllabuses.

(c) Most candidates could explain the importance of bilirubin in the onset of jaundice with a variable number of elements, some providing clear and complete answers. For some

candidates, there was some confusion about where bilirubin comes from and how it is removed from the body.

Question 22

(a) Most candidates calculated correctly, but others misread the values on the graph or simply performed an incorrect calculation.

(b) Most candidates described the activity correctly.

(c) Most candidates provided a correct explanation.

Question 23

Most candidates showed knowledge on this question, some providing excellent answers and showing full understanding of the supplying of oxygen to the tissues, whereas others exhibited very little knowledge, discussing simply the exchange of gases in the lungs and/or tissues. Many candidates did not use the curve to organize their answer, as required, wasted time explaining transportation of CO_2 in great detail and failed to explain how the Bohr shift provides more oxygen to the tissues at the same partial pressure of oxygen.

Recommendations and guidance for the teaching of future candidates

Although the syllabus has changed, many recommendations from past subject reports still apply. Those apply to syllabus coverage, writing skills and examination techniques.

Syllabus coverage

- The syllabus has to be covered completely, including understandings, applications and skills.
- The syllabus must be covered in class and complex topics should not be left for the students to cover on their own.
- Practical skills and understandings from the core and the AHL are necessary for section A in Paper 3 and should therefore not be approached as different compartments. 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.
- Although candidates should have a comprehensive view of biology, this should be according to their level and the syllabus contents. Teachers are therefore expected to make connections between parts of the syllabus, but not to go much further than the syllabus limits; guidance notes in the subject guide and examination papers are designed accordingly.
- It is important to update the teaching according to the present syllabus and, if necessary, amend contents accordingly, removing parts and approaches relating to past syllabuses.
- Teaching of all understandings should be at objective level 3, when applicable.

- Teachers and candidates are encouraged to use multiple sources of reference.
- It is always recommended to practice from past examination papers and mark schemes, but candidates and teachers should be aware of syllabus differences and expect that new questions might have a different perspective.

Reading and writing skills

- Many candidates could have reached a better performance in this exam by reading into the questions more carefully. A school approach to reading into details, using specific vocabulary, could perhaps improve the situation.
- 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.
- Many answers in this examination lacked sufficient detail and proper use of specific terminology. Teach the vocabulary of biology as candidates need to use subject-specific vocabulary in their answers. Biology education is language education. Candidates must have access to a strong vocabulary of subject-specific words and concepts. Teachers may choose to build up a glossary of terms used in the programme. If candidates are at a loss for words they will be unable to express their ideas with clarity. Candidates' answers were often too superficial for HL biology. This is true irrespective of whether candidates were learners of English as an additional language or not.

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 longer answers often looked unplanned and contained repetitive and irrelevant material. Developing the habit of taking a little time to lay down and organize an answer's core elements would improve answers and prevent the omission of important ideas. Coach candidates on how to structure longer response questions. 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 key words in the question and plan their answers.
- Do not repeat the question or stem in the answer box. This is not awarded any marks and uses up time and space needed to answer the question.
- The number of marks is often an indication of the expected details and number elements for a complete answer. An "outline" question should never be answered using only one word.
- Bring a ruler into the exam. This could help measure values on graphs with the required precision.
- Most candidates write within the prescribed boxes. All candidates should nevertheless be reminded that examiners view scanned papers on screen 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 and especially small and tight handwriting often causes 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 responses which extend into a continuation booklet. An indication that an answer is continued should always be made in the main booklet whenever a continuation booklet is used.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 4	5 - 9	10 - 13	14 - 17	18 - 22	23 - 26	27 - 35

General comments

Although this is the first time the new guide has been examined for November schools, only a negligible number of students failed to answer section A. Teachers appear to have taken advantage of the May 2016 paper to support the students. The feedback from centres indicates that teachers were satisfied with the paper difficulty and scope of the paper.

Of the teachers who completed G2 forms, most felt that the level of difficulty of this paper was appropriate. The majority thought that this paper was of a similar standard or a little more difficult than last year's. Most felt that both clarity of wording and presentation were at least good.

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

There was a lot of confusion between respiration and photosynthesis in plants.

There was considerable difficulty in the recognition of structures in microscope images.

Very few candidates understood the question on the reasons for the differences in nutrient stores in taiga and tropical forests.

There were many vague answers given which were probably more due to poor exam technique than to lack of understanding. For example, it is not enough to say that "carbon dioxide is absorbed by the soda lime", candidates must identify the source of the gas.

A number of candidates continued their answers outside the boxes. It is much preferable if candidates use additional pages if they feel the need to respond at a greater length.

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

Option B tends to be taken by well-prepared students.

The external assessment details in the guide state that section A will contain “two to three short answered questions based on experimental skills and techniques, analysis and evaluation”. This section had some good discriminating questions in which the better candidates performed well.

