May 2016 subject reports

Biology

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 27	28 - 39	40 - 52	53 - 64	65 - 77	78 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 13	14 - 24	25 - 35	36 - 48	49 - 62	63 - 75	76 - 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

A very large range of inventive and original investigations were presented. 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 work presented were classic investigations that represented a low input from the candidate. Some were even the investigations specified in the programme with no modification.

Consideration of safety and ethics were frequently lacking (often in field work).

There were trivial investigations that were not of the appropriate level for the IB biology course and some that were simply not biological in focus.

Very few databases, simulations or hybrids were presented. Those involving modeling were very rare. This is most likely because their inclusion in the internal assessment component is new. Their numbers may grow in future sessions.

Candidate performance against each criterion

The application of the assessment criteria by teachers was generally good, though often overgenerous. Therefore, 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 and it does discriminate between the candidates but many just seemed to hurriedly finish off the investigation. As one examiner explained “they seemed to power down after having started well”. This could be the effect of it being done 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 expression of personal significance at all.

The originality of the exploration 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 to collect 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 in 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 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 and controls need to be discussed.

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.

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 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.

There were some microbiological methods being carried out that were very inappropriate for a school environment. Culturing microbes at 37°C is unacceptable, for example, testing the

bactericidal properties of saliva or culturing bacteria from tooth plaque to test the effectiveness of toothpastes.

There were some potentially dangerous practices in physiological investigations, for example, the use of manual sphygmomanometers in the investigation of blood pressure, this requires adequate training.

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

The environmental impact and safety for field work 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 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.

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.

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. 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 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.

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.

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. A scientific context is needed for a full discussion and this was frequently superficial or absent.

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 not often 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 communication criterion was generally achieved. Those who communicated well were candidates who had already scored highly in the other criteria.

The most common problems in the work were:

- Use of whole pages for titles or contents. These are not necessary.
- Blank data tables presented at the end of the method section (unnecessary).
- Repetitive tables, when one would do.
- Multiple graphs drawn when they could have been combined, this would not only save space but also improve comparisons.
- Bibliography, footnotes, end notes 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 considered 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 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.

In general the reports were of a suitable length.

There were not 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 choice 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. These will be 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 helpful to the moderator).
- 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 spread sheet or a programmable calculator will not be expected.

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). Where the comments issue was identified this session, the IB was able to expand these comments and re-upload the material.

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.

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 motive behind the teacher's marks.

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 appropriate

to pool it. In the last programme, data pooling was appropriate in some cases as work could be submitted separately for DCP and therefore did not also have to be include an original protocol if D was not being assessed.

As the current IA requires only one investigation it is difficult to see a clear way to independently explore and yet still pool data. If it is an environmental investigation, students could certainly refer to measurements taken by other students and, sometimes, for example in field work, it may be appropriate to pool some data but without similar sampling designs it would be difficult to completely pool data.

Students must therefore 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 for example but they would need to be working independently.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 14	15 - 19	20 - 24	25 - 28	29 - 33	34 - 40

General comments

Nearly 83% of the teachers responding on G2 forms 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, 35% of teachers thought the standard was similar; the rest believed it was more difficult. Over 66% of the teachers felt that the clarity of the wording was good to excellent. The proportions were higher for the presentation of the paper, with a few more finding it excellent.

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

The questions that were answered least successfully were on DNA profiling, sodium-potassium pump and dominant alleles.

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 biological molecules, differences between DNA and RNA and the Krebs cycle.

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

As this was the first session under the new syllabus, comments are included here on many questions, especially the questions that proved to be controversial or caught candidates out, unexpectedly.

Question 1

This question was too easy, as 90% of the candidates correctly answered this question, easily recognising the molecule of a sugar. Some of the other structures were not of real molecules and in retrospect, this should not have happened.

Question 2

This question was a good discriminator; good candidates had the right answer while weaker candidates did not realize that it is the breaking of the H bonds between water molecules that makes it a good coolant.

Question 3

A very good discriminator, where only the capable candidates recognized glycogen as a polysaccharide.

Question 4 and 5

These questions proved to be too easy.

Question 6

There were many comments on the G2 forms about this question. The teachers were concerned that candidates would confuse embryonic development with embryo, but this did not seem to happen. The question was too wordy and rather confusing, but the answer was obtained out of common sense. Most candidates went for the correct answer D. This was the only possible answer, as when located in a gene promoter, DNA methylation acts to repress gene transcription. DNA methylation is typically removed during zygote formation and re-established through successive cell divisions during development.

Question 7

This question had the greatest number of G2 comments. Although teachers believed this was an unfair question, some candidates were able to see the tandem repeats only present in answer D. This was the only answer with 7 base pair repeats (there can be between 2 and 60 base pair in a tandem repeat). It is agreed that it is possibly too short a sequence to easily see the repeats and that this could have put off some good candidates.

Question 8

This question proved to be a very good discriminator. Some teachers complained that the structure was showing a bit of a loop, therefore they believed the answer should have been tertiary structure instead of secondary structure. In the diagram it is clear that the entire model is of a tertiary structure of a protein and that the box is only showing a bit of an alpha helix, therefore the secondary structure is being shown.

Question 9

This question had very high discrimination; good candidates were able to answer it well. It is true that the question ought to have clearly stated that A was the graph showing enzyme activity without inhibitor, therefore allowing candidates to compare with the activity using an inhibitor. As this graph is in most books, candidates did not seem to have any problems answering that B was the curve showing competitive inhibition.

Question 11

Was a good discriminator and was testing a topic of the nature of science (NoS) section.

Question 12

Teachers complained that this was a tricky question. Most candidates chose the correct answer of G3P, but some believed that RuBP was the first to contain radioactive carbon. The major complaint was that in the question the fact that ^{14}C was radioactive was not stated in the question. This is in the guide, so part of the testing required candidates to infer this from the question.

Question 13

This was a very good discriminator. Good candidates were able to see a prokaryotic cell carrying out binary fission. It would have been better to have a scale bar next to the diagram.

Question 14

Despite the complaints, this question is perfectly suitable for this test as in 1.1 of the guide there is an application that states that one should question the cell theory using atypical examples, including striated muscle, giant algae and aseptate fungal hyphae. This was a very good discriminator.

Question 15

This question brought many comments. The IB has agreed with many teachers that the diagram is not appropriate, as facilitated diffusion was meant to be shown, but the change in the shape of the protein could have implied the use of energy through active transport. Therefore both answers A and D were accepted.

Question 16

Many teachers believed this question was beyond the scope of what is needed to be known about the sodium-potassium pump. Although the team agree with them; this question could be answered just by looking at the movement of ions, therefore it is acceptable.

Question 17, 18 and 19

These were all very good discriminators.

Question 20

Although some teachers criticized this question, it is perfectly fair. Many candidates believed that dominant alleles have a joint effect with recessive alleles in co-dominance.

Question 22

This question was a very good discriminator. Many candidates were able to recognize the recombinants.

