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BIOLOGY TZ2 (IB Africa, Europe & Middle East & IB Asia-Pacific)

Overall grade boundaries

Higher level

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

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 17	18 - 31	32 - 43	44 - 55	56 - 68	69 - 80	81 - 100

Time zone variants of examination papers

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 candidates' scripts for the different versions of the examination papers. For the May 2008 examination session the IB has produced time zone variants of the Biology papers.

Internal assessment

Component grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 15	16 - 21	22 - 27	28 - 31	32 - 37	38 - 48

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 15	16 - 21	22 - 27	28 - 31	32 - 37	38 - 48

Clerical procedure

The moderators generally agreed that the procedure for the selection of the moderation sample was understood and correctly followed by most schools. It is most important, however, that the teachers keep up to date with these. There are a significant number of examples of schools using old 4PSOW forms and the requirement that the candidates sign the 4PSOW form was missed by a large number of schools. For candidates examined from May 2009 there will be important changes in the procedures used by the IB for internal assessment. The teachers MUST be aware of these changes. Teachers who included the "complete", "partial" and "not at all" breakdown of their marks were providing helpful information to the moderators. This combined with comments and feedback to the candidates made it very clear as to how the teachers were awarding marks.

There are a large number of teachers that take a lot of time and trouble to prepare their Internal Assessment sample. This effort is very much appreciated.

A problem, which directly affects the progression of the moderation, is when teachers do not enclose all the instruction sheets and/or summaries of oral instructions for the investigations in the moderation sample. Most schools complied with this requirement for the investigations involving Planning (a) and (b) assessment. It is also necessary, however, for investigations where Data Collection is being assessed. When Data Processing and Presentation is being assessed the method (designed by the candidate or provided by the teacher) and the raw data are required. Finally when Conclusion and Evaluation is being assessed all the steps in the scientific process are needed. This will still be true for the revised procedures from May 2009.

The duration of the practical programmes was generally correct and evidence of the Group 4 Project was usually present though a number of moderators commented on the absence of evidence for the Group 4 Project.

A problem which persisted this session concerns collusion between candidates. Too often moderators noted that material is submitted which clearly a copy of another candidates work. This type of incident is the subject of a Problem Report Form. This will lead to an enquiry into malpractice by the IB examination board.

Areas of strength

Most teachers covered adequate material with very varied practical programmes. Many moderators noted an improvement in the types of investigations used for planning investigations. There is evidence of a decrease in the number of investigations that collect purely qualitative data. This is a move in the right direction because in May 2009 all assessed investigations will require the collection and processing of quantitative data.

Areas of weakness

A problem raised by many moderators was the trivial nature of some investigations submitted for moderation. Where schools were presenting work of a sufficient complexity this tended to be the case with all of their assessed work.

Moderators noted that some teachers still give too much help for the assessed work. In Planning (a), aims and objectives are being given which are too detailed. For Planning (b), methods were given and were followed with no modification by the candidates. In Data Collection less photocopied data sheets was being used but in Data Processing and Presentation candidates were still being told how to process their data in some schools.

It must be stressed that when an investigation is used for internal assessment it is the work of the individual candidate which is to be assessed not that of a group. Teachers must provide opportunities within the practical programme where candidates may be individually assessed. The problem of overt collusion is treated above but teachers must set assignments that have enough scope to them to ensure that all the candidates are not going to be doing effectively the same investigation. The general aim set by the teacher needs to be sufficiently open-ended and the material and protocols available should be sufficiently diverse.

There was generally a lack of awareness by candidates of the degrees of precision in their measurements. This was perhaps the commonest comment from the moderators. In the revised programme it will be expected that candidates should develop an awareness of the limitations of their instruments and their methods. They should be using methods of error analysis (e.g. standard deviation and correlation) in their processed data. Of course this requires that the investigations are sufficiently complex and collect sufficient data for candidates to carry out this analysis.

The consistency in the number of decimal places used also presented problems. Some candidates were not consistent with them at all especially in their processed data. If data is measured to one decimal place then the mean calculated from this data cannot be accurate to three decimal places. A lot of these errors are due to a weakness in the appreciation of processing done on calculators.

