May 2018 subject reports

**Biology time zone 1**

To protect the integrity of the examinations, increasing use is being made of time zone variants of examination papers. By using variants of the same examination paper candidates in one part of the world will not always be taking the same examination paper as candidates in other parts of the world. A rigorous process is applied to ensure that the papers are comparable in terms of difficulty and syllabus coverage and measures are taken to guarantee that the same grading standards are applied to for the different versions of the examination papers. For the May 2018 examination session, the IB has produced time zone variants of biology HL and SL.

**Overall grade boundaries**

**Higher level**

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**Standard level**

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Internal assessment

Component grade boundaries

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The range and suitability of the work submitted

Many centres presented a very large range of inventive and original investigations. These were a real pleasure to read. However, examiners reported that there appeared to be a greater reliance on classic investigations, some of which are prescribed in the core of the program, with little or no attempt to modify them. This impacts on the personal engagement criterion.

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

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

There were some trivial investigations that were not of the appropriate level for the IB biology course and some with little biological content at all.

Once again, very few simulations were presented though the numbers of databased investigations seem to be increasing a little. Those involving modelling remain rare. New material has been posted on My IB (which has replaced the OCC) including some exemplars that concern these approaches. It is hoped that they may clarify their use and how they are marked.

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

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

A few samples were uploaded with pages missing. Some were scanned in black and white so it was impossible to understand colour coding used on graphs. The IB expects centres to check all uploads before they are submitted for assessment.

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

The samples should be completely anonymous. Examiners were still finding candidate names, teacher’s names, school names and other forms of identification on the uploaded material.
Some of the material was scanned upside down before it was uploaded. This problem can be resolved while moderating but it is irritating and time consuming for examiners.

Overall more centres had their marks adjusted this session. In 60% of centres the teacher’s marks were modified.

Candidate performance against each criterion

The application of the assessment criteria by teachers was generally good, though often overgenerous, sometimes very generous. There are cases where teachers are pointing out significant weaknesses in a criterion and then awarding the highest grade. Therefore, more rigour is necessary when applying the final mark. Teachers were only occasionally considered too severe.

The evaluation criterion is still the weakest for many. This criterion is difficult and it does discriminate between the candidates. For many examiners, the analysis criterion needed more attention. Many candidates were happy to leave the processing at the level of calculating means.

Personal engagement (PE)

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

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

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

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

A number of examiners observed that teachers seem to be content with a statement of purpose at the beginning of the report and then award a 2. Teacher’s need to look further for evidence when judging this criterion. A sub-section devoted to the criterion personal engagement is not what is required.

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)
• Evidence of trial runs
• 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 to obtain the highest mark band for the majority. Scientific names were not always used and the range of the independent variable was not given. For example, a candidate whose question read, “How will different amounts of sugar have an effect on cell respiration in yeast used in bread making?” should have considered including: the species of yeast, 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.

It seems for the teachers’ comments on the samples that a lot seem to be satisfied with less focus in the research question.

The requirements for the background are that it needs to be focused and contain relevant information that is clearly linked to the research question. There were many cases of superficial or irrelevant material taken from a standard textbook. 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 candidate appreciates the other factors that may impact on the experiment. Uncontrolled variables (e.g. room temperature) may have a significant impact; they need monitoring. One cannot assume that putting the experiments in the same place is enough. Control experiments need to be considered more frequently.

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

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

When marking this part 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 little or no evidence of concern. It is not sufficient to identify potential areas where safety is an issue, there needs to be an indication of how the issue is avoided.

There were some microbiological methods being carried out that were very inappropriate or unacceptable for a school environment (e.g. collecting bacteria from a bathroom, culturing them at 37°C and exposing them to varying concentrations of antibiotics).

The following guidelines should be applied:

- Only culture known non-pathogenic strains of microbes (i.e. avoid culturing from hands or swabs of door handles)
- Do not test for antibiotic resistance as there are enough antibiotic resistant strains circulating in the environment without more being selected for
- Apply strict rules of hygiene and aseptic techniques
- Do not culture microbes at 37°C: incubation should be carried out at or below 25°C
- Always label cultured plates so they can be clearly identified and never open them for inspection
- Tape the lids on but do not tape all the way round a Petri dish as this encourages anaerobic conditions that are best avoided
- Never assume that what is growing in the culture is the strain that was inoculated, even if non-pathogenic strains have been used
- Always sterilize used cultures and dispose of the cultures using local health and safety regulations.

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

The use of animals in experimentation must always remain within their natural tolerance limits. For example, dosing rats with different levels of alcohol is unacceptable practice.

When assessing safety, ethics and environmental issues, teachers must watch out for the following during the experimental phase:

- Evidence of a risk assessment
- An appreciation of the safe handling of chemicals or equipment (e.g. the use of protective clothing and eye protection)
- Consideration of basic hygiene
- The application of the IB animal experimentation policy
• A reasonable consumption of materials
• The use of consent forms in human physiology experimentation
• The correct disposal of waste
• Attempts to minimise the impact of the investigation on field sites.

Candidates may require guidance.

Analysis (A)

The presentation of raw data was generally accurate but qualitative observations were often missing. 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. These will also impact on the communication criterion. A candidate should 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). Error bars do not have to be of the standard deviation. Maximum-minimum range bars can be used and this is possible for samples of less than 5.

There were examples of candidates calculating mean rates by averaging the data for all the trail runs and then calculating the mean from this. This is inexact. The rate for each run needs to be calculated and then the mean from all the rates.

Candidates are still confusing R² with the correlation coefficient r. R² is the coefficient of determination. R² can be used as an indicator of the goodness of fit of a trend line. It can approximate to the product moment correlation coefficient (r) if the trend line is straight but it is always a positive value unlike the correlation coefficient, which can be negative.

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 produce a statistic, such as a p-value or a correlation coefficient, are fine but the candidate needs to know what the value actually represents.

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 maximum-minimum 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. In weak candidates the interpretation was a written repetition of the data in the tables with no attempt to point out the trends or to compare data. The use of statistics may have been satisfactory but they were not always well interpreted. As with calculators, the use of a program like Microsoft Excel is useful but can lead to accepting values without truly understanding them. Huge mistakes can result from this (for example, confusing the t-statistic with the p-value), leading to an erroneous conclusion. Often the interpretation was handicapped by the limited degree of data processing.

Evaluation (EV)

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

Conclusions were not always supported by the data and explanations were missing. The candidates did not always refer back to their research question at this point. Some candidates were rather overoptimistic in their conclusions. Clearly the data did not fully support it but they would aim to put a positive spin on it. Sometimes a bold statement that the results “prove” the hypothesis right would be made.

A scientific context is needed for a full discussion and this was frequently superficial or absent. A number of examiners commented that candidates are correctly interpreting statistical significance tests but they are not referring back to the research question.

The evaluation of methodology is still a challenge to most candidates. The consideration of the strengths was frequently missed. Weaknesses were often restricted to practical details or sloppy manipulation and the level impact on the conclusion was often not discussed. Proposed improvements were sometimes unrealistic and often too vague. Extensions were often missed or illogical, not following on from the investigation. This was an area where examiners felt that teachers were often marking over generously.

When assessing the evaluation criterion in the investigation, teachers should look for the following:

- A conclusion that is supported by the data
- A conclusion that refers back to the research question
- An explanation based upon a scientific context
- A discussion of the strengths – this might be quite general or implicit or it might refer to specific parts that worked well or data that was consistent
- Discussion of the reliability of the data
- Identified weaknesses in the method and materials
- The evaluation of the relative impact of a weakness on the conclusion
- Sensible, realistic improvements
- Details on the improvements (e.g. not just the investigation needs to be repeated but
how many times)

• Realistic extensions that clearly follow on for the investigation.

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:

• Unnecessarily using whole pages for titles
• Unnecessarily using whole pages for a list of contents
• Blank data tables presented at the end of the method section
• Repetitive tables: there is no need for a raw data table AND a table with processed data
• Raw data relegated to the appendix when there was no reason for it which upsets the flow of the report
• Tables split over two pages or with a title on one page and the table or graph on the next
• Multiple graphs drawn when they could have been combined: this not only saves space but it also improves comparisons
• Squashed graphs so the distribution of the data is difficult to judge, which is often a result of candidates not reformatting when amending fonts
• Bibliography, footnotes, endnotes or in-text citation missing
• References with an incomplete format (often only a URL was given)
• Inefficient data tables headers: the art of designing data tables needs to be taught (e.g. hand drawing a sketch of the table layout should be considered first)
• Scientific nomenclature was not always used and the formats were not always respected.

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

When presented, the format for the citations was mostly correct.

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

Units were occasionally missing.

Use of non-metric units (e.g. °F, pounds, ounces, teaspoons, cups) was frequently noted by examiners. This was reported more commonly in North American schools.

Measurement uncertainties were sometimes missing.

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

Generally, 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. If they were accompanied by extensive appendices where the raw data is stored then this would impact on the mark.