Question 23

This was a highly criticized question. Many teachers believed that D was the correct answer. The fact is that not all species overproduce offspring. There are many species in danger of extinction (for example, the Giant Panda) and it is clear that these species are not over-reproducing themselves.

Question 26

Some platyhelminthes do not have a mouth and none have an anus, therefore the correct answer is B.

Question 27

This question was poorly worded but most candidates had the correct answer A. This is obviously the most correct answer, as the most extreme xerophytes have modified their leaves and transpire through their stem. It is true that some xerophytes accumulate salt, but they are not the majority. It is not right to say that moisture is absorbed at night.

Question 28

This question discriminated very well. Most candidates mentioned the meristems allowing for the production of roots, stems and leaves.

Question 29

This question was addressing section 9.4 of the guide. The NoS statement explains that 85% of plants depend on pollinators for reproduction, therefore C was the correct answer.

Question 31

This question had low discrimination as good candidates were confused by it. Many answered that the structures were analogous, but rabbits jump and frogs swim, so they are homologous. The question was related to the structure of the pentadactyl limb.

Question 32

The wording of this question could have been clearer.

Question 33

This question had relatively high discrimination. Some teachers complained that amylose was not in the guide, but it does appear in section 2.3.

Question 34

This question was difficult, but also a good discriminator. Many candidates wrongly believed that surface area affects the secretion of enzymes in the villi. This is not true, as surface area affects the absorption of substances, not the secretion of enzymes.

Question 35

This question brought about a lot of controversy. The answer could really be obtained out of common sense.

Question 36

This question discriminated very well. Good candidates were able to distinguish arteries from veins. Some teachers complained that arteries carry oxygenated blood and veins deoxygenated blood, but this is not true for pulmonary and umbilical arteries and veins.

Question 37

This question was in general well answered, as candidates recognized that antibiotics do not affect viruses.

Question 38

This was one of the best discriminatory questions. Good candidates had obvious studied section 11.2 well.

Question 39

Although the presentation of the information was quite novel, candidates were able to answer this question without problems.

Question 40

Most candidates recognized cell X as a primary spermatocyte. There were some complaints that the chromosomes were not very clear, but this did not seem to be the case.

Standard level paper one

Component grade boundaries

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Mark range:	0 - 7	8 - 10	11 - 13	14 - 17	18 - 20	21 - 24	25 - 29

General comments

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

The questions that were answered least successfully were on genetic code, meiosis and dominant alleles.

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 biological molecules, differences between DNA and RNA and transcription.

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

As this was the first session under the new syllabus, comments are included here on many questions, especially the questions that proved to be controversial or caught out candidates unexpectedly.

Question 1

This question was too easy, as 90% of the candidates had this question right, easily recognising the molecule of a sugar. Some of the other structures were not of real molecules and in retrospect, this should not have happened.

Question 2

This question was a good discriminator; good candidates had the right answer while weaker candidates did not realize that it is the breaking of the H bonds between water molecules that makes it a good coolant.

Question 3

This question helped to discriminate well.

Questions 4

This question proved to be too easy.

Question 5

Some teachers complained that this question was unfair, as only the universality of the genetic code was expected in the guide. This is true; nevertheless the answer can be deduced and in section 1.5 the guidance does mention that there are some minor changes that have accrued since the origin of species. Most candidates went for answer B, believing that there were differences between base sequences of genes in different species. Although this answer is a true statement, it does not explain why the genetic code is not universal in all cases. The same happens for answers A and D.

Question 6

An easy question.

Question 7

This question was a good discriminator and was testing a topic of the NoS section.

Question 8

This was a very good discriminator. Good candidates were able to see a prokaryotic cell carrying out binary fission. It would have been better to have a scale bar next to the diagram.

Question 9

Some teachers complained that eukaryotic cells are not compartmentalized. In section 1.2 of the guide it specifically mentions this as a characteristic to take into consideration.

Question 10

Despite the complaints, this question is perfectly suitable for this test, as in 1.1 of the guide there is an application that states that one should question the cell theory using atypical examples, including striated muscle, giant algae and aseptate fungal hyphae. This was a very good discriminator.

Question 11

This question brought many comments. The IB has agreed with many teachers that the diagram is not appropriate, as facilitated diffusion wanted to be shown, but the change in the shape of the protein could have implied the use of energy through active transport. Therefore both answers A and D were accepted.

Question 12

This question was answered well by good candidates, therefore was a good discriminator.

Question 13

This question was a very good discriminator. Many weak candidates wrongly believed that fusion of gametes occurs in meiosis and not that it is a consequence of it.

Question 14

This was the most successful question, as good candidates were able to find the parents that could give all blood groups. Weaker candidates went for answer B.

Question 15

Although some teachers criticized this question, it is perfectly fair. Many candidates believed that dominant alleles have a joint effect with recessive alleles in co-dominance.

Question 16

Despite some complaints, this question was well answered by good candidates. In general, proteins are separated using a polyacrylamide gel. The SDS-page method is one of the most popular in molecular biology procedures. In this case, proteins are previously denatured. SDS molecules bind to unfolded proteins in large excess, providing extra negative charges to the molecules. Therefore, upon SDS-treatment, the specific charge (the charge-to-mass ratio) of different proteins will become roughly identical.

Questions 17

Although most candidates got the right answer, many candidates wrongly believed that autotrophs have internal digestion.

Questions 18

This question was a very good discriminator.

Question 19

Some platyhelminthes do not have a mouth and none have an anus, therefore the correct answer is B.

Question 20

Although this question was asking for a detail of the photosynthetic process, the answer is stated as an understanding in section 2.9.

Question 21

Although the correct answer is a bit wordy, it could easily be found by discarding the other answers.

Question 22

This question was cancelled. The addition of the word “always” in the question meant that none of the answers was completely correct. It has been replaced for publication.

Question 23

This question had low discrimination as good candidates were confused by it. Many answered that the structures were analogous, but rabbits jump and frogs swim, so they are homologous. The question was related to the structure of the pentadactyl limb.

Question 24

Most candidates answered the correct answer D. Some teachers complained this answer was only partially correct, as the product of amylase digestion is maltose, and this is not absorbed in the villi.

Question 25

An image from an electronmicrograph would have been better. A layer seems to be missing, as the serosa is very small. The majority of candidates however gave the correct answer.

Question 26

This question brought about a lot of controversy. The answer could really be obtained out of common sense.

Question 27

This question discriminated very well. Good candidate were able to distinguish arteries from veins. Some teachers complained that arteries carry oxygenated blood and veins deoxygenated blood, but this is not true for pulmonary and umbilical arteries and veins.

Question 28

This question discriminated very well.

Question 29

This question was generally well answered, as candidates recognized that antibiotics do not affect viruses.

Question 30

Some teachers complained this topic is not in the guide, but it is specifically mentioned in section 6.6.

Higher level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 19	20 - 25	26 - 35	36 - 44	45 - 54	55 - 72

General comments

There were far more G2 comments from teachers than in previous sessions, which helped significantly with the grade award process. Thank you to those people who took the time to submit a form.