Grade inflation seems to be a problem in certain schools. It is sometimes observed that candidates have clearly not responded to an aspect of a criterion (e.g. there is no sign of the variables having been identified PI (a) Aspect 3). The teacher comments on this omission and still awards the candidate full marks. It is possible that this may be due to the teacher scaling the marks. The Internal Assessment criteria are for application throughout the IB schools and thus they cannot be treated like this. The criteria must be applied rigorously or the effect of the moderation will be severe down grading.

Rules applied by the moderator

At the start of the moderation session the moderators in the team are provided with guidelines which are intended to bring everyone into line and establish some ground rules for moderating. Following the moderation samples of the moderators work are sent to a senior moderator for remarking. A summary of the ground rules are given below:

- Do not try to compensate for lowering a candidate's mark by raising another candidate's within the sample. These changes will not necessarily cancel out.

- Your own marking is subject to adjustment by the senior moderator/principal moderator so you cannot comment on the standard of marking on the 4/IAF feedback form to the school.

- Always apply the principle of positive marking. If it is a borderline judgment support the teacher's award and annotate your marking with 'borderline-teacher supported' so that your senior moderator follows your reasoning.

- Do not worry if you find yourself consistently supporting the teacher. If that is what the work deserves then there is no problem.

- Senior moderators should continue to support the teacher where possible even if it means disagreeing with the assistant moderator.

- If you have a query as to the marking standard, contact your senior moderator immediately. It is possible to mark other samples while awaiting clarification, but you may have to re-mark all pieces of work in which the same situation occurred once your clarification is received.

- Senior moderators should endeavour to reply to queries as soon as possible.

- Do not change your marking standard once your sample has been sent to the senior moderator/principal moderator as this will not be reflected in the moderation factor. Remember to keep annotating the candidates' work in case an IMR report is called for by the school after the diploma grades are published.

- Choose a sample of eight candidates that cover a wide mark range so that there are no marks in a zone in isolation. Since there are many concerns that it is the high achievers who are most prone to be marked down, a couple of marks above 26 out of 30 should be included where possible.

- Choose a sample that includes a wide range of schools.

- Do not include candidate work that you are unsure about in the sample to be sent to the senior moderator.

- If you have schools in your allocation which have serious problems with IA avoid including those in your sample. They are atypical. If you are concerned about them fill in a PFR form.

- Do not punish simplicity through downgrading; comment appropriately on the form 4/IAF.

- Trivial investigations will probably be affected by moderation more seriously than complex investigations because they lack scope in discriminating between the candidates. A clear message needs to be sent to these teachers in their feedback.

- Bear in mind that there should be no difference in the application of the criteria to higher level or standard level candidates.

Be sure to read:

- the Examiner's Manual

- any further guidance from your senior moderator very importantly the Teacher Support Material (TSM) 1 and 2 on the Online Curriculum Centre (OCC)

There are a number of specific situations that occur regularly. There are a number of specific responses to these. One is where too much help or guidance has been given by the teacher the other is in the presentation of uncertainties to the data.

Where too much help has been given

Inevitably in your allocation you will come across write-ups where a teacher has quite clearly given too much assistance to the candidates. Some common examples:

- Planning (a): the research question, hypothesis and/or variables are given. A general aim is fine if the candidates have significantly modified it (e.g. made it more precise).

- Planning (b): a method sheet is given which the candidate follows without any modification. All candidates are using identical methods. **Note:** A basic or standard protocol may be given by the teacher (e.g. the rate of photosynthesis may be determined by counting the bubbles released by a pond weed) but this must provide

enough scope for the candidates to modify it (e.g. establish the independent variable, controlling variables, providing periods of equilibration, ensuring fair testing between the experiments etc).

- Data Collection: a photocopied table is filled in by the candidate. **Note**: Data logging by a computer or calculator interface is acceptable. If, however, you have doubts about the degree of automation, contact IBCA to ask the school for details of their data-logging system.

- Data Processing and Presentation: a graph with axes already labelled is provided.

- Conclusion and Evaluation: structured questions are given to heavily prompt the candidate through the discussion, conclusion and criticism.