Recommendations for the teaching of future candidates

- Present the criteria to the candidates early on in the course and use them for the assessment of practical work
- Explain the expectations of each component of each criterion
- Ensure that the candidate’s work has some original purpose. It should not be the repeat of a classic investigation
- Teachers should add comments throughout the work (rather than at the beginning or end)
- Apply the criteria more rigorously
- Counsel the candidates on the feasibility of the investigation, focussing research questions, safety ethics and environmental impact, use of statistical programs and the use of citations
- Teach candidates how to design tables and draw graphs
- Consider the global context of the candidate’s entire IB workload when scheduling the individual investigation in the scheme of work
- Teachers should visit My IB to see updated examples of individual investigations that are considered adequate (teacher support material)
- 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 submit 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 need 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 (screen shots should be considered)
- Anonymity: candidate/school names and the session numbers must all be removed before scanning and uploading.
Higher level paper one

Component grade boundaries

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General comments

A total of 147 teachers answered the G2 form.

Nearly 80% of the teachers felt that the level of difficulty of this paper was appropriate, with 20% feeling it was too difficult. When comparing to the May 2017 paper, 42% of teachers thought the standard was similar; 29% believed it was more difficult; 7% much more difficult and 12% a little easier.

Over 67% of the teachers felt that the clarity of the wording was good to excellent. The proportions were higher for the presentation of the paper (82%), with a few teachers even finding it excellent.

This paper is gradually moving away from factual recall and definitions to more elaborated and thinking questions. More assessment objective 3 aims have been tested in paper 1 than in the previous syllabus, making paper 1 more challenging overall. This type of question has been successfully included in the specimen paper and in papers from other exam sessions. Grade boundaries have reflected this, so candidates are not disadvantaged. Some teachers making comments using the G2 forms seem unhappy that general understanding can now be tested more effectively in multiple choice questions and others still attack any questions that require more specific knowledge. The examining team is aiming to test significant knowledge and the sort of secure understanding that can be broadly applied, so there is a mixture of styles of question on this paper and will be on papers in the future.

It is always hard to predict how challenging candidates will find a question and there were a few questions especially near the start of the exam that proved to be too difficult. In the future, these types of question will be found later in the exam paper.

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

- Huntington’s disease
- Carboxylation in photosynthesis
- DNA in zygotes.
The areas of the programme and examination in which candidates appeared well prepared

- Features of carbon that makes it suitable as a basis of life
- Common features of DNA replication, transcription and translation
- DNA structure
- How water molecules enter cells
- Seed dispersal.

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

Question 1

It is unusual to have such a challenging question at the start of the exam. Nevertheless, this turned out to be a good question, as it discriminated well: capable candidates answered it well and less capable candidates got it wrong. This question is based on knowledge from topic 6.5 and should have been studied by candidates.

Question 2

This question proved to be too hard for many candidates. Many believed that repolarization requires potassium to move across the membrane by active transport, when it does so by facilitated diffusion, where no energy is required.

Question 3

Candidates also found this question hard, but it was a very good discriminator. This proved an effective question.

Question 4

Most candidates understood the need of cyclins in the cell cycle.

Question 5

Most candidates answered this question correctly, showing they knew the features of carbon that makes it suitable as a basis of life.

Question 6

This was a successful question with high discrimination and three quarters getting it right. There were some complaints that this question was testing knowledge not present in the guide. This is not the case, as in topic 2.2 it asks for the modes of transport of cholesterol, and fats in blood in relation to their solubility in water.
Question 7

Candidates were able to answer this question well, as the diagrams were sketched clearly. Nevertheless, it could have been more appropriate to show the kinking of the unsaturated fat molecules at the double bonds.

Question 8

To get the answer, the candidate must be clear about the structure and function of the proteins listed as found in topic 2.4. Some candidates believed actin was more resistant than spider silk. The question did have a trick, as cellulose listed is not a protein.

Question 10

Some candidates wrongly believed that a chromatid from each chromosome from the father is passed to the next generation; only 23 are passed.

Question 11

This question did not discriminate well. The confusion arises because it is not clear whether all processes had to occur at a time. There was a spread of answers with a majority answering the correct answer.

Question 12

Candidates had to know that Huntington’s is an autosomal dominant disease. Many candidates believed it was sex linked.

Question 15

Many candidates believe that the organisms in the higher trophic levels have a lower energy content. This misconception probably arises from the fact that energy is lost in each stage of a food chain.

Question 17

This question has been altered for publication as two answers have been accepted, A and C. In C, the lack of interbreeding amongst species of the island and mainland causes speciation. At the same time these changes are allowed due to variations in each lizard population.

Question 18

Radial symmetry is a characteristic used to differentiate between phyla, so this question is fair.
Question 19

This question was in general well answered. At A, the node shows the separation from the ancestral species. The differences from the actual species is the greatest, as in each subsequent node there is a change.

Question 20

This question has been excluded as the correct answer (malnutrition) was not included as an option.

Question 21

This question asked for a factor that will increase frequency of sinoatrial signals to the heart muscle. Many candidates wrongly believed it was oxygen, although most recognised it was epinephrine.

Question 22

Many candidates still confuse antigens with antibodies.

Question 24

This was a good question as it linked two ideas. Unfortunately, it proved to be hard for candidates. Two answers were accepted, plasma membrane and myelin sheath.

Question 26

This question was easy. Some candidates wrongly answered that the antiparallel strands could be seen using X rays. Nevertheless, most candidates did recognise the helical shape as the correct answer.

Question 29

Most candidates answered this question well. It discriminated well too. Many weak candidates believed that end-product inhibition occurs in the last enzyme of the chain of reactions instead of the first enzyme.

Question 31

Most candidates answered this question badly, confusing NADP with reduced NADP as the correct answer.

Question 37

Most candidates correctly identified the fact that the data allowed to test for the vaccine effectiveness and the distribution of the disease. As the stem mentions that the disease has been eradicated in countries where the population has been vaccinated, the cause of the disease cannot be an answer. Analysis of epidemiological data is in topic 11.1.
Question 39

The answers to this question show poor knowledge of the kidney. Ultrafiltration occurs in the glomerulus which is in the cortex.

Question 40

The answer to this question shows poor knowledge. Many candidates failed to see that the egg has DNA from mitochondria.
Standard level paper one

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General comments

Nearly 81% of the teachers that answered the G2 form felt that the level of difficulty of this paper was appropriate. The others thought it was too difficult. When comparing to the May 2017 paper, 52% thought the standard was similar; 20% believed it was more difficult, 6% much more difficult and 12% a little easier.

Over 60% of the teachers felt that the clarity of the wording was good to excellent. The proportions were higher for the presentation of the paper (74%), with a few teachers even finding it excellent.

This paper is gradually moving away from factual recall and definitions to more elaborated and thinking questions. More assessment objective 3 aims have been tested in paper 1 than in the previous syllabus, making paper 1 more challenging overall. This type of question has been successfully included in the specimen paper and in papers from other exam sessions. Grade boundaries have reflected this, so candidates are not disadvantaged. Some teachers making comments using the G2 forms seem unhappy that general understanding can now be tested more effectively in multiple choice questions and others still attack any questions that require more specific knowledge. The examining team is aiming to test significant knowledge and the sort of secure understanding that can be broadly applied, so there is a mixture of styles of question on this paper and will be on papers in the future.

It is always hard to predict how challenging candidates will find a question and there were a few questions especially near the start of the exam that proved to be too difficult. In the future, these types of question will be found later in the exam paper.

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

- Greenhouse gases
- DNA structure
- Huntington’s disease
- Function of muscles in intestine wall
- Difference between antibiotics and antibodies.
The areas of the programme and examination in which candidates appeared well prepared

- Features of carbon that makes it suitable as a basis of life
- Common features of DNA replication, transcription and translation
- Cyclins in cell division.

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

Question 1
This question was easy and discriminated well: capable candidates had the correct answer and less capable had the wrong answer.

Question 2
It is unusual to have such a challenging question at the start of the exam. Nevertheless, this turned out to be a good question as it discriminated well. This question is based on knowledge from topic 6.5 and should have been studied by candidates.

Question 3
This question proved to be too hard for many candidates. Many believed that repolarization requires potassium to move across the membrane by active transport, when it does it by facilitated diffusion, where no energy is required.

Question 4
Candidates also found this question hard but it was a very good discriminator. This proved an effective question.

Question 5
Most candidates understood the need of cyclins in the cell cycle.

Question 6
Most candidates answered this question correctly, showing they knew the features of carbon that makes it suitable as a basis of life.

Question 7
This question was of relative difficulty and was a very good discriminator. Most capable candidates realized that the solvent properties of molecules allows them to appear in sweat.

Question 8
Poor knowledge of fats and their effect on health.
Question 9

To get the answer, the candidate must be clear about the structure and function of the proteins listed as found in topic 2.4. Some candidates believed actin was more resistant than spider silk. The question did have a trick, as cellulose listed is not a protein.

Question 11

Most candidates believe that nitrogenous bases join phosphates instead of pentose sugars joining them. This shows poor knowledge of the DNA structure.

Question 12

An easy question.

Question 16

Candidates had to know that Huntington’s is an autosomal dominant disease. Many candidates believed it was sex linked. There are a few G2 comments on the fact that applications should not be tested. This is not right, as applications can be tested.