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

Candidates found several parts of question 1 difficult and in particular they struggled to identify significant trends within data and ignore the ‘noise’.

Many candidates found these topics difficult: intestine structure, neonicotinoid pesticides, adaptations of mitochondria, histology of intestine and water transport in xylem.

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

Most candidates were able to demonstrate good understanding of health issues relating to the circulatory system, enzyme action, enzymes involved in DNA replication, the use of Punnet squares to show patterns of inheritance, energy losses in food chains and some aspects of kidney function.

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

Section A

Question 1 was not unusual in having three separate pieces of data, but it was unusually long in terms of the total mark allocation.

(a) Most candidates successfully identified the highest mean blood glucose concentration.
(b) Answers here were varied with many candidates correctly stating either that insulin is not produced or that beta cells are destroyed. A common incorrect answer was to state that diabetes is a purely genetic disease.
(c) There were also varied answers here with some candidates not appreciating the significance of the presence of insulin mRNA or not stating it clearly enough.
(d) Many candidates failed to pick out more than one significant trend here. The data before the transplant was not relevant so the three phases that could have been described were the initial drop in blood glucose in the transplant group, the period when both groups remain relatively constant but the transplant group stayed lower and finally the rise in the transplant group to the original level before the transplant. For the latter two points the timing was expected.
(e) Very few candidates scored both marks here. The point commonly made was that the drop in the transplant group is temporary. Very few candidate also made the significant point that the transplant did not cause the blood glucose concentration to drop down to the level before diabetes had been induced, so even in the early stages the treatment was not fully effective.
(f) This was an easy value to read off the graph and nearly all candidates got it.
(g) Many candidates found it difficult to tease out the causation here and implied that because group 2 were given some insulin they did not need to produce so much themselves. The stem stated that the patients in both groups were Type 1 diabetics and the best candidates realised that in group 1 the stem cell treatment had been more successful so more proinsulin was produced and cut, leaving more C-peptide.
(h) This was another place where many candidates failed pick out enough significant similarities and differences. One similarity and four significant differences were included in the mark scheme but most candidates scored only one or two marks (out of three).
(i) Most realised that there are ethical concerns if an embryo is damaged or killed and not if stem cells are taken from the placenta and umbilical cord before they are discarded, but the phrasing of answers was often too imprecise for a mark to be awarded. Terminology was frequently vague or incorrect. The terms embryo and fetus are not

interchangeable, for example.

(j) Many teachers correctly commented on G2 forms that there was an ambiguity in this question. It instructed candidates to use data from all three studies and also to evaluate the use of embryonic stem cells. Only study 1 had specifically been carried out using embryonic stem cells and study 3 was certainly done with umbilical cord rather than embryonic stem cells. It was therefore very important for candidates to quote which study they were using for a particular point and not all did this. Another weakness of some answers was to mention trends in the data without making them clearly a strength or weakness as is expected in an evaluation. The best answers coped well with the ambiguity in the question and scored full marks.

Question 2 had a theme of obesity, fats and appetite control.

(a) (i) Teachers expressed fears in G2 forms that candidates would be unable to use the nomogram through unfamiliarity. In fact most candidates successfully read off the value as instructed.

(b) (ii) Many candidates could name a health problem of the circulatory system correlated with obesity, but vague terms, such as clogged arteries, were not allowed.

(c) This was generally well answered. Most candidates showed a saturated hydrocarbon chain correctly and many also showed the carboxyl group.

(d) Despite the fact that the hormone leptin is a new concept in the syllabus many candidates were able to answer this question accurately. In weak answers there was some confusion over the origin of leptin and its role.

Question 3 was loosely based on muscle.

(a) This was possibly the least successfully answered question on the paper. Very few candidates were able to name the two tissue layers. In retrospect it was probably unreasonable to use two marks for a small and perhaps insignificant aspect of the programme. Candidates were expected to see that layer II was circular muscle because of the orientation of the muscles cells in this transverse section. In practice almost no candidates did this. A few knew that I and II were circular and longitudinal muscle. No penalty was made for getting these layers the wrong way round but even so very few marks were awarded. Many candidates were clearly guessing and in some cases the answers showed a misunderstanding of the organs being a group of tissues. These candidates suggested a wide range of answers in including types of cells or parts of cells.

(b) This application was not well known by the majority but even without specific knowledge of neonicotinoid pesticides it was possible to score some marks by sensible use of the information provided in the question and wider biological understanding. This type of pesticide is under intense research at the moment because of its effect on bees so it is a topical example of the nature of science.

(c) Many candidates included the idea of a mutation in their answer and also that insects with genes for resistance would survive, breed and pass on these genes to their offspring. The only common mistake was to confuse resistance and immunity.

Question 4 was based on evolution.

(a) There was much criticism of the cladogram from teachers in G2 forms and predictions that candidates would not understand it. In practice, most candidates realized for point

A, they were expected to give a feature of fish that is absent in birds and mammals, the reverse of this for B, and for C a characteristic of mammals that is absent in birds and fish. This was an effective test of candidates' knowledge of the characteristics of these three chordate groups.

(b) In this question candidates were expected to apply their understanding of evolution and speciation to the context of the early evolution of vertebrates. All that was expected was a methods of reproductive isolation, differential natural selection and divergence until the differences between populations and their gene pools were great enough to prevent interbreeding. Candidates mostly got at least part of this.

(c) Question setters try to include some stimulus material to make questions more interesting but the first sentence of this question proved to be a distraction rather than a help. Candidates only really needed to think about the second sentences and so describe two structures and explain how they help the mitochondrion to carry out its function of producing ATP.

Section B

The choice of extended response questions was reduced from four to three in this first exam paper of the new programme. There was no evidence that candidates' answers were weaker than before. The mark allocation was also reduced from 20 to 16, with only one quality mark rather than two, allowing more questions in section A. Question 5 was the most popular and Questions 6 and 7 were chosen in approximately equal numbers by candidates. Each question had two shorter and relatively easy parts based mainly on core material and one more challenging part based on AHL topics.

Question 5 had enzymes as its theme.

(a) This was generally well answered with most candidates able to give enough of the important features of enzyme action to score well. One mistake seen in a number of responses was to state that the active site is on the substrate rather than on the enzyme.

(b) Knowledgeable candidates had no difficulty in scoring full marks by giving an accurate description of the role of enzymes in DNA replication. It was not necessary to focus on the leading and lagging strands as the action of the various enzymes is largely the same, though of course primers are repeatedly added to the lagging strand and then replaced. Some candidates were obviously concerned that they were being asked about prokaryote DNA replication. This is of course the type of DNA replication that is specified by the programme and has been for many years. It is worth making sure that candidates know that they have learned about this rather than eukaryote replication.

(c) This part was very well answered with many candidates scoring full marks. There were a few errors in notation with different letters of the alphabet used for alleles of the same gene or X and Y chromosomes indicating confusion between autosomal and sex-linked genes.