In such cases, do not assume that the mark awarded by the teacher should be reduced to zero. **Examples:**

Criterion	Problem	Teacher awards	Maximum moderator can award
Planning (a)	*Teacher gives the problem or research question*	*c; c; c = 3*	*n; c; c = 2*
Planning (b)	*It is clear that the candidates have been told what apparatus and materials they require.*	*c; c; c = 3*	*n; c; c = 2*
Data Collection	*The candidates have used a photocopied data table with headings and units.*	*c; c = 3*	*p; n = 0*
Data Processing and Presentation	*The candidates have been told, on the method sheet, to draw a graph from their raw data and which variables to plot.*	*c; c = 3*	*c; n = 1*
Conclusion and Evaluation	*The candidate has only indicated as a criticism that they ran out of time and their only suggestion as an improvement is that they should repeat the investigation.*	*c; c; c = 3*	*c; n; p = 1*

For further guidance contact your team leader.

In all cases, constructive feedback to the teacher is needed. Always be positive, be diplomatic, give them the benefit of the doubt and give clear, useful advice.

When you are moderating the investigations, remember that we do not know the candidate's prior knowledge or skills. Thus we cannot anticipate the interpretation of the data using a particular piece of theoretical background nor can we anticipate a particular way of analysing the data. We should award marks more for what the candidate has achieved rather than what he/she has omitted.

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Errors and uncertainties

It is now expected that the candidates treat uncertainties in their data. This has an impact on Data Collection (DC) Aspect 1 and Data Processing and Presentation (DPP) Aspect 2.

Note: Data processing may well take place in the same table used for the raw data. This is acceptable, there is no expectation for separate tables for raw and processed data.

Degrees of precision (Data Collection)

Where instruments are used the degree of precision should be given (e.g. $\pm$ 0.1 cm) where it has an impact on the investigation. This will be particularly true for biochemistry investigations (e.g. enzymology) where laboratory grade reagents are being used (e.g. volumes, temperatures). However where the biological material used is derived from a natural source (tissue or whole organisms), the natural variation of the material may mean that degrees of precision can be treated as insignificant.

Significant figures (Data Collection and Data Processing and Presentation)

The number of decimal places should not exceed the precision of the instrument used if it is given.

The number of decimal places should be constant for the data in a column of figures.

For data derived from raw data (e.g. means) the number of decimal places should not exceed those of the raw data.

In the calculation of mean population density, results to the nearest whole organism are expected.

Deriving uncertainties through processing (Data Processing and Presentation)

We are **not** expecting the propagation of errors in processed data.

Standard deviations are expected **only** where the data permits (i.e. a sample size of at least 5 and a normal distribution).

Candidates may go even further and determine confidence limits through the standard error of the mean. This is acceptable but not obligatory.

A candidate may also indicate the range of uncertainties as the range between the highest and the lowest value in a sample. This is acceptable but not obligatory.

Candidates may also indicate uncertainties by tracing a trend line through their data on a graph.

Candidate performance against each criterion

Planning (a)

As stated some teachers provided too much guidance e.g. "Plan an experiment to investigate the effect of temperature on the rate photosynthesis of a green plant". The independent variable has been given by the teacher in this statement.

The aim or research question should contain the name of the organism that was used (ideally the scientific name) or the name of the source material e.g. catalase from the tuber tissue of potato (*Solanum*).

Formulating a hypothesis is also still in need of attention. The candidates are frequently not explaining their hypothesis scientifically, yet some teachers still award "complete".

Candidates are also failing to identify the independent variables or the controlled variables of their experiment. A number of teachers are awarding "complete" when the candidates have not fulfilled this aspect and some teachers still seem to be unaware of what independent and dependent variables are. Variables need discussing in order to identify those that can be controlled and those that may influence the investigation but cannot be controlled. This is probably the weakest aspect of this criterion both in its treatment by the candidate and in the marking done by the teachers. Either it is missed out or the candidate lists a series of variables without much discrimination.

Investigations where candidates are working in groups, such as the Group 4 Project, are to be avoided for the assessment of the two planning criteria, unless the individual contribution of each candidate can be clearly identified. The evidence seems to suggest that this practice is diminishing. In the revised programme the Group 4 Project will <u>only</u> be used for the assessment of the Personal Skills criterion.

Planning (b)

Most teachers were providing adequate scope for the candidates to plan their own investigations. However, many moderators noted that sometimes the investigations are trivial. There were also reports of investigations that were too similar from one candidate to the next. Teachers in these cases may need to consider setting the planning exercise under test conditions.