Question 17

Many candidates believe that the organisms in the higher trophic levels have a lower energy content. This misconception probably arises from the fact that energy is lost in each stage of a food chain.

Question 19

This question proved to be difficult. In topic 4.4 carbon dioxide and water are mentioned as the most significant greenhouse gases. The misconception could be due to the fact that water is not anthropogenic therefore not much can be done to avoid its presence.

Question 20

This question has been altered for publication as two answers have been accepted, A and C. In C, the lack of interbreeding amongst species of the island and mainland causes speciation. At the same time these changes are allowed due to variations in each lizard population.

Question 21

Most candidates recognised inheritance as the explanation for the presence of Neanderthals DNA in humans, as it is a common ancestor. The fact that speciation occurred would explain the differences in the DNA.

Question 22

Radial symmetry is a characteristic used to differentiate between phyla, so this question is fair.
Question 23

This question was in general well answered. At A, the node shows the separation from the common ancestral species. The differences from the actual species is the greatest, as in each subsequent node there is a change.

Question 24

Candidates showed poor knowledge of the function of muscles in intestines.

Question 26

This question tested knowledge of many topics in topic 6.3. The candidates had to go through different distractors in order to discard them. A could not be possible as the selective pressure is decreased. Answer C is eliminated because proteins are not cloned, it is genes that are cloned. Answer D is eliminated because it is the antibiotics that block metabolic pathways.

Question 27

This was a good discriminator.

Question 28

This was a fair question as in topic 6.4 it says that type II pneumocytes secrete a solution containing surfactant that creates a moist surface inside the alveoli to prevent the sides of the alveolus adhering to each other by reducing surface tension.

Question 29

This was a good question as it linked two ideas. Unfortunately, it proved to be hard for candidates. Two answers were accepted, plasma membrane and myelin sheath.
Higher level paper two

Component grade boundaries

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<td>35 - 44</td>
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General comments

90% of those who responded thought that the paper was of appropriate difficulty, with the others thinking it too difficult. Almost 60% thought that the paper was of a similar standard to last year’s. Of the remainder, more thought that the paper was easier than thought it more difficult. 70% of respondents thought that the clarity of the paper was good, or better than good. More than 80% thought that the presentation was good or better.

Only two questions elicited large numbers of comments from teachers, one because it was thought unclear what style of answer was expected and another because the answer was not felt to be a fact worth memorising. The first issue was resolved by accepting a wide range of styles of answer and as the second issue only involved one mark out of 72, we can be happy that teachers were mostly content with this exam.

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

- Chemical composition of mollusc shells
- Functions of DNA
- The greenhouse effect
- Spermatogenesis.

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

- Diagnostic features of mammals
- Roles of free and bound ribosomes
- Homologous structures in living organisms
- The structure of membranes according to the fluid mosaic model.
The strengths and weaknesses of the candidates in the treatment of individual questions

Section A

Question 1: Data based question on the effects of an infection in bats

(a) This was intended to be an easy calculation to start the question but only about half of candidates answered it correctly. Many candidates failed to realise that the total number of flights was obtained by multiplying the mean by the sample size.

(b) No specific knowledge of echolocation was expected here. Candidates just had to visualise bats flying over a recording station and realise that not all bats would do this in the sample period and some might do it repeatedly or in inseparable groups.

(c)(i) Percentage calculations often cause problems for some candidates. In this case about half calculated the percentage decline correctly.

(ii) The important point to remember in this question was that results for both the infected and uninfected species of bat were important. The uninfected bats were effectively a control group that could be compared with the infected bats. This greatly strengthened the evidence. As this was an ‘evaluate’ question, candidates could only score two marks if they gave one argument in support of the conclusion and one against it.

(d) Most candidates answered this question successfully, realising that the distribution of spikes in body temperature indicated that infected bats were emerging more from hibernation, especially as infection spread during the winter.

(e) This was a test of candidates’ general understanding of animal physiology, including the requirement to fuel the body’s energy requirements from food taken in or stored. Answers ranged from the highly perceptive to the very confused. A common error was to state that the spikes in body temperature would have caused enzyme denaturation, but as the temperature maxima were all below 30°C this was very unlikely. Answers implying that the infection would overstress the immune system were not accepted.

(f) Less punctilious candidates tended to state simply that there was a positive correlation between the two variables but this was not accepted, as date of death is not a quantitative variable – it just represents the passage of time. Instead candidates were expected to state the trend that as the mean interval between hibernation emergence got shorter, the date of death was later. This question proved to be an effective test of whether the candidate could interpret the relationship shown by the graph and also state their answer clearly enough.

(g) This was another discriminating question, with the strongest candidates explaining clearly that the correlation evident in the graph did not establish a causal link.

(h) Candidates gave a variety of reasons for some bats surviving longer than others and the mark scheme allowed any biologically reasonable answer to be accepted. A common error was to refer to resistance to the disease rather than immunity.
(i) In this question candidates were expected to predict the effect of the disease on bat populations, using the data in the question. The implication is that we are looking to the future, not harking back to the past. Some candidates merely restated what the data showed had happened during the research period. It was also necessary to make clear what would change, so for example it was not enough to say that there would be death of bats – the answer had to make it clear that the death rate would be increased.

**Question 2: Mammalian features and homologous structures**

(a) Most candidates could give at least one mammalian feature and many could give two. The question asked for features that are only found in mammals, so homeothermy, which is also found in birds, and other features that are not diagnostic were not accepted.

(b) This was generally well answered with most candidates explaining that similarities in structure but differences in function suggest adaptive radiation from a common ancestor.

**Question 3: Mollusc versus arthropod features and linkage**

(a)(i) This was harder than 2(a) as it involved distinguishing two phyla. Many candidates knew that molluscs (mostly) have a shell. About a third were able to give a second valid feature. Among the less well-prepared candidates there was a lot of misinformation, for example the suggestion that molluscs lack an anus and/or mouth. A common error was to try to base the answer on information in the text and state that molluscs are recognised by the base colour and band width of the shell.

(ii) Only the best-prepared candidate knew the major chemical component of the mollusc shell. Chitin was not accepted as it is not always present. A frequent mistake was to give calcium as the major component. This was not allowed as it is the compound calcium carbonate that is the component and if a single element within it were to be given, oxygen makes up the largest proportion by mass, not calcium. Some teachers questioned the importance of the knowledge that mollusc shells contain CaCO₃. It was included in the program because fossilized mollusc shells become part of limestone rock, taking carbon out active recycling and reducing atmospheric CO₂ levels, so the composition of mollusc shells is of great biogeochemical importance. The effect of acidification of the oceans on secretion of CaCO₃ by molluscs and other marine organisms is also an important current environmental issue. Knowledge of it might well affect the way that IB candidates choose to live their lives in the future.

(b)(i) It was quite difficult to earn the single mark here because both sex-linkage and gene linkage had to be defined. The distinction that had to be made was that sex-linked genes are located on sex chromosomes and genes with linked loci are on the same non-sex or autosomal chromosome. Only about a quarter of candidates gave a complete enough answer.

(ii) About half of candidates realised that the possibility of gene linkage is investigated by carrying out a cross. Either a test cross or a cross between two double heterozygotes was accepted. Relatively few candidates stated that gene linkage would be indicated by more parental combinations of characters in the offspring and fewer recombinants, but it was possible to score full marks without this. Weaker candidates who attempted a Punnett square tended to
put alleles of one gene down the side of the square and of the other gene across the top, rather than showing gametes with one allele of each gene on both the top and sides of the grid. Some candidates misunderstood this question and thought that they were being asked how to represent gene linkage on the page. As this was an understandable misunderstanding, a mark was added to the mark scheme for any valid representation of gene linkage.

**Question 4: Effects of mutations, functions of DNA and ribosomes**

(a) This question elicited a very hostile response from many teachers. More was written about these two marks on G2 forms than about the rest of the exam. The criticism was largely that the question was testing a trivial piece of memorisation. The first mark, for giving the codon and anticodon with a sickle cell mutation, could in fact be worked out from the information provided. It proved to be an effective test of general understanding of the differences between DNA and RNA. The second mark did require knowledge that in sickle cell anemia, glutamic acid is substituted by valine. The details of sickle-cell anemia are included as an Application in 3.1 of the Core. Applications can be tested in IB Biology papers, but they will never form a large part of the exam. It is much more important to test candidates’ general and transferable biological understanding. Knowing that the substituted amino acid is valine decided whether a candidate got one out of the 72 marks on this exam. Interestingly there were candidates over much of the range of total marks who did know this. Sometimes weaker candidates find simple pieces of factual knowledge easier than deep conceptual understanding, so it seems fair to include the occasional test of a specific fact. Were the exam only to test deep understanding, some candidates would score no marks. The reason for including sickle cell anemia in the program is that it exemplifies the massive effects that a single base substitution can have and it is an interesting case study from various other perspectives as well.