Question 6 was based on membranes and kidney function.

(a) There were many neat and accurate diagrams of membrane structure showing a variety of proteins. It was not difficult to earn the three marks. Peripheral proteins should be shown on the surface of the phospholipid bilayer, not embedded in it.

(b) This part was less well answered, with candidates failing to make the basic points about the events caused by putting plant tissue into a hypertonic solution. Some candidates misunderstood the term ‘tissue’ and talked instead about placing whole plants in a solution. Candidates should be careful to state that hypertonic means a higher solute concentration, not just a high concentration. Explanations of osmosis in terms of water concentration should be discouraged as there are no units for measuring such concentrations. Water potential terminology is not expected as it is not part of the new programme.

(c) Answers to this question were very varied. The functions expected were osmoregulation and excretion thus the focus should have been on how the nephron can vary the volume and concentration of urine so as to bring the blood back to normal levels, and on how waste products can be concentrated in urine to conserve water. Some teachers commented on G2 forms that is was unreasonable to expect details of the structure of associated blood vessels but all that was required was the structure of the glomerulus. Able candidates who had prepared carefully were able to score highly but weaker candidates tended to be very muddled.

Question 7 was more heterogeneous than the other section B questions and touched on plant cell structure, energy flow in food chains and water transport in plants.

(a) Diagrams of plant cell structure were mostly rather poor and few candidates scored full marks. The question specified ‘as seen in an electron micrograph’. Many diagrams showed the appearance of plant cells in a light micrograph. This allowed marks for cell wall and cell membrane to be awarded, but not for internal structures such as the nucleus as their representation was not detailed or accurate enough. In contrast to the membrane diagrams in 6(a), many of these cell diagrams were carelessly drawn with overlapping, multiple or discontinuous lines used for structures that have a single continuous edge.

(b) This is a familiar question, though there was a slight twist in that candidates were expected to explain specifically why food chains cannot be long. Nearly all candidates wrote about energy losses between trophic levels and many mentioned the '10% rule' though in some cases got it the wrong way round and stated that 10% of energy is lost. Too few candidates mentioned the most important idea – that release of energy by cell respiration and its use is accompanied by loss of energy from a food chain in the form of heat.

(c) This question caused some problems. It was another case where a sentence had been added to set the scene, but it proved a distraction rather than an aid to focus. The wording of the question as a whole was clear, but many candidates seemed not to have read to the end of the second sentence and they did not therefore explain how losses of water by transpiration are replaced. Some answers were concerned exclusively with xerophytic adaptations. An extensive markscheme was devised that allowed these answers to score up to five marks. Those candidates who did actually describe the uptake and transport of water within the plant were able to score full marks. There were few really strong answers and many misunderstandings. One in particular is worth mention: capillary action due to adhesion of water to xylem walls only helps to refill xylem vessels when they are air-filled. If a plant is transpiring the xylem will be filled with water under tension and adhesion cannot cause upward movement.

Recommendations and guidance for the teaching of future candidates

- Answers should only be placed inside the boxes on the exam paper. Usually the space inside the box is sufficient for the expected answer but if more space is needed this should be on an extension sheet, not outside the box. Use of extension sheets should be clearly indicated by the candidate in every answer to ensure that examiners quickly and easily find the additional text.
- Use firm lines when doing drawings as faint lines do not show well on scanned exam responses. Try to avoid sketchy lines that overlap or have gaps.
- If graphs or diagrams are included to help in an answer, other than a question asking only for a diagram, then annotations should be included around the diagram, not just names of structures. Only annotations can give sufficient information to help with an answer.
- Candidates are expected to have studied applications that are included in the programme as a way of building transferable understanding. Though questions should not focus on memorization of details of applications, some familiarity with this material is needed.
- Teachers should allow plenty of practice at data analysis and encourage candidates to find what is significant in the data. Candidates should look for the simple first and not be afraid of stating something that might seem to be obvious. Candidates should avoid using excessively colloquial language in data analysis or ambiguous terms. For example, the term ‘spikes’ is being used instead of ‘rises steeply’. A spike surely is a steep rise followed by a steep fall.
- Teachers should make sure that the changes to the command terms are reflected in their approach to questions. There are several significant changes including the introduction of the combined term ‘compare and contrast’.
- Questions using the word ‘evaluate’ require judgements to be made, not just repeating partial results or processed data.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 14	15 - 21	22 - 29	30 - 36	37 - 50

General comments

438 teachers submitted G2 forms. Of the responses, 79% thought that the paper was of an appropriate difficulty, with the others considering it too difficult. There was almost a 50:50 split between respondents who thought it was of a similar standard or a little more difficult than last year’s paper, and those who thought the opposite. There were several comments made that too many marks were available for chemistry of life, and, as is usual for the first paper of a new

specification, there was a lot of question dissection. There were a few comments made about the there being too much in the paper for the amount of time allowed. However, examiners did not report 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 DA sections proved difficult. Many did not compare but just restated numbers. Those who did frequently did not compare the correct variable.

Linking effect was an issue e.g. in 2(c) high level of leptin to decreased food intake seemed surprisingly difficult for some.

In 3(b) the greenhouse effect was poorly understood and the link between long and short waves appears not to have been reinforced.

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

For many of the factual recall sections such as 2(c) (however the sticking point was leptin released by adipose tissue with many not knowing this), most if not all question 4 well prepared candidates did well.

Evolution and nervous impulses proved to be again a good discriminator with good, well prepared candidates demonstrating solid understanding.

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

Question 1

It should be noted that when describing relationships, marks will not be awarded for just stating numbers from a graph without their significance. Qualifications must be used, such as more, greater etc. Several teachers thought that this question was too difficult and assumed too much knowledge. In effect it could be answered without any knowledge of embryology or cyclins as the information was given.

(a) Many candidates scored zero as they just quoted numbers without stating that, for example, nerve cells increase the least. A number of candidates confused the circle denoting the nerve cells with the square denoting the control. There was some comment that the description of ‘external’ and ‘inner’ caused some confusion. This did not seem to be evident in the marking.
(b) Most candidates were able to spot that cell population growth was slower in the differentiating cells.

(c) Most candidates gained at least 1 mark, for stating that the % of cells in G2 was similar in both (compare mark), but % nerve cells in G1 was greater than control etc. (for contrast mark). Weaker candidates tried to compare all 3 cell lines.
(d) This proved a good discriminator, with only the better candidates being able to link the percentage of cells with population growth, for example, more cells in G1 with slow population growth.
(e) Very few candidates were able to state that the product of mitosis was 'two genetically identical nuclei' as stated in the specification. The word 'cells' was accepted in place of 'nuclei'. The word 'cycle' at the end of the question was, as several teachers commented, not entirely accurate.
(f) As with 1(c), weaker candidates tried to compare all three cell lines, not just control and nerve, as asked. Most candidates gained at least one mark for stating that D3 was similar in both (compare). Cyclins are mentioned in the specification in 1.4, but a detailed knowledge of their action was not required (as thought by several G2 comments) as sufficient information was given.
(g) This proved to be a very good discriminator. Better candidates did realize that to discuss differentiation, then the control cells also need to be included. It should be noted that the question asked about possible roles.