In listing materials, candidates often missed some essential items. For instance, it is impossible to investigate a rate without some form of timer. Solutions were often listed or mentioned in the method without giving any idea of their concentrations or volumes, this would be particularly important to control during enzyme activity investigations.

In the control of variables it was rare to find candidates giving their materials time to equilibrate to the environmental conditions, especially where the investigation was using whole organisms (e.g. in transpiration or in photosynthesis).

Candidates appear to be considering replicates of their experiments resulting in sufficient data being collected. In the revised programme it will be expected that the candidates plan to collected significant amounts of data over the range of the independent variable and at sufficient intervals to observe a trend.

Data Collection

Raw data must be presented. Candidates in some schools are still presenting averages or rates as raw data.

Some teachers are still selecting investigations that generate data that is too trivial. Their candidates are not being tested effectively on their capacity to measure and to organize the data. The data should be sufficiently complex so that it can discriminate between candidates. Producing significant amounts of complex data does not necessarily require sophisticated apparatus or costly reagents. It can be understood that some investigations are time consuming and do not generate a lot of data in a lesson. Though they have their place in a scheme of work it would be advisable to avoid using these for internal assessment.

Data tables must be accompanied by clear precise titles (e.g. "The data" is insufficient).

The most common problem raised by the moderators, concerned uncertainties. Candidates should be indicating the degrees of precision in their measurements based upon the

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instruments that they are using. They should also be consistent in their application of decimal places. From the comments made by some teachers on their candidates' work, they are aware of the need for uncertainties to be given in raw data yet the fact that the candidate has failed to state them does not have an impact on the marks awarded by the teacher.

It is clear that "complete" does not mean perfect but there are occasions where the quoting of uncertainties will be very important when evaluating the reliability of the data. E.g. when using the changes in mass or size to determine the water potential of plant tissues the degree of precision of the balance or the ruler used is important.

Qualitative data alone will no longer be adequate for assessment of Data Collection and Processing in the new programme. However, qualitative observations that accompany the quantitative data will be expected.

Data Processing and Presentation

When quantitative data is produced by an investigation, some teachers still make the mistake of telling the candidates how to process it. Many teachers seem to think that they can teach the mark and recapture method of population estimation and then assess it for DPP at the same time. This type of investigation is inappropriate even if the candidates have not been told what form of processing to use because there is not much scope for the candidates. Either they use the Peterson (aka Lincoln) Index or they do not.

There are some signs of candidates carrying out error analysis in their processed data but not enough. Use of trend lines or error bars showing uncertainties will be expected in the new programme.

Several candidates are using spreadsheets to process their data and to create graphs, which is good. This will become an essential part of the course in the revised programme. Unfortunately they show signs that they have not yet mastered the basics of graph drawing. For example, trying to plot a curve using three data points is inappropriate. Drawing graphs of raw data may be the first step in analysing the data but it is not likely to score complete. Some candidates think that plotting the data from each of the replicates rather than their means is adequate. When graphs are drawn manually some candidates seem to have difficulty in using a ruler and an excessive number do not use millimetre graph paper.

Conclusion and Evaluation

Candidates still show little evidence of having consulted literature sources with which to compare their results. Background research to support a conclusion will be essential where it is considered relevant in the revised programme. Correct citation of the source on information will be expected.

Teachers are still ignoring the need for the candidate to criticize and suggest improvements to the investigation. It is one of the areas where the teachers are ignoring the criteria. Moderators are obliged to lower the marks in cases like this. If a candidate fails to evaluate the investigation and suggest improvements, the maximum the candidate can score is "cnn" = 1

When weaknesses are highlighted and improvements suggested they should not be superficial. The evaluation should be based upon the errors and uncertainties revealed by their data. E.g. If an outlier appears in a series of data one would expect the candidate to spend some time exploring the origins of this error.

Too often one gets the impression that the candidate feels that they have to say something to fulfil this aspect so their evaluation becomes trivial or irrelevant. The candidates often fall

back on suggesting poor manipulative skills can cause unexpected data, leaving the teacher to evaluate only the conclusions drawn. Statements like "I could have used the balance incorrectly" are not very helpful.

Manipulative skills

The practical programmes, in general, provide adequate scope for assessment of this criterion. In the revised programme this will be assessed summatively over the whole course. Therefore, there will only be one mark for this criterion. Consequently moderators will expect to see signs that the candidates have been involved in a number of tasks of suitable complexity.