(b) Few candidates knew functions of DNA other than coding for polypeptides. This question was based on the last Understanding in 7.1 of the AHL: Some regions of DNA do not code for proteins but have other important functions. The guidance given in the program relating to this is: The regions of DNA that do not code for proteins should be limited to regulators of gene expression, introns, telomeres and genes for tRNAs. All these answers were seen, but from very small numbers of candidates. Some candidates were looking for ways in which humans can use DNA, such as proving paternity or solving crimes, but these were not regarded as true functions of DNA itself.

(c) About half of candidates could distinguish between the role of free and bound ribosomes, with weaker candidates often not knowing what any ribosome does.

**Question 5 Mitosis, ATP synthase and cell respiration**

(a)(i) This was the most successfully answered question on the exam, with at least 90% of candidates answering correctly. A few candidates thought that the labelled structure was a cell membrane, but its thickness indicated instead that it was the cell wall.

(ii) All phases of mitosis and interphase were suggested by candidates. About a third recognised that the chromosomes were on the equator so this must be metaphase. Curiously,
it wasn’t always the stronger candidates who got this right and it wasn’t clear what was leading some of the stronger candidates to other answers.

(b) Candidates mostly found this question difficult and, in many responses, there was no knowledge of the location of ATP synthase or of movement of protons in chemiosmosis. There are some impressive answers though, with excellent knowledge of this important area of cell physiology.

(c) This was the second most unpopular question in the exam with teachers. The commonest criticism was that the wording of the question did not make it clear what style of answer was expected. Because of this any reasonable style of answer was accepted, including simply ticks and crosses for the use of oxygen and release of carbon dioxide. For ATP production, which happens in both the cytoplasm and mitochondrion, ticks in both columns were not accepted for the mark because this does not distinguish between the two parts of the cell, which the question instructs candidates to do. Some candidates gave an estimate of the numbers of ATP produced per glucose and others just said that more was produced in the mitochondrion. Some of the strongest candidates stated the names of the stages of respiration that produce ATP in these two parts of the cell. Any answer that successfully distinguished was allowed.

(d) About half of the candidates drew a valid curve with the same energy levels at the start and finish but a lower peak due to reduced activation energy. Almost every other curve imaginable were seen among the answers from candidates who did not recall the effect of enzymes.

Section B

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

**Question 6: Membrane structure, resting potentials and hydrogen bonding**

(a) This was the most successfully answered question in Section A, with many neat and well labelled diagrams of the fluid mosaic model of membrane structure. Most candidates got the phospholipid bilayer correct and also inserted some globular proteins. Peripheral proteins were often positioned incorrectly by being placed in one of the layers of the bilayer rather than on the periphery of the membrane. Cholesterol was included by many candidates and was accepted as long as it was positioned between phospholipids. Given its size and amphipathic nature it is likely to be in a similar position to a phospholipid molecule in a single half of the bilayer. Glycoproteins and glycolipids were sometimes confused.

(b) Candidates mostly found this part of the question harder and there was evidence of some confusion between resting potentials, action potentials and repolarisation. Nevertheless, candidates who were well prepared were able to score full marks relatively quickly.

(c) This was a wide-ranging question, as hydrogen bonding affects many structures and processes in living organisms. Scores were spread over the whole seven-mark range. For full marks candidates had to recall and explain many aspects of hydrogen bonding, not go into great detail about just a few. The commonest error was to state that hydrogen bonds are strong – collectively they are, but individually they are weak interactions. Some candidates confused
intra and intermolecular bonding and described covalent bonding between hydrogen and oxygen in water molecules. A frequent weakness was to describe cohesion and adhesion together as though there are the same phenomenon – if they were, we wouldn’t need different terms for them. There was also some confusion between latent heat of vaporisation, specific heat capacity and boiling point. Transcription and translation were rarely included in answers despite the important role that yet hydrogen bonding plays in each.

**Question 7: Greenhouse effect, plant uses of light of different wavelengths and phloem transport**

(a) As ever, there was widespread confusion about how the greenhouse effect causes global warming. Few candidates explained clearly how short-wave radiation from the sun mostly passes through the atmosphere but some of the long-wave radiation that the Earth re-emits is absorbed by greenhouse gases. The word ‘radiation’ was not understood by some, who took it to mean high energy radiation as emitted by radioactive isotopes. Confusion between ozone depletion and global warming remains very widespread. As the greenhouse effect is threatening ecosystems around the world and may lead to entire countries disappearing underwater, candidates really should have a sound understanding of how it is occurring, so this is a target area for much more thorough study.

(b) Most candidates realised that wavelengths of light equated to different colours and knew that plants look green to us because they reflect green wavelengths. Most also knew that wavelengths of light absorbed by pigments such as chlorophyll are used in photosynthesis. A minority of candidates omitted to mention photosynthetic pigments or photosynthesis and instead wrote only about photoperiodic control of flowering. Two marks were available for this, but they were not often awarded, as accounts tended to be rather muddled. A detailed consideration of the phytochrome mechanism is not expected in the current program.

(c) This is a familiar question, but perhaps because weaker candidates tended to choose question 7, many of the accounts were inadequate. The word ‘organic’ was widely misunderstood and was taken to mean anything transported in a plant, including water and inorganic ions. Many candidates therefore wrote about xylem and phloem. As with all questions in section B, there were some impressive answers

**Question 8: Spermatogenesis, estrogen, progesterone and muscle contraction**

(a) The interest that candidates have in human reproduction does not always translate into careful study of it. HL biologists are encouraged to look in detail at the key processes, including spermatogenesis. Falling male fertility is an important health issue and it will undoubtedly have an impact on some candidates. Spermatogenesis is a topic that is bedevilled with an excess of terminology, but the mark scheme was constructed both to reward candidates who had mastered this and also those who understood the principles in general but not specific terms. Answers ranged from detailed and impressive to horribly ignorant.

(b) The roles of estrogen and progesterone in human reproduction are complicated, so it was no surprise that many candidates got some details wrong. The question was written to make both the menstrual cycle and pregnancy relevant, so there was plenty to say and well-prepared
candidates generally scored full marks. This is another topic that is important in adult life, so it is worth careful study and not just in preparation for IB exams.

(c) Muscle contraction proved to be another topic where thorough preparation was essential to score well. Weaker candidates tended to give some general ideas about antagonistic muscle contraction and not mention any of the events that occur within sarcomeres. As with other parts of this question, there were some impressive answers showing a thorough understanding of complex events at a molecular level.

Recommendations and guidance for the teaching of future candidates

- Percentage calculations should be practised as they are useful in data analysis. Having calculated a percentage, it is worth checking whether the answer seems plausible and if it does not, an error should be looked for and corrected.
- If the command term in a question is ‘evaluate’ candidates should aim to weigh up the strengths and limitations, so for example in a question where a conclusion is evaluated, a scientist should assess how far the evidence supports the conclusion. Arguments for and against the conclusion should if possible be included.
- It is unsafe to assume that candidates already understand topics that might seem very familiar such as the greenhouse effect. If candidates claim that they do already understand them, a test can be used to check this and if it shows that there are misunderstandings, these can specifically be addressed.
- Topics such as human reproduction that are significant in candidates’ future lives are worth studying carefully both in preparation for IB exams and beyond.
Standard level paper two

Component grade boundaries

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General comments

The exam seemed quite balanced as some questions allowed candidates to show their knowledge adequately while providing some challenging questions for the more adept candidates to achieve higher marks.

Of the 69 teachers who completed the G2 form, 90% found the difficulty of the paper to be appropriate, with 9% suggesting it was too difficult. Most thought that the exam was of similar standard to May 2017 (62%), with 13% suggesting it was more difficult and 13% a little easier.

Presentation and clarity of the paper was described as good, very good or excellent by 82% of teachers who reported.

Some G2 comments suggested that there was too much recall and not enough opportunity for candidates to demonstrate understanding and/or problem-solving. The paper does, at first, present itself as mostly cognitive kinds of questions. In fact, the exam required deeper understandings than immediately apparent as the second and third marks for a question were often not gained. Only strong candidates put forth strong explanations for extended answers in section B.

Comments about individual questions being off-syllabus seems to come from an incomplete acceptance of what understanding and application of a concept entails. Furthermore, the grade descriptors for science subjects which are used as the criterion reference for course grades from 1 to 7, includes gradations for handling novel contexts and allowing candidates to show insight or originality. Some questions are asked to invite evidence of these qualities.

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

- Topic 1.3: Drawing of fluid mosaic model
- Topic 2.6: Differences between DNA and RNA
- Topic 3.4: Inheritance of ABO blood types
- Topic 4.3: Carbon cycle
- Topic 6.2: Many excellent answers on blood clotting.
The areas of the programme and examination which appeared difficult for the candidates

- Mathematical expectations of science subjects, page 23 of the biology guide
- Interpreting scatter graphs
- Understanding graphs with unusual axes
- Topic 2.3: Structure of amylose and amylopectin
- Topic 2.4: Formation of polypeptides
- Topic 2.9: Pigments and wavelengths of light
- Topic 5: Explain evolution from data; Antibiotic resistance.
- Topic 6: Blood clotting; Parts of the alveoli.

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

Section A

Question 1: Data based question

Candidates appeared well poised to draw basic numerical information from a graph, but there was a big difficulty in properly interpreting the data shown in order to address the biological questions posed.