Question 2

- (i) From the received G2 comments, teachers thought that the nomogram was too difficult. However most managed to give the correct answer of 60Kg.
- (ii) Coronary Heart Disease was the most common correct answer. Although obesity and Type 2 diabetes are related, diabetes is not a problem of the circulatory system as asked for. It should be noted that the command term was 'state', not 'describe'.
- Most gained at least one point for the unsaturated chain. Common mistakes were losing marks for having the carboxyl hydrogen joined to the chain, instead of the Carbon.
- It was obvious that many teachers had not included Leptin in their new scheme of work. Several comments from G2 forms (perhaps from these same teachers) seemed to imply that 3 marks was too much for this part.

Question 3

(a) (i) The expression 'thermal properties' seemed to confuse weaker candidates, who looked ahead to part b and tried to compare them as greenhouse gases. Perhaps the use of 'physical properties' might have been better. Many were able to state, for example, that water has a high boiling point, but did not get the mark as they did not continue to say that it was much higher than methane.
(b) (ii) Most remembered about hydrogen bonds, but lost the mark for forgetting to state that they are between molecules.
(c) The writer of this question presumed that the more visual learners would use the diagram to produce an annotated response. In fact, very few used the diagram at all. The difference between long and short wavelengths was very confused, and weaker candidates were obsessed with explaining the composition of the greenhouse gases, and the role of the ozone layer (usually incorrectly). As a major problem affecting the planet, there seemed to be a lot of confusion.

Question 4

(a) Most candidates gained two marks, the most common mistake being to label the deoxyribose as ‘ sugar’ or ‘ ribose’

(b) Again this seems to be an area that escaped some teachers in their reading of the new specification and resulted in a large number of G2 comments, most of which seemed to think that the oversimplification of the cladogram led to confusion. In the end better prepared candidates had no problem with the question, managing to state a fish characteristic for A, something in common between birds and mammals, e.g. homeothermic for B and a general mammalian feature for C (but not forgetting the monotremes)

(c) If candidates had been taught this section, they knew that the domain was eukaryotes.

Section B

For the first time, there was a choice of one out of two questions, instead of one out of three. Several teachers seemed surprised by this, even though the specification and practice papers were printed far in advance. There were comments implying that this does make the paper more difficult as it restricts choice.

Question 5

(a) Enzymes – The command term was ‘outline’. Many candidates tackled it as if they were setting out to write as much as they could about enzymes, whilst missing the main points about catalysis, specificity, making the reaction go more easily and the active site and substrate.

(b) Genetics – A very large number of candidates did not understand the word ‘autosomal’ and described the inheritance of haemophilia correctly. They were given some credit. Many lost the first mark as they failed to include a key to explain what the letters they were using represented. Candidates must remember to state what they may think is obvious.

(c) Nerve impulses – Most candidates knew the purpose of myelin. Unfortunately many could explain little else. Well prepared candidates gave very clear answers. The confusions between sodium and potassium and diffusion and pumps were rife.

Question 6

(a) Eukaryotic plant cell – Well prepared candidates drew clearly labeled diagrams that were dark enough and scanned well. Many lacked precision, with labeling arrows pointing at spaces. Some G2 comments from teachers correctly pointed out that it does not explicitly say that candidates need to draw a plant cell as seen under EM. However 1.2 does state that some cells contain a cell wall, and on the same page it states that candidates should be able to discuss structure and functions of the organelles in a palisade mesophyll cell. Combining these, it is thought that the candidates should have been able to access sufficient points for 4 marks.

(b) Gas exchange and simple diffusion – Most candidates knew what aerobic respiration was, but could not apply it to the question. Perhaps under the pressure of the examination, candidates many did not progress to the second line and therefore missed the expression ‘unicellular eukaryotic organism’. Detailed knowledge of the alveoli and the Krebs cycle did not gain marks.

(c) Evolution – Several G2 comments were made which questioned whether the candidates should be answering a question on evolution. It is a topic that has appeared on the examination many times and well prepared candidates had no trouble answering it. The number of 'Lamarckian' answers where individuals instead of populations or species were evolving showed the continued decrease shown over the last few years.

Recommendations and guidance for the teaching of future candidates

- This was the first examination under the current syllabus. Teachers should make sure that the candidates are aware of differences in the specification when attempting past questions.
- In addition, teachers should ensure that their schemes have been fully updated as it was obvious that some centres had not taught, for example, Leptin 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 receive any marks.
- 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. Teachers must advise candidates not to write outside the boxes. Additional pages should be used instead. Also, it should be stressed that if candidates are continuing after writing in the box, they are almost certainly writing too much. If they do go on to extra pages, this should be stated in the response box.
- Some candidates do panic when they see question 1. Perhaps they should be encouraged to start on section B and then return to question 1. In section B, and in the longer answers, for example, 1(g) and 3(b), 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.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 16	17 - 22	23 - 27	28 - 33	34 - 45

General comments

As this was the first sitting of examinations for the new syllabus, there was a significant increase in the number of respondents and the feedback was thoughtful and very useful.

The comments on the G2 forms indicated that 80% of the respondents felt the difficulty level was appropriate although 44% felt it was more difficult than last year. This is an increase from last year's statistics in which 30% felt the exam had been more difficult than previous years. The clarity of the wording was considered good to excellent by 70% of respondents and the presentation was felt to be good to excellent by 74% of respondents. This is lower than in previous exam sessions with several concerns expressed about sentences that may have confused rather than helped learners of English as an additional language.

The paper has changed in both format and content compared to previous years, with a compulsory section A appearing for the first time. Many respondents felt what would be included in section A had not been made adequately clear. Many thought that this section would only assess the seven required practical investigations. As indicated on page 147 of the Biology guide, "Section A: candidates answer all questions, two to three short-answer questions based on experimental skills and techniques, analysis and evaluation, using unseen data linked to the core and AHL material". This includes a much wider range of material under skills and application. Many respondents also felt that the paper actually showed overlap with the type of questions tested on paper 2.

Another concern by respondents, linked to the change in format of the paper, was with the instructions. The instructions on the front page were clear, but the presentation of "Section A" followed by "Option A" created the possibility of confusion so that some candidates might not answer section A as, at a glance, it might be mistaken for option A. This is a concern that will be addressed in the future but candidates need to be reminded to read and follow instructions carefully, even when under the pressure of examination day. While any candidate omitting a section of the exam is worrying, the percentage observed to do this was small overall.

Several respondents also felt that the time allocated was not enough as the number of marks had increased from 40 to 45 with no additional time allowed. There were also comments that there were more graphs and data for the candidates to read through making it difficult to complete in time. Examiners did not find an indication of this when marking.