Personal Skills

This criterion will only be assessed during the Group 4 Project in the revised programme. So there will only be one mark for this criterion.

The Group 4 Project

This will continue to be an essential requirement of the all Group 4 courses. It is a very valuable exercise in practicing candidate-generated investigations. It is being used by some teachers for the assessment of criteria where the candidate should be assessed on their individual capacities. As the Group 4 Project is a collaborative effort this is not appropriate to use it for assessment in this way. In the revised programme the project will only be used for the assessment of Personal Skills and nothing else. The project will also be the opportunity for the candidates to show how internationalism operates in scientific enterprises.

Recommendations for the teaching of future candidates

- Consult the online curriculum centre (OCC) frequently for Teacher Support Materials (TSM). New guidelines and exemplars have been published. Guidelines for the programmes that started in September 2007 and are examined from May 2009 are already posted

- Do not use workbooks and work sheets with spaces to be filled in for internal assessment.

- Explain the criteria to your candidates at the beginning of the course and at intervals during the course.

- Use non-assessed practice exercises for training your candidates.

- Select investigations carefully for assessment so that they are not trivial.

- Provide situations that are open-ended and with enough scope for variation when assessing Planning (a) and (b) (these become Design in the new programme).

- Teach the candidates early on how to carry out error analysis on their data and train them in data processing techniques.

- Do not provide too much guidance. Use investigations where the candidates have to carry out tasks on their own or where their individual efforts can be assessed.

- Use the notation c (complete), p (partial) and n (not at all) on the work assessed for internal assessment and provide additional notes on the sampled work (not just for the benefit of moderator but also for your candidates too).

- Provide clear, precise information on the instructions given to the candidates.

- In schools where there are several teachers, practice internal moderation.

- Teachers must be vigilant to prevent collusion between candidates when they are assessing the criteria. Setting the planning phase as a test may be a way of avoiding collusion between candidates.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 10	11 - 17	18 - 24	25 - 28	29 - 32	33 - 36	37 - 40

General comments

There were nearly 100 G2 forms submitted for which the examining team were grateful. Two thirds of the teachers who commented felt that the paper was of a similar standard to last year's and the remaining teachers were evenly split between thinking that it was slightly more difficult or slightly easier. One teacher felt that the paper was too difficult; one felt that it was too easy and all of the rest thought that the level of difficulty was appropriate. Almost all thought that the paper was either good or satisfactory in terms of syllabus coverage, clarity of wording and presentation. There was a wide spread of marks on this papers and most of the discrimination indices showed that the questions had performed effectively.

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

Some questions performed in a predictable way and no comments need to be made about them. The comments that follow relate to questions where candidate performance was very good or very poor or questions that aroused comment from teachers on G2 forms.

Question 2

This was a poorly answered question with many candidates failing to read it carefully enough and choosing answer D. This looked superficially correct but contained a clear implication that animal cells are distinguished from plant cells by having a membrane, whereas all living cells have a membrane. Candidates should be encouraged to read each word in possible answers correctly and especially at the start of the exam, not to feel that they must hasten to choose an answer.

Question 3

This question was answered correctly by more than four fifths of candidates indicating good understanding of mitosis, but it did not discriminate very effectively between stronger and weaker candidates. This may have been because the question was easy, or it may be that some of the stronger candidates chose answer A, even though it referred to meiosis rather than mitosis and many cells carrying out mitosis do not contain 23 types of chromosome.

Question 10

Several teachers commented that this question did not specify whether the mother had hemophilia or not. The examiners were unable to find any published reports of females with this condition. If candidates had assumed that the mother definitely did have hemophilia then the correct answer would have been C, which was chosen by very few candidates.

Question 11

This was answered correctly by 90% of candidates, indicating good understanding of the ethics of reproductive cloning in humans.

Question 13

This was answered more poorly than expected. Saprotrophism is an area that often seems to be poorly understood by candidates. The points that need to be stressed are that when saprotrophs carry out external digestion of dead organic matter they obtain energy from it but this is not recycling of energy as they will release the energy by respiration and it is then lost as heat.

Question 14

This proved to be the easiest on the paper with few candidates failing to recognise the correct use of a quadrat.