(a) Most answers were within the given range.

(b) Overall answered well. A few failed to label their answer as an advantage or disadvantage.

(c) Two marks often earned with mp a “more yellow in fields” and mp b “more unbanded in woods”. Some candidates used only numerical data to distinguish and thus failed to get marks.

(d) Almost everyone recognized the “Least frequent” as “pink” but for “Most frequent” answers were often incorrect with “yellow” as the shell color.

(e) A very difficult question with few candidates earning any marks. The problem was that for a snail of a particular color candidates did not compare the percentage of juveniles to adults to look for an increase or decrease. This would have provided the evidence to discuss survival of the snail. Many candidates erroneously thought that yellow color meant high survival because they only looked at the vertical axis of the graph/percentage of adults. Other candidates claimed that pink color meant low survival because of a low percentage of adults and because they reasoned the pink color meant the snails were more conspicuous to predators.

(f) Many candidates referenced natural selection. They seemed to know that variation in snail color could mean differences in predation rate which would affect survival. Fewer candidates explained that surviving snails could then pass their variation to offspring. Those candidates who offered these ideas usually transferred their thinking to the data and earned mp b “higher adult frequency of brown shows selection.” Greater success was seen in this question than part (e).
Question 2

(a)(i) This was often blank. Those who knew about branching also tended to know the 1-4 and 1-6 linkages.

(ii) This question received several G2 comments. Candidates, however, did not seem to have trouble with it. About half the candidates know that humans lack the necessary enzyme, some knew it was cellulase.

(b) Many candidates did not respond to this question. Weak answers did know about water removal. Responses tended to earn all marking points or only the one about water removal. The question served well to distinguish among marks at the upper end of the performance scale.

(c) Clearly candidates know how to distinguish between RNA and DNA. Note that the command term is state, so the markscheme is more generous than what would be acceptable for a distinguish question.

Question 3

(a) Many did not use the correct symbols but were able to gain marks for correct genotypes. Most candidates got mp b (for showing how to use a Punnett grid) and some lost mp a for incorrect notation. Those who did poorly on this question did several notable errors. Some used notations of sex-linked diseases and got no marks. or used the Punnett grid poorly with many candidates trying to show 9 different combinations in the grid given. A few candidates who had correctly shown the possible genotypes linked them to the incorrect phenotypes (AO is not a phenotype) and even fewer stated the predicted ratio or percent of each phenotype.

(b) Many answers did not have comparative answers between arteries and veins. Also, many answers lacked nouns. For example, "arteries are wider than veins" without mentioning anything about the lumen. That arteries have thicker walls was known, also that veins have valves; few mentioned elastic fibers. Candidates often misread the question and gave physiological differences such as blood flowing away from heart in arteries.

(c) Candidates found this question difficult. A range of incorrect responses were provided included sealing of the wound with scab formation without references to the actual mechanism. Or the blood cells coming and sealing the wound etc. A few stronger scoring papers made references to clotting factors/platelets (mp a) or thrombin and sticky fibrin threads. This was a good response to examine how well a candidate can construct an explanation of a complex phenomenon (as described in the grade descriptors).

Question 4

(a)(i) Most earned the mark; inability to metabolize was seen often but the other mark points were also common. "Viruses cannot reproduce" which is either incorrect or incomplete. Weaker answers often say that viruses do not have a nucleus, suggesting confusion with prokaryotes and a problem with the definition of life.
(ii) Often blank but a few knew it was bryophyte.

(b) A problem occurred here when candidates began their answer using the external features of an arthropod as their reference instead of the pictured mollusc; here again, candidates misread the question.

(c) Many knew that pigments/chlorophyll absorb light energy/sunlight; a few also knew about red and blue light/wavelength absorption; photolysis was rarely given or other pigments for absorption of other wavelengths. This question proved difficult when candidates focused on describing the process of photosynthesis without focusing on the role of pigments.

Section B

Question 5 was answered more frequently than question 6.

Examiners sometimes found it difficult to understand handwriting. Observations were also made on the candidate’s use of points or a list. Full sentences should be encouraged.

Question 5

(a) Many parts of the membrane were known. Some candidates provided small diagrams so looking for details to mark was difficult. Where candidates opt to draw diagrams, they should be encouraged to make them larger.

(b) The results here were generally poor because four functions of life were not known or the given functions of life were outlined inadequately. Some candidates listed the functions of life without outlining what they are. Candidates should be cautioned not use a term in its definition. “Outline” is more than a “list”.

(c) Most candidates gained 3 or 4 of the 7 available marks for their explanations of the carbon cycle; the most common ideas were that carbon is absorbed from the atmosphere by producers, is transferred in food chains, is released through respiration, decomposing matter and through combustion. Very few candidates mentioned methane, peat and limestone as part of the carbon cycle. Many candidates drew a well annotated diagram which gained them marks. Poor, wordy descriptions including irrelevant material on global warming meant they lost the quality mark. Fossilization was poorly understood as formation of fossil fuels from dead and decaying organisms after decomposition as opposed to partial decomposition. Candidates should acknowledge different forms of carbon as organic compounds, carbon dioxide and carbonic acid.

Question 6

(a) This question was not read carefully in that it asked for the role of parts of the alveolus and not the entire alveolus itself. Those candidates who avoided that pitfall knew about pneumocytes I and II, the presence of capillaries around alveoli, surfactants and the roles that they played. The answers were vague stating what the alveolus does without focusing on its
structure. Some answers were broader than the question requires, going well beyond the alveolus.

(b) Many candidates managed to gain at least 2 of the 4 available marks. They realized that some bacteria can be resistant to antibiotics and that their frequency would increase over time. A deeper understanding was seen among those who wrote about genetic variation and resistance based on resistant genes. The idea of resistance to a specific antibiotic was often overlooked. Pneumonia is mentioned in the question as an example, but no actual information about the disease was expected, so it need not be in the syllabus to be part of a question.

(c) Many candidates did not know how to answer this open-ended question. Of those who did, some answers were excellent. Candidates made correct references to diabetes, heart diseases, anorexia, mental diseases, genetic diseases, such as colour blindness and sickle cell anemia, being the most common. The biology guide gives many possibilities that range over topics such as heart disease (topic 2.3), sickle cell anemia (topic 3.1), Down syndrome (topic 3.2), cancer as linked to radiation and mutagenic chemicals (topic 3.4), hemophilia and Huntington’s disease (topic 3.4) and emphysema (topic 6.4). These were all seen among the answers. Once the non-pathogenic disease/condition was identified, various factors leading to it were usually given.

Weaker answers revealed that many do not know the difference between pathogenic and non-pathogenic diseases. Some candidates described HIV, food poisoning and other fungal diseases as non-pathogenic.

Recommendations and guidance for the teaching of future candidates

- Advise candidates to take time to read the question. It was evident that some questions were not fully understood.
- Help candidates to focus on the scientific context of the topics. They should become familiar with, and be able to reproduce, listed drawings.
- Practice more data analysis questions. Candidates appear to lack basic data comprehension skills. The mathematical expectations are in the biology guide, page 23.
- Teach candidates how to analyze a variety of graphs and build conclusions based on them by connecting the data to subject knowledge and concepts.
- Practice drawing molecules, bonds, and sequences of reactions making sure that the structures are drawn accurately.
- Functions of life is a concept with decision making implications and ethical issues. Candidates must be able to list and describe/define them without reusing the term itself.
- Handwriting must be legible. Examiners will only mark what can actually be read.
- No part of the guide can be overlooked. 'Applications' and 'skills' sections are meant to amplify the 'understandings' sections. The sections depend on each other.
- Answers on controversial topics must be based on evidence, not unsubstantiated claims that may have come up in class, the media or elsewhere.
- The requirements for the command terms need to be made clear, especially distinguish, evaluate, discuss, suggest, explain and compare & contrast. When having
a class recitation on content, it is common usage to state “we discussed that topic...” This common usage is unlike the expectations of the command term “discuss”, leading to confusion.

- A useful activity is to teach the development of an idea through three objective levels. For example, take a question and answer as ‘list’ then ‘outline’ then ‘explain’. Another pathway through the objective levels might be “define” then “describe” then “discuss”. Have candidates recognize how much more is required as the answer is pushed from objective 1 through objectives 2 and 3. Command terms and objectives are found at the end of the biology guide.

- Use of scientific language and terminology must be encouraged. It is an expectation of this course that the candidates will develop a full subject vocabulary of terms beyond the words used in the biology guide. Having candidates develop flashcards and vocabulary lists to edit, share and study could be very helpful.

- Teachers should encourage candidates to work on their penmanship. Many papers were extremely difficult to read and took twice as much time to mark as clearly written papers. Candidates need to learn how to write legibly and fluently. Papers written in pen produced better scans.
Higher level paper three

Component grade boundaries

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General comments

This year there were fewer G2 responses from teachers than in the past two years. All teacher comments are considered at grade award meetings so teachers are encouraged to take the time to give feedback.

The comments received on the G2 forms indicated that 92% of the respondents felt the difficulty level was appropriate. About 70% felt it was of a similar standard to last year with the remainder evenly split between those thinking it was more difficult and those who thought it was easier. The clarity of the wording was considered good to excellent by 83% of respondents and the presentation was felt to be good to excellent by 86% of respondents which is slightly higher than last year.