Positive comments on the changes to the paper were also noted with several commenting that this revised version gives candidates more opportunity to "demonstrate mastery of process and data analysis, rather than mastery of static content" and that they felt it to be "tough but fair", and that although "challenging with more critical thinking required", it was "not impossible". The paper was felt to have good questions, if candidates were clear on concepts and had studied.

The most popular options this session were C and D with a large number choosing A as well. While option B was less popular than the others, candidates selecting this option were often well-prepared. Very few candidates attempted more than one option which was good to see.

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

The level of knowledge shown by candidates was highly variable, ranging from excellent to extremely weak, with concern that some candidates should have been entered for SL rather than HL biology. In general a large number of candidates struggled to express their answers

clearly and concisely and lacked the expected subject-specific vocabulary. Questions on new areas of the syllabus (neural pruning and plasticity) were often poorly answered.

Command terms were not clearly understood or ignored. Candidates often did not 'evaluate' but instead 'described' and instead of 'outline' they would respond as if the question asked them to 'state' or 'list'. These words need to be used correctly throughout teaching so that they are familiar to candidates in an examination situation.

Topics that appeared difficult to candidates included:

- Coral, CO2 levels and coral bleaching
- Use of aphids
- Role of auxin on plant cells
- How synaptic density changes with age
- How neurons can be altered by memory and learning
- Clear use of sequence alignment software
- Biomass, photosynthesis and respiration relationship
- Estimating population sizes in a marine environment.

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

In general, candidates did well at retrieving information from graphs and performing basic calculations, even if they did not appear to fully understand the data. In almost all cases, candidates were able to read graphs and interpret trends accurately. Objective level 1 questions such as those that required labeling of diagrams were done well.

Candidates appeared to be better prepared for topics which had been on the previous syllabus (liver function).

Topics for which candidates appeared well prepared included:

- Colour vision
- Continuous culture fermentation
- Microorganisms used in bioremediation
- ELISA test
- Role of the liver.

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

Section A

The majority of candidates scored lower on section A than on their selected option.

Question 1

(a) The vast majority were able to read the graph correctly, noting that as CO_2 increased, calcification decreased. Only stronger candidates used terms such as 'negative

correlation' or 'inverse relationship'.

(b) The majority were also able to get the mark here, usually for noting that the mesocosm allowed for control of all variables although many seemed doubtful as to what a mesocosm was.

(c) Candidates found this difficult and few could correctly outline why increasing CO_2 levels affected coral. Many simply repeated the stem of the question. Few seemed to know that coral had an exoskeleton or shell made of calcium carbonate, instead referring in general to the 'reef'. Few also knew the relationship between increasing CO_2 levels and coral bleaching.

Question 2

There were several respondents commenting on the suitability of this question on the G2 forms. This question was based on the skills in 9.2 of the syllabus including "Skill: Analysis of data from experiments measuring phloem transport rates using aphid stylets and radioactively-labelled carbon dioxide".

(a) The vast majority of candidates were able to correctly label this as xylem although many respondents on the G2 form indicated that they found the diagram difficult.

(b) Most candidates were able to score the one mark for this part of the question as many alternatives were given in the markscheme. However, many candidates did not seem to know what an aphid stylet was and mistakenly talked about the stylet 'growing' or referred to it as part of the root.

(c) This was a discriminating question with better candidates able to clearly explain how aphid stylets were used to study the movement of solutes in phloem, also referring to the use of radioactive carbon dioxide. Many unfortunately seemed to have not been exposed to this topic, used imprecise language, referred to the aphid stylet as if it were a piece of lab equipment they could use, or left this blank.

Question 3

(a) Almost all were able to use the data and see that juvenile shots rooted more successfully than mature shoots.

(b) Only the better candidates were able to give a correct reason for this. Many candidates incorrectly simply said that juvenile shoots were more adaptable to change or better able to grow without suggesting why. Few remembered meristem tissue.

(c) This question asked candidates to 'outline' which is to give a brief account or summary, not 'state'. Thus more than simply naming a variable was required for the mark.

(d) This was a very discriminating question with a range of marks from 0 to 3. Many received zero or were only able to score one out of the 3 marks available for noting that auxin played a role in cell elongation. Candidates overlooked the fact that the question asked for 'the effects of auxin on plant cells', often describing phototropism in plants shoots instead which was not awarded any marks. How auxin works on plant cells walls was a new addition to the syllabus and does not seem to have been covered by all.

Option A: Neurobiology and behavior

This was a fairly popular option which discriminated well between candidates, with better candidates who were well prepared scoring highly. From the G2 comments on option A, teachers thought the questions were very fair and consistent with no surprises.

Question 4

(a) Almost all were able to read the correct value off the graph and score one mark.
(b) This question was poorly answered and one that seemed poorly understood. Many candidates did not 'explain' how synaptic density decreases (after 8 months) but instead described the graph. Some were able to get a mark for knowing that the neural pruning occurred and others that the change in density was due to lack of use but little other knowledge was apparent.
(c) Most were able to correctly label the diagram and get two marks.
(d) Some carelessly drew only half the pathway for the reflex arc and therefore did not score the mark for this question.

Question 5

(a) Almost all were able to state the relationship shown in the graph.
(b) Almost all were able to correctly identify the bat as the animal with the lowest brain mass of those shown in the graph.
(c) There were very few good answers to this question. Many were able to score one mark for noting that the ratio for humans was furthest above the line of best fit/correlation curve but few were able to further discuss the evidence provided by the graph. Many confused ratio with brain mass.

Question 6

This question was quite discriminating with one or 2 marks awarded to many candidates. Although summation appeared to be fairly well understood, candidates struggled to express themselves clearly. Many struggled to explain summation using the graphs provided so only the better candidates received 3 marks.

Question 7

(a) This question was surprisingly poorly attempted considering that Pavlovian conditioning is not new to the syllabus. Although many candidates were able to achieve one or 2 marks, very few were able to score 3. Candidates tended to confuse stimulus and response and did not focus on conditioned and unconditioned stimuli.
(b) Most were able to score at least one and many 2 marks for two advantages of bird migration during winter.
(c) Many were also able to score 2 marks for this question on synchronized oestrus in lions.
(d) This question on how neurons can be altered by memory and learning was the one with the weakest candidate answers in this option. Many were confused as to how this was different from question 4(b). Seldom was more than one mark awarded and then for increase in number of synapses.

Question 8

This question on colour detection was similar to ones that have appeared on past papers and candidates seemed very well prepared for it, with a good number of candidates receiving full marks. Weaker candidates tended to include irrelevant material, such as information on rods, but they were able to get marks for knowing the sequence of transmission of the impulse from the cones to the brain. Few mentioned wavelengths of light.

Option B: Biotechnology and bioinformatics

This was the least popular option but for those who did select it, all grade levels were seen and it discriminated between the various grade levels well. G2 comments indicated that teachers considered option B straightforward and covered each of the topic areas fairly.