Question 15

A surprisingly poorly answered question: many candidates chose answer C, thinking that two species with the same specific name, even though they are in different genera, would be more closely related than two species in the same genus.

Question 16

This question caused some confusion between cause and effect, with answer A being chosen by significant numbers of candidates, even though it gave increases in global temperature as a cause of the greenhouse effect. The examining team discussed whether C could be considered to be correct in some senses, but decided that D was clearly the best answer and the instruction to candidates is always to choose the best answer.

Question 17

Few candidates had any difficulty with this question, knowledge of structures involved in absorption proving to be almost universally good.

Question 20

This question provoked discussion amongst teachers and examiners. Unless the changing room had been hotter than human core body temperature, D was incorrect! All of the incorrect answers were chosen by some candidates but the discrimination index showed that the stronger candidates could deduce the correct answer.

Questions 24 and 26

These questions had very high discrimination indices, showing that they are testing areas of the programme that weaker candidates find particularly difficult: end-product inhibition of enzymes and chemiosmosis in the chloroplast.

Question 27

More than 85% of candidates answered this question correctly, showing that they could identify blue and red peaks on an action spectrum for photosynthesis.

Question 28

There was a large amount of information for candidates to digest, but the question discriminated very effectively and it was not unreasonably difficult with over 60% answering correctly.

Question 29

This question revealed some widespread misunderstanding with less than 25% of candidates choosing the correct answer, which was C. Far more chose answer D, which shows a chiasma that has formed by the ends of two chromatids swapping partners. Chiasmata are formed by crossing over, which involves the breakage and rejoining of chromatids or DNA molecules. This is one area where teachers need to ensure that they are teaching the topic correctly.

Question 31

This was the most discriminating question of the paper, with an index of 0.66. The acrosome and cortical reactions are obviously difficult topics that only the stronger candidates tend to master.

Question 35

This question was one of the least successful on the paper and the low discrimination index shows that some of the stronger candidates answered it incorrectly. Larger numbers of candidates than expected chose answer D, presumably because they did not realise that insects are arthropods and have wings. The examining team considered whether to reject this question but decided to retain it, because it was reasonable to expect candidates to be able to pick B as the correct answer. Fishes and birds have bones to which antagonistic muscles are attached, but earthworms and arthropods do not.

Questions 38 and 40

These two questions discriminated well, but were answered incorrectly by large numbers of candidates, indicating a lack of knowledge of hydrophytes and transpiration. Some teachers felt that answer D in question 40 was unfair for candidates working in their second language. There was no evidence of this and all candidates should be able to distinguish between the processes of diffusion and evaporation.

Higher level paper two

Component grade boundaries

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

General comments

One hundred and seven G2 forms were received from teachers. 77% of respondents believed that the paper was of a similar standard to the May 2007 paper. Of the remainder, slightly more felt the paper was easier than those that felt it was harder. 95% of respondents believed that the paper was of the appropriate standard. 77% believed that the syllabus coverage was good, 78% believed that the clarity of wording was good and 90% believed that the presentation of the paper was good.

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

Candidates found the following areas of the examination especially difficult:

- Relating aerobic respiration and photosynthesis events to their cellular locations

- Demonstrating knowledge with respect to excretion and the roles of ADH, the loop of Henle and the collecting duct

- Outlining a basic technique for gene transfer

- Drawing the structure of a dicotyledonous seed

- Distinguishing between a cell in anaphase 2 and telophase 2

- Integrating all of the information provided in question 1 in order to discuss the different factors affecting core temperature

- Communicating an understanding of polygenic inheritance

- Demonstrating the necessary knowledge to compare spermatogenesis and oogenesis

- Explaining the relationship between sexual reproduction and variation in a species

- Identifying the general factors affecting population size.

The levels of knowledge, understanding and skill demonstrated

Broad knowledge of factual information was common among candidates. The candidates did well at explaining DNA replication as well as the production of antibodies. Good answers explaining the control of glucose in the blood were also common. Most candidates were able to decipher graphs competently. Compared to past papers, candidates used comparison keywords such as highest, lowest, etc with greater frequency and were less prone to describe data using values.

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

For section B, questions 4 and 7 were the most frequently chosen.

Question 1

(a) (i) Most candidates had the right answer. Some candidates answered with a temperature. A small number of candidates answered "7:00", probably interpreting "day" in the question as "lights on".