The most popular options this session were again C and D with a large number choosing A as well. Very few candidates attempted more than one option or omitted section A 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 very good to extremely weak. Once again there were a very large number of candidates who did not seem to be prepared for this examination and found all sections difficult. There unfortunately seemed to be an increase in the number of candidates actually scoring no marks at all on the entire paper. Many struggled to express their answers clearly and concisely and lacked the expected subject-specific knowledge and vocabulary. Candidates struggled to give detailed specific, named examples when required. Command terms such as ‘compare and contrast’, ‘distinguish’ or ‘explain’ caused problems in understanding what was required by the question with many candidates simply giving a brief outline at best. Questions 2(c), 10(a), 15(c), and 19(b), which all asked candidates to ‘compare and contrast’ or ‘distinguish’ were generally poorly answered. Some stronger candidates tried to lay out their thoughts in a table, but even these responses indicated muddled thinking with little knowledge of how to correctly carry out the task.

Section A presented difficulties for almost all candidates. The same problems seen in the internal assessment component were seen in the answers to the questions dealing with required practical investigations (practical 2 and 7 were specifically targeted in this section). Candidates struggled to produce a focused research question, to describe how to control
certain variables, rather than simply listing variables to be controlled, and to evaluate limitations. This led many examiners to wonder if candidates had actually carried out the required investigations and if they had been taught the skills required.

Topics that appeared difficult included:

- Details relating to required practical investigations including osmolarity and use of a potometer
- Energy requirement of brain
- fMRI
- role of ear in balance
- role of viral vectors in gene therapy
- example of natural selection leading to a changed animal behaviour
- biological control
- biogeographic characteristics of nature reserves
- human effect on phosphorus cycle
- factors leading to hypertension.

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

Objective level 1 questions such as 'list' or 'state' were answered correctly by those who had done any studying at all. Questions related to topics on recent examinations were often among the best answered, showing that past papers were being used by some centres for examination preparation.

Topics for which candidates appeared well prepared included:

- Neurulation
- Colour vision
- Biofilms
- BLAST
- Keystone species definition
- Steroid hormones
- Liver
- Bohr shift.

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

Section A

Question 1

a) Many candidates struggled to understand this graph and to see that venom increased the percentage of hemolysis but only in a certain range. Thus, it seemed that they either scored two marks or none in most cases.
b) This question did not score well as candidates tended to make a list of controlled variables, even if they did this in sentence form, rather than describe how they would control the variables. Despite the fact that the question clearly stated that this was an investigation on plant osmolarity, which they should have done in class, many tried to include snake venom from Question 1(a) in their responses. The vague use of ‘amount’ as seen in internal assessment individual investigations was also seen here. ‘Amount’ could mean volume, mass, length or another quantity and must be specified.

**Question 2**

(a) This question had several G2 comments from concerned teachers. The guidance in topic 6.4 states that ventilation can be measured by “data logging with a spirometer or chest belt and pressure meter”. There were more correct answers than in a question in May 2017 on the same topic but still many incorrectly stated that a respirometer is used, but as stated in topic 2.8, this is used to measure respiration rate particularly in small invertebrates or germinating seeds.

(b) Many candidates were able to do this calculation correctly. A common mistake was to misread the graph, sometimes taking two values for tidal volume and sometimes confusing the symbols and reading the value off the wrong axis.

(c) Almost all candidates were able to get one mark for noting the similarity that both ventilation and tidal volumes increased with increasing treadmill speed but few could get a second mark for a difference. Candidates seemed to focus on the very last data point rather than looking at the overall trend. Another common mistake was to state that ventilation rate is higher than tidal volume which indicated an inability to read a graph with two y-axes.

**Question 3**

(a) This question was based on required practical 7. A reasonable number of candidates were able to get a mark for identifying the dependent variable in this potometer investigation as rate of transpiration (or rate of water uptake) but not a clear independent variable or an organism to be tested. Thus (and as in internal assessment), the research questions given were not clearly focused.

(b) This question on evaluating limitations of the potometer was poorly done by candidates of all abilities. Very few marks were awarded for this evaluation question since candidates at best gave a list of limitations that were manipulative or procedural in nature. This again is an area of internal assessment to which teachers need to give more attention.

**Section B**

**Option A: Neurobiology and behaviour**

**Question 4**

This question was fairly well answered by candidates at all levels and a good discriminator despite the error in the diagram.
(a) Many candidates were able to score full marks on this question on neurulation but better candidates gave good clear descriptions.

(b) Most candidates were able to get one mark for stating that spina bifida was due to the spine/spinal cord not forming properly or incomplete closure of the embryonic neural tube. However, few could get a second mark for indicating what might cause this such as lack of folic acid or exposure to certain environmental conditions during pregnancy or genetic causes.

(c) Weaker candidates were able to get one mark for knowing that unused neurons are lost during neural pruning and better candidates were easily able to get a second mark.

**Question 5**

(a) Almost all candidates could state a function of the cerebral hemispheres in (i). A point that should be noted is that if a question asks for **one** function, a list of several should not be given as examiners are instructed to only look at the first one in the list. In (ii), candidates were able to understand the data and thus gain the 2 marks; however, none really ‘discussed’ the claim that the data supports the idea that humans are more intelligent than elephants.

(b) Very few were able to get a mark for suggesting why the brain has such a high energy requirement. There were many vague answers that it ‘controls everything’ or ‘never stops’ rather than an understanding of maintenance of resting potential and the role of sodium/potassium pumps (topic 6).

(c) There was generally a poor understanding of fMRI other than the idea that scans were taken while the subject was exposed to a stimulus. The fact that changes in blood flow were involved did not seem to be known.

**Question 6**

(a) For (i) candidates commonly incorrectly stated ‘audio receptors’ rather than ‘mechanoreceptors’. For (ii) candidates often were not awarded a mark as they simply said damage to hairs rather than hair cells or sensory hairs.

(b) This question on the role of the ear in balance was surprisingly poorly done by a majority of candidates. There seemed to be confusion between the cochlea and the semi-circular canals.

**Question 7**

(a) Most candidates could correctly choose an inhibitory drug from those shown in the diagram.

(b) This was poorly done. Candidates could state that either genetic predisposition or dopamine secretion contributed to addiction but not outline how this did so.

(c) Although it did appear that candidates had some idea of how birdsong came about, they had a very difficult time putting this into words and actually distinguishing between the role innate and learned behaviour played in birdsong development. Problems with inaccurate use of language were common.
(d) Candidates of all ability levels struggled to give an example of a change in animal behaviour as a result of natural selection. Most gave an unnamed or theoretical example or mentioned any type of animal behaviour they could think of from the list of behaviours given in the syllabus. Of these, only the first, change in migratory behaviour in blackcaps, is about 'change by natural selection'.

**Question 8**

Only the strongest candidates achieved full marks on this question to explain how the eye can distinguish between different colours. Most had an idea that cones played a role in colour vision, even if they could only get a few marks here. Many spent much of the time writing about rods which are irrelevant to this answer. It is important that candidates read the questions and select from their knowledge what is relevant.

**Option B: Biotechnology and bioinformatics**

As in the past few years, this option was selected by only a few centres. Despite this it is a very accessible and interesting option and candidates who are prepared can do very well.

**Question 9**

(a) Candidates were able to get the marks in both (i), usually for methane, and (ii) for a variable that needed to be controlled in the fermenter.

(b) This was poorly done, not because candidates did not know factors that affected activity of organisms in the fermenter, but because they could not explain why they affected rate, which is what the question asked.

(c) If candidates knew the structure of cell walls in gram-positive and negative bacteria, they could get an easy 3 marks but many did not.

**Question 10**

(a) Candidates found this graph challenging as well as the command term to ‘compare and contrast’.

(b) The explanations of how the combined Bt and Ht crop was produced were not very clear in most cases.

**Question 11**

(a) Biofilms are quite well studied by most candidates and thus most were able to get a mark for defining biofilm in (i) and get some marks in (ii) for explaining the difficulties in treating biofilms.

(b) *Pseudomonas* as an organism used in bioremediation seemed fairly well knowns many were able to get 1 or 2 marks for this question.
Question 12

(a) While many candidates had an idea of why model organisms are used, few could outline the benefits clearly.

(b) Likewise, although BLAST appeared to be known by most candidates, describing how it is used to establish phylogenetic relationships was not well organized or presented.

Question 13

This longer response caused difficulty for several candidates as they did not seem to have a clear idea of what gene therapy was.

Option C: Ecology and conservation

Although this was probably the most popular option, many candidates were not well prepared for it.

Question 14

(a) Although some weaker candidates confused keystone species with indicator species, many candidates understood what keystone species were. The better candidates gave very clear definitions.

(b) Candidates seem to have some understanding of what mutualism is. However, they were unable to give a specific example which is what the question asked for. Instead, general ‘examples’ were given such as insect and flower, cow and bird. It was noted that very few candidates referred to “Zooxanthellae and reef-building corals”, the example from the subject guide.