Question 9

(a) This was fairly well answered with many able to achieve the mark, usually for noting that NADH was a reducing agent or electron donor.
(b) This was an easy question with almost all candidates able to predict one metabolite using the diagram.
(c) The process of continuous culture fermentation seemed to be familiar to all candidates selecting this option with many scoring the 2 marks.
(d) This was discriminating as many found it difficult to clearly show why the given process represented pathway engineering.

Question 10

(a) Most were able to identify the pattern of change in the graph in (i) but suggesting a reason for the pattern (ii) was more discriminating with fewer candidates able to express clearly why this was happening.
(b) Most seemed able to give two environmental benefits and thus earned the 2 marks.
(c) Most candidates were also able to explain the use of Ti plasmids in genetic modification, although some steps were left out, such as the reinsertion of the Ti plasmid in the bacterium or the role of the antibiotic resistant gene.

Question 11

(a) Some candidates had difficulty with this but many were able to give one way the dye was used by the bacterium.
(b) Some were able to achieve the mark by using the term ‘biofilm’ while others understood the concept but did not seem to be familiar with the term.
(c) This was a relatively easy 3-mark question on bioremediation but a few missed out on details or confused organisms and actions.

Question 12

(a) Almost all candidates seemed familiar with reading cladograms and were able to answer this question.
(b) Again almost all candidates were able to answer this question.
(c) This was a more discriminating question. Many were able to score one mark for indicating that DNA from the tissue sample was amplified using PCR but few were able

to give additional details needed to receive 2 or 3 marks. They tended to confuse the answer to this question with that of the following one.

(d) This question on sequence alignment software was often confused with that on PCR. Better candidates were able to explain the use of BLAST software for DNA and protein sequences.

Question 13

Most candidates had a fairly good idea of how to use an ELISA test to detect antigens from a pathogen although the order of steps, and antigen and antibody, were sometimes confused. This discriminated well between candidates.

Option C: Ecology and conservation

This was a very popular option. There were a few questions that candidates seemed to find particularly challenging. Likewise on the G2 forms, there were several comments about questions 16 and 17 which some respondents felt were vague and also on the fact that more analysis seemed required for this option than for others.

Question 14

(a) Identification of the procedure seemed like an easy question but in fact few candidates were correctly able to indicate that a transect was used and that using the graph as a guide, samples were probably taken at 20m intervals. Many tried to show how a random number generator would have been used instead.

(b) Many were able to score 2 marks for listing sources of ammonium in the soil. However, some confused pesticides with fertilizers.

(c) This was a discriminating question with only some able to suggest a reason for lower ammonium levels in the forest interior. The ‘forest edge’ seemed to lead some candidates incorrectly into a discussion of the edge effect.

Question 15

(a) This question appeared to be fairly well understood but not always well answered. Some candidates simply listed the separate ranges without comparing them thus not getting the marks. As this was a ‘compare and contrast’ question, purely numerical descriptions do not score marks.

(b) Again candidates often gave very poorly worded and confused answers and struggled to explain what a realized niche was. However, many were able to receive one mark as they understood that competition between species narrowed the niche.

Question 16

Candidates struggled with most of this question as they showed confusion regarding the relationship between photosynthesis, respiration and biomass. Rarely was the connection made to photosynthesis and productivity.

(a) Many candidates received the full 2 marks for seeing both the increase in biomass as well as the change in rate of increase as well.

(b) Many candidates were able to score one mark for indicating that the increasing biomass was evidence for plentiful rainfall but seldom was a second point made. A few noted

that a forest could not develop without rainfall or that water is a limiting factor for photosynthesis.

(c) A few candidates realized that succession was occurring and the biomass increased as larger plants replaced smaller ones. Carrying capacity was sometimes mentioned when climax community is what they should have been referring to. Others seemed to have no idea as to why biomass was increasing.

(d) Candidates did not seem to understand what was being asked in this question so marks for this were seldom seen.

Question 17

This question was based on section C.3 and the "Application: Case study of the impact of marine plastic debris on Laysan albatrosses and one other named species" so was on the syllabus despite G2 comments to the contrary.

(a) Most understood that plastic was being mistaken for food so were able awarded the mark.

(b) Most were only able to score one mark for suggesting that perhaps Kure had more exposure to human populations and waste than Oahu (which is not in fact the real situation). Most candidates did not see the role of ocean movement and currents in distribution of floating plastics in waters around the two locations where the albatrosses feed.

(c) Most answers about sources of microplastic debris were vague. However, many were able to get a mark for indication that plastics were carried from land sources to the ocean. A few knew that some washing products contain microplastics.

(d) This question on biomagnification was surprisingly poorly answered, a few even writing about magnification using a microscope. Vague answers were given and few properly outlined the concept of biomagnification or seemed to know that substances accumulate in the tissues or gut of organisms.

Question 18

This seemed to be the lowest scoring of the longer response questions at the end of each option. Candidates found this question very difficult, not knowing how to approach it. They did not seem to have the content knowledge required nor did they know how to 'evaluate' the methods used to estimate population size. Many did nothing more than describe a few steps in the capture-mark-release-recapture technique. Others mentioned the general difficulty of collecting data of populations in the ocean. Some mentioned echolocation/sonar with some evaluation as well as the use of the age structure of fished populations, but very few were able to achieve all 6 marks.

Option D: Human physiology

This option was very popular and discriminated well between candidates with the best candidates able to score highly. While many G2 respondents felt the questions of option D were fairly distributed over the different topics of the option, a few felt they were outside the scope of the syllabus.

Question 19

(a) Most were able to score 2 marks by outlining what is meant by an essential amino acid.
(b) Most candidates showed a reasonable knowledge of PKU although many struggled to differentiate between what was required in (i) and (ii). Most were able to state the cause of PKU for part (ii) but fewer could deduce why tyrosine is considered to be a conditionally essential amino acid in (i). Many wrote the same answer in both sections.
(c) There were many comments on this part of the question on G2 forms, some indicating that this was not on the syllabus. Content knowledge was not needed to answer the question as the data provided could be used to score full marks. This section was discriminating. Many candidates struggled to 'evaluate' human milk as a source of amino acids and did not use the data provided. Instead many wrote general statements about human milk, often talking about immunity.
(d) Many were awarded 2 marks but good, clear answers were not common. Candidates sometimes confused oxytocin and prolactin and most seemed unsure where these hormones came from.
(e) Teacher comments on the G2 form indicated that some thought this question outside the scope of the syllabus although exocrine glands are mentioned in D2. While the question was ostensibly about mammary glands, the diagram was generic and could have been any exocrine gland seen with a light microspore. Most candidates received one mark for identifying the ducts visible in this general diagram and better candidates mentioned the secretory cells or acini.

Question 20

(a) Almost all were able to correctly read the graph and estimate the mean residence time.
(b) Most candidates received one mark for noting the relationship between percentage digestible matter and mean residence time but only better candidates were able to explain this. Many were misled into talking about the time taken for digestion to occur rather than mentioning fibre increasing water absorption into the feces and aiding movement by peristalsis.