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

Section A

Question 1

(a) Nearly all candidates could suggest a valid reason for the wire mesh.

(b) Most candidates could score some marks for describing the respirometer. Some candidates talked about the oxygen bubbles passing along the tubes; others failed to mention respiration.

(c) Discussing the use of the respirometer to measure plant oxygen consumption discriminated well. Some candidates confused photosynthesis and respiration and stated that plants respire by taking in CO_2 and converting it to O_2. Some wrote that plants do not respire at all.

Question 2

(a) Almost all candidates could suggest a reason for the differences in the results.

(b) Many candidates answered water bath or incubator as a means of controlling the temperature though some suggested Bunsen burners, air conditioners or thermometers.

(c) The concepts of control and variables were well understood.

Question 3

(a) Most candidates identified the slide as coming from the small intestine though some simply put intestine which was considered too vague.

(b) Many candidates gave answers that were not tissues such as villi, lacteals and mucous.

(c) Most candidates could calculate the magnification. Many knew the formula but made errors in calculations and measuring

Section B

Option A

Question 4

(a) The majority of candidates recognised that the right ear would not here all conversation.

(b) Most candidates stated that the woman needed louder sounds to hear with the right ear but few related this to the amplification of sound by the bones.

(c) This questions discriminated well with most candidates scoring at least one point, often for the auditory nerve. A few candidates confused the cochlea with the semi-circular canals.

Question 5

(a), (b) and (c) Most candidates were successful in their outline of the embryonic processes. Nearly all knew about neurulation. The question discriminated well among weaker candidates.

Question 6

(a) Most candidates could identify the cerebellum but most candidates scored only one from a possible two marks for outlining its function.

(b) Few candidates used the required terminology so did not receive full marks. Many candidates received one mark for reference to folding of the cortex.

Question 7

(a) Very few candidates could label both structures shown in the diagram of the eye.

(b) Most candidates scored some marks explaining how the pupil reflex could be used to assess brain damage. The stronger candidates scored full marks.

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 8

(a) and (b) Nearly all candidates could identify the fungus as *Aspergillus niger* and state that 30˚C was the optimum temperature for enzymes.

(c) Most candidates could recognise the negative feedback of citric acid but fewer could explain the continued increase in sugar consumption.

(d) Most candidates could state two uses of citric acid. Most common error was simply stating “food additive” which was considered too vague an answer.

Question 9

(d) Explaining how crop yield was increased was omitted by many candidates.

Option C

Question 11

(b) Many candidates did not interpret the question correctly and referred to competition with *Balanus*.

(c) The question wanted candidates to describe the changed distribution and say why. Most referred only to competition. Candidates did not always answer according to the mark scheme though their answers did show some understanding. There was considerable confusion between niche and habitat.

Question 12

(a) Most scored rainforest and desert; tundra sometimes given as III.

(b) Many candidates seemed to be confused in their responses and did not seem to understand the question. Few linked decomposition with saprotrophs.

Question 13

(a) Most candidates scored for evenness but not richness. Many wrote excess information, possibly due to too many answer lines being provided.

(b) Some candidates did not mention diversity/biodiversity, but talked about evenness and richness.

Question 14

(a) and (b) The benefit/harm of using DDT was generally well understood.

Option D

Question 15

(a) Most candidates scored at least one of the two possible marks.

(b) Fairly well answered though some candidates simply stated there was an increase in the QT without giving a reason.

(c) Showed varied levels of understanding with systole and diastole being common incorrect responses.

Question 16

(a) and (b) These questions were generally well answered, reflecting familiarity with previous exam question. Some candidates stated that leptin is produced by hypothalamus.

Question 17

(a) Mostly correct, 1.3g was a common error.

(b) Most candidates could state a function of sodium in the diet.

(c) Mostly correct but many incorrect responses listed nutrients: proteins and vitamins.

(d) Most candidates mentioned calcium but fewer mentioned Vitamin D.

Question 18

(a) Many identified the Kupffer cell with hepatocyte being a common error.

(b) The better candidates were able to explain the role of bilirubin in jaundice and receive full marks. Weaker candidates described the symptoms but not the cause.

Recommendations and guidance for the teaching of future candidates

Enable students to identify different structures from a variety of sources, including photographs, diagrams and micrographs.

Make sure that all candidates have access to the syllabus and are familiar with the command terms included with each syllabus statement. They should also be familiar with the structure of the examination and the instructions at the beginning of the paper. This lowers student anxiety and allows them to use the five minute reading time as a confirmation of what they already should know.

The candidates must be familiar with the entire content of the new guide. There were cases where good candidates were leaving blank spaces on their answer scripts suggesting they had not been exposed to the content.

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.

The new guide is based on an approach to teaching based on scientific reasoning and thinking. This implies that students should not simply memorise processes but need to understand what is occurring in order to answer the questions.