(ii) Most candidates answered this question correctly. A number of answers referred to time rather than temperature. Some omitted units.

(b) Most candidates scored one or two marks for this question. Some candidates listed values without making an effective comparison and therefore gained no marks despite being able to analyze the data.

(c) Most candidates deduced that the rats were more active at night because of their higher core temperature, but there were variable answers concerning the time as candidates seemed to interpret the question in different ways, giving either a period or a precise time. A small number of candidates answered "9:00", relating low temperature with high activity.

(d) (i) The vast majority of candidates described the relationship correctly.

(ii) Performance on this question was more variable. Most candidates only gained one mark here. Well prepared candidates could make the link between cellular respiration and heat production. Others restated the relationship without linking oxygen consumption, aerobic respiration and heat production.

(e) (i)The majority of candidates noted that control rats consumed more oxygen than the fasting rats. A lower number could add a comparison of the spread of data.

(ii) Most candidates gained one mark, either mentioning huddling or a reduction in activity; fewer earned the mark for vasoconstriction. Many candidates tried to relate maintaining temperature to metabolic activities, mainly using reserves or fat and other explanations that would have required more oxygen.

(f) Most candidates had a correct answer, within the acceptable range. There were a few wrong answers where the candidates used the top of the error bars to do their calculation. An increasing number of candidates are including uncertainty figures with their answers. Uncertainty figures on published markschemes are notes to the examiner regarding the range of acceptable answers but it is feared that candidates are interpreting them to indicate

(g) Most candidates only stated that leptin increases temperature and oxygen consumption. Many would then proceed to summarize the data in a descriptive fashion rather than interpreting the data to reach a conclusion as the command term 'analyze' requires.

(h) Very few candidates discussed the reliability of the data though the command term 'discuss' should include a consideration of more than one possible explanation.

Question 2

(a) (i) Most candidates wrote prophase 1 for 2(a) which was accepted as an answer. The cell is more likely a transverse section through a cell in metaphase 1, which was also accepted.

(ii) Many correctly identified the second image as anaphase 2 though a number wrote telophase   A number left off '1' and '2' despite the stem identifying the micrographs as images of cells in meiosis.

(b) (i) A large number of candidates wrote a proper definition. Some candidates mentioned alleles instead of genes and a small number were confused with the concept. Still others showed an awareness of the concept but made other errors in word choice

(ii) The majority of candidate who answered correctly for the previous question could gain at least one mark for repeating that many genes were involved. A large number gained the second mark for continuous variation. Candidates had difficulty communicating the idea succinctly.

Question 3

(a) A large number of candidates gained at least two marks for this question. Many answers mentioned a widespread root system which is an adaptation for dry conditions but not an adaptation for water conservation. A number of others listed more than three adaptations.

(b) Most candidates answered uric acid, though when explaining their answers, they experienced more difficulty. Success in answering this question tended to be centre specific suggesting that it was a topic that may not have been taught in some cases.

(c) Success with this question tended to be centre specific. Many candidates did not include the role of the loop of Henle in the reabsorption of salts. Few used the term osmoregulation. Many were not specific in mentioning the collecting duct as the target of ADH or the collecting duct as the location of synthesis of aquaporins. Many incorrectly identified the collecting duct as the site of synthesis of ADH.

Question 4

(a) Many candidates gained full marks for this question, though others lost marks for not fully labelling the diagram. A common error was labelling the sugar "ribose" instead of "deoxyribose". Poorer answers involved the elements being improperly linked. Many gained full marks who did not correctly respond to the question by, for example, drawing a double strand of DNA.

(b) Most candidates demonstrated some awareness of the process of gene transfer. Many did not take into account that eukaryotic genes would possess intron sequences, though this was not penalized. Better prepared candidates produced very clear explanations, whereas weaker answers had some of the steps in the wrong order or lacked correct details in some of the specific steps. A number described the steps of the process of gene therapy using viruses.

(c) Many candidates explained correctly and logically the process of DNA replication, including differences between the leading and lagging strands. Common mistakes included: not using the full name of the enzymes involved, and confusing them in other cases. Weaker candidates did not distinguish what was happening in the leading and the lagging strand and confused some steps.