Question 21

(a) Many candidates were awarded one mark for noting that ventricular systole occurred in the QRS interval but few could go further than that.
(b) This was discriminating with stronger candidates able to achieve the 2 marks but some confused protein and steroid hormone actions and others tried to explain the effect of epinephrine on the heart. There were several comments on the G2 forms that the reference to epinephrine was not needed and may have confused candidates who were learners of English as an additional language.
(c) Most were able to outline the use of a defibrillator but some only stated the name of the instrument so did not receive the mark as this question asked them to 'outline' the treatment. While some teachers on G2 forms indicated this was not on the syllabus, one of the applications in D.4 is "Application: Use of defibrillation to treat life-threatening cardiac conditions".
(d) Most candidates were able to score one or 2 marks with stronger candidates awarded full marks but good clear answers were not that common.

Question 22

Variations on this question have been asked in examinations for the past syllabus so candidates seemed well prepared on the functions of the liver. Many candidates were able to get full marks although often irrelevant material, such as discussion on bile or details of glucose control, was included. Candidates needed to focus on regulation of chemical and cellular composition of the blood and only stronger candidates did both.

Recommendations and guidance for the teaching of future candidates

Preparation of candidates is essential. Many of these recommendations have been made with regard to the past syllabus but still apply to the new one.

- Teach the details of the option and do not leave complex topics to candidates to cover on their own.
- Teach and practise command terms in class and on homework, tests and exams to ensure candidates are familiar with what is expected by each verb. The objective level 3 words are particularly important as candidates often do not seem to know what is expected from words such as ‘evaluate’ or ‘compare and contrast’. For 'compare and contrast', have candidates practise making a table and using the words 'more' or 'less'. For 'evaluate', they can practise defending their declarative statements using the word 'because'.
- Ensure teaching notes are updated to reflect the new syllabus content and remove old content. Some candidates seemed to have been taught from the old specifications.
- Look up details to topics which may not be familiar as there are new ones on the syllabus. Do not expect one textbook to have everything you need to know in it. Multiple sources as well as use of the internet should be used by teachers.
- Teach all “Understandings” in the syllabus to objective level 3.
- 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.
- 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. Visual organizers may help.
- Focus on the many techniques, experiments, and examples that are embedded in the syllabus to prepare for section A of paper 3.
- Practise section A type questions. Use a variety of graphic presentations.

Examination techniques need to be taught and practised. The following guidelines for candidates may help:

- Read the instructions carefully before beginning the exam.

- Be specific and use correct terminology.
- Do not repeat the question or stem in the answer box. This is not awarded any marks and uses up space needed to answer the question.
- Do not write outside the answer box as this will not be visible to examiners. Use continuation booklets instead. The best candidates gave a sufficient number of points in the space provided; very few gained additional marks from responses which extended into a continuation booklet.
- Use the command terms and the number of marks available as a guide as to how much detail is required. A one-word answer is not enough for 2 marks or for an 'outline' question.
- Write legibly as examiners can only mark what they can read.
- Bring a ruler to the exam and use it to read graphs more accurately.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 3	4 - 7	8 - 11	12 - 15	16 - 20	21 - 24	25 - 35

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

It was apparent that many candidates had not been prepared for the changes in the examination format with poor performances in section A. Some candidates did not attempt any of the questions in section A suggesting they had not been exposed to the new examination structure or did not use the five minutes of reading time to read the instructions on the paper. Question 2, on the Meselson and Stahl experiment proved particularly difficult despite being a required skill listed in the programme guide. The external assessment details in the guide state that paper 3 will contain "two to three short answered questions based on experimental skills and techniques, analysis and evaluation".

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

The section B options were well answered by the candidates showing the candidates were more comfortable with questions of a similar style to the previous guide. The option questions discriminated well among the candidates. Options C and D were most popular and option B least popular. Nearly all candidates performed well in the longer 4-mark questions in section B.

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

Section A

Question 1

(a) (i) and (ii): Most candidates could estimate the osmolarity of the plant tissue though fewer could identify the samples in hypotonic solution. Credit was given to candidates whose answers considered the dissociation of sodium chloride in water. (iii) Candidates had difficulty differentiating between a source of error and a mistake through carelessness or improper technique.

(b) Discriminated well with only good candidates scoring full marks. Many referred to ion movement before the interval labelled X on the graph.

Question 2

Question 2 on the Meselson and Stahl investigation was generally problematic and very poorly answered though a few candidates did score high marks.

(c) The majority of candidates described the shading and densities as opposed to explaining the pattern in terms of the N present in the DNA.

(d) Many candidates scored 2 marks distinguishing between semi-conservative and conservative replication.

Question 3

(b) Generally well answered though many referred to exchange within the mesocosm rather than with the surroundings.

Option A

Question 4

Question 4 was generally well answered. A few candidates had difficulty labelling the diagram of neurulation but most could outline plasticity.

Question 5

Candidates confuse left visual field with the left eye.

Question 6

Many candidates confused the semicircular canals with the cochlea and described the role of the hair cells in in hearing.

Question 7

The graph showing the relationship between brain and body mass proved difficult for many candidates to interpret with both axis being on a log scale. The markscheme gave some flexibility and most candidates scored marks.

Question 8

Some confused ideas but most understood the nervous system processes and structures involved.

Option B

Question 9

Fairly well answered by the few candidates attempting this option.

Question 10

(a) The graph proved quite difficult to interpret as longer bars show less plowing.
(b) Most scored for comparing function of a known sequence with an unknown gene.
(d) Very few mentioned the use of a gun device in biolistics.

Question 11

Generally well answered showing good knowledge of biofilms.

Question 12

Most candidates scored marks in explaining bioremediation.

Option C

Question 13

Most candidates performed well here though some confused niche with habitat.

Question 14

(a) Most candidates could give the differences in the soil but many attributed the older dune characteristics to the younger dunes.
(b) Mixed responses but most could outline how ecosystems can be predicted based on climate.

Question 15

Candidates struggled to find reasons the fox had lower PCB levels and restated that they had lower levels. Only the better candidates could deduce conclusions about PCB's.

Question 16

Nearly all candidates gave good explanations on how alien species affect community structure.

Option D

Question 17

Generally well answered though a role of the vagus nerve caused some confusion.

Question 18

Most candidates could outline the importance of acid conditions in the stomach and interpret the data on refined and unrefined diets.

Question 19

Discriminated well. Few candidates recognised structure I as a venule. The better candidates successfully outlined functions of hepatocytes.

Question 20

Both parts (a) and (b) were well answered with many full mark answers explaining how electrical signalling leads to ventricular contraction.

Recommendations and guidance for the teaching of future candidates

- Candidates should be made familiar with the command terms especially now that the objectives themselves are not defined by a command term.
- Candidates should become familiar with the structure of the examination and the instructions at the beginning of the paper. This lowers anxiety and allows candidates to use the five minute reading time as a confirmation of what they already should know.
- The new guide is based on an approach to teaching based on scientific reasoning and thinking. This implies that candidates should not simply memorise processes but need to understand what is occurring in order to answer the questions.