(c) Many candidates could differentiate between potential and actual niche but a common error was that they indicated that a niche was place where an organism lives.

Question 15

(a) Almost all candidates could list one factor that would influence succession.

(b) The ability to answer this question on the process of primary succession was discriminating between candidates of different levels. Many did not know about pioneer species and struggled to clearly indicate the sequence of steps in primary succession. Some wrote only about climax communities.

(c) While candidates knew about food chains and food webs, they struggled to put similarities and differences clearly into words as is required when asked to ‘compare and contrast’.
Question 16

(a) This question was well-answered by most candidates although some did fail to mention that invasive alien species have negative effects.

(b) There were many vague answers given to this question on the effects of invasive alien species such as ‘they destroy the environment’. Marks were most often awarded for knowing they could lead to species extinction or that they thrived reproductively due to lack of a natural predator. Candidates did not use terms such as interspecific competition or out-compete.

(c) This question was poorly answered by the majority of candidates as they struggled to link an example of invasive alien species with its biological control. Candidates who could give an invasive alien species usually described non-biological methods such as poisoning, trapping or hunting. Although many knew that cane toads are an invasive alien species, this is not an example of a species that is biologically controlled.

(d) Almost all candidates could give a consequence of marine plastic pollution.

(e) Biomagnification was understood to some degree by most candidates although the specific vocabulary was lacking to explain the consequences clearly. Unfortunately, there were some who did link it with microscopy.

Question 17

(a) Almost all candidates could get both marks for (i) and (ii).

(b) This was also a very poorly answered question by almost all candidates. Many confused nature reserves with zoos or discussed climate, limiting human interference and providing resources. The point that was most clearly seen was to link fragmented areas by corridors. The edge effect does not seem to be understood.

Question 18

This appeared to be the most difficult of the longer response questions with many answers referring specifically to the mark scheme from a question on use of phosphorus in agriculture asked last year. Thus, there were many responses in which candidates wrote about pending shortages of phosphorus. There was little reference to use of fertilizers in agriculture or that they get into water systems. Many were unclear about eutrophication, if they knew it was related. Too many candidates wrote about any form of pollution they could think of including global warming, fossil fuels and traffic pollution, or ‘harming the environment’ in general. There were several G2 comments on the choice of this topic for a longer response question as they felt the carbon cycle and nitrogen cycle were more important and given more space in textbooks. Nitrogen and phosphorus cycles are given an equal number of statements in the Understanding section of topic C6 while the carbon cycle is in the SSC. It has perhaps been asked less frequently in past papers than the nitrogen cycle but is no less valid or important a topic.
Option D: Human physiology

This was a very popular option and candidates appeared to be better prepared for this than the other options, especially at the upper grade levels.

Question 19

(a) Almost all candidates were able to get (i) and many also got a mark for (ii).

(b) This proved to be one of the most difficult questions in this option across all grade levels and was generally poorly answered. Candidates who did know points about both gastric juice and pancreatic juice often could not put those differences into a table to make valid comparisons. For example, candidates often placed low pH on the gastric juice side paired with an enzyme name on the other side. Weaker candidates referred to bile and hormones in the pancreatic juice as well. The most common correct answer was that gastric juice was acidic while pancreatic juice was alkaline. There was some concern that this question does not come from the option as pancreatic juice is not mentioned specifically, although D2 does refer to 'digestive juices'.

(c) Candidates generally had a good knowledge of steroid hormones and most were able to get 2 marks with better candidates scoring 3. Very few gave an example, though.

(d) Almost all candidates were able to get 1 or 2 marks here as well. However, many incorrectly stated that acidic conditions provided the ideal environment for most enzymes.

Question 20

As the liver has appeared on many past examinations, this question was generally well answered.

(a)(i) Despite the awkward diagram with the liver flipped and the arrow of oxygenated blood coming from below, most candidates could select the hepatic portal vein. Candidates do need to have knowledge of blood flow in the liver.

(a)(ii) This question was also about blood flow in the liver although the skills tested were different. There were valid comments made on the G2 forms that 4 marks on hepatic circulation was perhaps redundant and too much. Candidates were unclear about the role of the sinusoids, but they familiar with the hepatic artery, hepatic portal vein and hepatic vein and thus able to score fairly well.

(b) There were many good responses to this question on the breakdown of hemoglobin.

Question 21

(a) Despite the fact that many candidates were able to get 1 or 2 marks, it seemed as if there was uncertainty as to what the SAN actually does and the type of impulse generated.
(b)(i) About half the candidates were able to see that the graph showed a correlation rather than proof that old age caused CHD.

(ii) Most were able to state a factor that was correlated with CHD.

c) Candidates in general did very poorly on this question as they could not explain the causes of hypertension. At best they gave a list of factors, even including high blood pressure which is hypertension.

Question 22

This longer response question was very well answered and stronger candidates often scored full marks. The Bohr Shift seemed fairly well understood and appropriate graphs to illustrate this were included. Even weaker candidates could often score 2 or 3 marks, usually for knowing that cell respiration affected the release of CO$_2$ and consumption of O$_2$.

Recommendation for the teaching of future candidates

Many of these recommendations have been made in the past and it is strongly advised that teachers action them as the same issues are occurring year after year.

Practical work, skills and applications

- Teachers need to pay more attention to the required practical work and the methodology of the labs. There are 7 required practical investigations for HL and many more skills and application.
- Ensure all required practical investigations are included on the PSOW. Explicitly teach the different prescribed investigations and the limitations of the different equipment involved. It is unclear if candidates understand the concepts behind practical work.
- Key ideas about research questions, variables, improvements and other parameters involved in investigations should be well taught. Candidates should write reports on their investigations using the above parameters.

Command terms (pages 166-167 of the biology guide)

- All examiners comment on the fact that lack of understanding of what is required by a question hinders candidate performance.
- Teach the use of command terms such as describe, distinguish, compare and contrast and explain. 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 ‘suggest.
- Tables can be a good way to answer compare or distinguish questions, but be careful to only address one feature on each row of the table.
- Practice command terms in class and on homework, tests and exams to ensure candidates are familiar with what is expected by each verb.

Course details

- Teach the details of the option.
- Include named organisms and specific examples as required in the syllabus.
- When dealing with ‘named’ examples, these should be specific illustrations of concepts
in the syllabus but take care to use appropriate, checked examples. The cane toad cannot be used for everything related to invasive species!
• Teach all "Understandings" in the syllabus to objective level 3.

Biological language
• 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. Vague answers are not awarded marks.
• Teach the vocabulary of biology as candidates need to use subject-specific vocabulary in their answers.
• If candidates are at a loss for words they will be unable to express their ideas with clarity.

Use of graphs
• Graph reading was a bigger concern than in recent years.
• Candidates should be taught to interpret data in different forms using a variety of graphical presentations.
• Practice section A type questions.
• This need not start at the diploma level and should be developed throughout secondary science education.

Use of past papers
• Past paper practice is an effective way to help candidates prepare for the exams. However, it should not be used as an exercise to memorize mark schemes.
• Give candidates experience of deconstructing past questions. This should teach skills of analysis.

Examination techniques
• Examination techniques need to be taught and practised from the beginning of the programme.
• Read questions carefully. Too often, candidates are writing responses that contain correct biological information, but unfortunately that information does not address the question being asked.
• Coach and give strategies to candidates on how to structure longer response questions.
• 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.
• Train to write logical sentences in a paragraph for the long responses.
• 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.
• 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.
• Be specific and use correct terminology. General answers do not receive any marks.
• Diagrams often help, especially in the longer response question at the end of each option. Even the most rudimentary of graphs helped some candidates score higher marks on question 22. Therefore, having candidates familiar with these diagrams and graphs would help prepare them.
• 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 or to measure if necessary.
Standard level paper three

Component grade boundaries

<table>
<thead>
<tr>
<th>Grade</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark range:</td>
<td>0 - 5</td>
<td>6 - 11</td>
<td>12 - 16</td>
<td>17 - 20</td>
<td>21 - 24</td>
<td>25 - 28</td>
<td>29 - 35</td>
</tr>
</tbody>
</table>

General comments

Most candidates correctly answered section A and one option. Options C and D were the most popular, and there were very few option B. There were fewer responses written outside the boxes provided, although many candidates continue to use extra pages.

There were 69 comments in the G2 forms. The majority considered the paper to be at an appropriate level (96%). 67% thought the paper was a similar standard to May 2017, with 15% easier. Clarity, presentation and accessibility were all judged to be good. In general, candidates seemed to be better prepared and the marks were certainly higher than last year.

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

Section A
- The significance of error bars when representing data
- Understanding and applying the command term “evaluate”
- Determining magnification of a structure, given a scale bar.

Section B

Option A
- The function of the nucleus accumbens
- Understanding and applying the command terms “compare and contrast” with suitable language
- Identification and function of semicircular canals
- Understanding perception of sound and how cochlear implants function.

Option B
- Understanding pathway engineering
- How bioinformatics are used in production of GM plants
- Recalling genera of bacteria and their roles in bioremediation.
- The difficulties of treating biofilms.

Option C
- Understanding the edge effect
• The process of succession
• The effect of abiotic factors on distribution of organisms, giving specific examples.

Option D
• Comparison of the composition of blood in the hepatic and hepatic portal veins
• The control of digestive juice secretions by the nervous and endocrine systems.

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

Section A
• Interpreting a substrate concentration vs enzyme activity graph
• Understanding mesocosms.

Section B
Option A
• Identifying the cerebellum from a diagram of the brain
• Discussing methods used to identify the roles of parts of the brain.

Option B
• Uses for industrially produced citric acid
• Advantages of GM plants.

Option C
• Competitive exclusion
• Effect of human activities on a developing ecosystem.

Option D
• Risk factors for CHD
• Causes and consequences of malnutrition in humans.

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

Section A

This was well answered by many candidates, with some high scores.

Question 1

This was a straightforward question on enzyme action, but with graphical data that confused many candidates.

(a) The majority of candidates gained 2 marks here, with just a few misreading the concentration at peak activity.
(b) Despite an experiment on enzymes being a compulsory practical, few candidates correctly identified two factors. Many stated temperature, but not pH, although these would be the most obvious. Time was often chosen, but this would be measured in the dependent variable. The choice of hydrogen peroxide concentration by many indicated that controlled and independent variables are poorly understood.

(c) The command term “evaluate” appeared not to alert most candidates that there was not one clear answer. The majority identified 70mM as the optimum in the graph, but only a very few commented on overlapping error bars leading to uncertainty over a 30mM concentration range.

Question 2

(a) The majority of candidates achieved two marks, although some quoted figures rather than making it clear that mixing resulted in increased zooplankton biomass. There were very few references to the small difference below 7 days or the falling rate of increase for the disc method after 13 days.

(b) There were many references to controlling conditions, which were credited, but fewer mentions of size and representation of the natural environment. Some candidates had evidently set up a mesocosm in the laboratory, but had little knowledge of the different variants.

(c) Stating set-up or method errors such as leaking seals should be avoided. The open top was an obvious clue for a sensible suggestion and many candidates realised that the initial plankton populations might have differed. Teachers commented on this question being too broad, but the mark scheme attempted to cover this.

Question 3

(a) Many candidates gave an answer within the quite generous range, and provided a correct unit. All candidates should have access to a ruler; although this was not specified on the front of the paper, it is part of the equipment that should be brought to an examination.

(b) Many fewer candidates managed to calculate magnification, either using the previous answer or the scale bar. One mark was awarded for a correct word or numerical equation. There was much confusion with units, leading to answers out by more than one factor of 10. The use of nm confused some candidates.

(c) A was frequently identified as endoplasmic reticulum or sometimes as a vesicle. Perhaps candidates expect to see the Golgi apparatus more curved in shape. A G2 comment noted that the arrow could have been more carefully placed.

Section B

Option A: Neurobiology and behaviour

Question 4

(a) The cerebellum was more often identified than the pituitary gland.
(b) A few candidates knew at least one function of the nucleus accumbens and some provided three.

(c) This was a challenging question because of the command terms. Candidates had a general knowledge of the cerebral hemispheres but failed to frame their answers as compare and contrast. Most referred to contralateral processing in some way. A few knew about the location of Broca’s area.

**Question 5**

(a) A straightforward question and easy to gain full marks even though the command term evaluation should have encouraged deeper answers.

(b) Many candidates outlined development of the neural tube, but those correctly reading the question generally scored at least two marks, especially through mentioning migration, synapse development and neural pruning.

**Question 6**

This was generally poorly answered.

(a) Many candidates could not identify the semicircular canals – semilunar canals and cochlea were seen.

(b) This proved very challenging for candidates as most had poor knowledge of normal hearing, and could not compare and contrast despite the help provided in the diagram. Those candidates scoring marks generally referred to vibrations vs electrical signals.

(c) The role of the semi-circular canals was again not commonly understood, although those few candidates with sound knowledge gained two marks easily.

**Question 7**

More candidates had good knowledge here, with some covering more than four methods. fMRI was sometimes confused with CAT or PET scans. Lesions and animal experiments were commonly mentioned.

**Option B: Biotechnology and bioinformatics**

There were very few candidates answering this option.

**Question 8**

(a) Nearly all candidates answered this correctly.

(b) Two uses of industrial citric acid were not always given.

(c) Answers were vague and the processes were not distinguished between.
(d) There was little knowledge beyond stating pathway engineering results in a product.

**Question 9**

(a) Most candidates stated a correct method.

(b) There was little evidence that candidates understood the technology involved in bioinformatics and its uses.

(c) Most candidates mentioned increased yield and resistance to pests or environmental conditions.

**Question 10**

(a) Candidates used a range of terms but were credited if they recognized that microorganism removed a pollutant.

(b) A bacterium used in bioremediation might be correctly named, but the role confused and few candidates scored more than one mark.

**Question 11**

Candidates did not focus on the difficulties of treating microorganisms in biofilms and knowledge was poor.

**Option C: Ecology and conservation**

This was a popular option, with at least a third of candidates answering it.

**Question 12**

(a) Answers were poorly expressed, with candidates explaining the term edge without specifying it is the boundary between two ecosystems.

(b) There was some confusion in the figures used in the paper for Simpson reciprocal diversity index, but this did not penalize the responses. There were some good answers, with many candidates recognizing the highest diversity in the edge zone. Some discussed species richness and diversity but fewer related it to the data for site F compared to the other sites.

(c) The transect, quadrat and capture-mark-release-recapture methods were all seen. Lincoln index or Chi-squared do not refer to methods in the field.

**Question 13**

(a) There were some good succinct answers here, if the terms were recognized.
(b) Competitive exclusion was often mentioned, but there was much less reference to the impact of competition on resources.

(c) The language used often was not appropriate – to say that a keystone species has an effect or controls the ecosystem is not sufficient. The effect of its removal was less often mentioned.

Question 14

(a) This was poorly answered, with infrequent reference to soil formation or climax communities. Initial colonization was often described as being by small plants rather than pioneer species or an example of one.

(b) Candidates could gain marks with little biological knowledge here. Some strayed into deforestation but most were credited with comments on building, pollution and planting.

Question 15

Candidates were often credited for stating two abiotic factors however, failed to describe specific examples of the effects on distribution. Light might be mentioned, but with no reference to its requirement in the photosynthesis of plants. More thought and planning would have resulted in higher quality answers.

Option D: Human Physiology

This was the most popular option.

Question 16

(a) Most candidates contrasted the data but few managed to find a comparison or referred to the error bars.

(b) Many candidates recognized that the earlier data supported the claim while the more recent did not.

(c) Obesity and lack of exercise were commonly stated and genetics occasionally. Diets were also frequently mentioned, but the type of fat had to be stated.

Question 17

(a) Few candidates knew that the blood in both veins is deoxygenated, so did not have a comparison. For a contrast, presence of nutrients and toxins in the HPV were often quoted. Some candidates described the route of blood flow in the veins rather than composition.

(b) Many candidates could state the breakdown of haemoglobin into its two components. Some knew about Kupffer cells, although did not mention endocytosis. More could state that the amino acids from globin were reused and that iron would be transported to the bone marrow.
Question 18

(a) Surprisingly many candidates did not know a function of fibre, stating that it helped in digestion.

(b) There were very few correct responses here. The link between nervous and hormone systems was rarely correctly described, although some candidates mentioned stretch receptors in the stomach. Some described the feedback system provided by secretin.

(c) The majority of candidates gained a mark for stating surface area is increased however, few gained a second mark, as absorption had to be linked with capillaries or lacteals. A few mentioned mitochondria producing energy for transport mechanisms.

Question 19

Some reasonable discussions of the causes and consequences of malnutrition were seen. Many candidates stated an excess or lack of a nutrient. There were references to obesity associated with CHD, starvation with muscle tissues breaking down, and anorexia with serious health problems. Some candidates were able to give an example of a nutrient deficiency, such as a deficiency in vitamin C or D. A few candidates referred to socioeconomic factors as the cause of starvation. References to a malfunctioning hypothalamus were not seen.

Recommendations and guidance for the teaching of future candidates

- Ensure that candidates have had experience of the seven practicals identified in the syllabus. This should include planning an experiment and identifying and naming the variables. Data recording and appropriate analysis should be taught during these practicals as well as for the internal assessment. In this way, standard deviation and error bars will be understood, as well as other possible data processing methods. When planning methods, the term “amount” should not be used, rather the specific measurement should be stated.
- Continue to explain the command terms and provide practice in answering questions. In particular, Compare and Contrast, Evaluate and Outline need to be made clear. Outline means more than a list. Candidates should look for similarity followed by a difference and use correct linking words. For evaluation candidates should assess both views and ensure they are covered.
- Encourage candidates to give concise and clear answers that do not include the stem. Given sufficient consideration, they should be able to answer within the spaces provided. In longer questions they should spend more time planning coherent answers rather than trying to fill the space with irrelevant information. Topics in the options that involve processes should be practised as flow charts, to help in recall.
- Ensure that the necessary detail in the options is taught and tested. Help candidates to recognise when a question is asking them to apply their knowledge.