Others incorrectly interchanged RNA and DNA, either as the substrate or in the name of enzymes. Many indicated that RNA primase puts a primer on the lagging strand only. Only a very small number of candidates had irrelevant answers, including those who confused replication and transcription.

Question 5

(a) Although a large number of candidates demonstrated knowledge of the structures found within a mitochondrion. Many however did not gain full marks because of a poorly drawn diagram where the intermembrane space and cristae were much too thick, not reflecting the relation between structure and function within the mitochondrion. There were often too many membranes with the cristae being

separated into distinct structures, instead of being an invagination of the inner membrane.

(b) This question proved to be difficult for most candidates. Most candidates could name some processes of photosynthesis and cellular respiration and many produced comparative charts. But they experienced more difficulty in identifying the location of the process within the cell.

(c) Most candidates who attempted this question gained some marks, but answers lacked detail. In many cases, candidates communicated many concepts partially in a few short sentences, when they would have done better to separate out ideas and unpack them in greater detail. Candidates often left simple ideas unstated. Where a diagram of a pyramid of energy was included, the proportion of the different trophic levels was often inaccurate.

Question 6

(a) Most candidates drew a bean seed, although it was sometimes named differently, gaining some if not all marks. Diagrams were often too small and of all diagrams on the paper, the most carelessly drawn.

(b) Most candidates followed the instruction to use a table, though some did not. The words *spermatogonia*, *spermatocyte*, *spermatid*, *oogonia*, *ooocyte* and the different stages of meiosis they related to were not commonly used.

(c) There was a wide range of answers for this question, but it seemed difficult for most candidates to gain full marks, probably because the answers were too general and did not include sufficient detail or specific concepts. 2^n was included but n was stated as the number of chromosomes.

Question 7

(a) Surprisingly, this question proved difficult for candidates. Many interpreted the questions as 'identifiy the factors that increase or decrease population size' when the question asked candidates to 'outline the effects'.

(b) Most candidates who attempted this question had a very good comprehension of the process and produced very well structured answers, gaining most of the marks. Weaker answers tended to confuse B-cell activation with the production of plasma cells and had difficulty putting the steps in a logical order.

(c) The basic process of blood glucose homeostasis was known by candidates. Poorly prepared candidates wrote about hypothalamus involvement. Many could not identify the correct role of α-cells and β-cells. Others confused glycogen with glucagon. Some referred to the production of α-cells and β-cells in response to blood glucose levels.

Recommendations and guidance for the teaching of future candidates

- Teach both the transverse and longitudinal views of a cell in metaphase

- Instruct candidates not to include uncertainty figures in their quantitative answers.

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- Make candidates aware that when only a specific number of responses are requested, including more answers is not a good strategy.

- Teach candidates that RNA primase creates at least one primer on both the leading and lagging strands.

- Ensure that candidates know that a mark will be deducted if the unit is left off.

- Remind candidates that measurements made with a ruler need to be precise.

- For diagrams, the following guidance is recommended:

  (i)   Lines should be closed, for example there should be no gaps in the membrane of the mitochondria. Unambiguous labels should be included. This is related to candidates making drawings that are unnecessarily small. The size of the diagram should be proportional to its complexity. Some seed diagrams were not much bigger than the actual seed. It is difficult to distinguish detail or to identify what a label is pointing to in a very small diagram. There should be correct positioning of structures in relation to other structures such as in the correct position of attachment of molecules within a nucleotide. There should be correct proportions in relation to other structures such as in not having the mitochondrial cristae drawn too thick or incorrectly proportioned bars of the different trophic levels in a pyramid of energy.

- Spend time teaching the skills of communication such as correct word choice, succinct writing and the correct interpretation of command terms. To this end, candidates should be encouraged to:

  (i)   define and use specific terms such as pathogen and antigen; state the obvious rather than leaving things to be inferred by the examiner; separate and unpack distinct ideas rather than bundling them tightly into one sentence; use examples to illustrate ideas including having ready names of specific organisms; spell similar words correctly such as glucagon and glycogen

- Teachers new to the programme should endeavour to obtain a library of past papers or use the CD Question Bank so that old exams and markschemes can be used in teaching as classroom based reinforcement exercises, homework assignments and revision exercises. These resources are also essential so that candidates can be given practice in analyzing data presented in different formats.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 12	13 - 15	16 - 20	21 - 26	27 - 31	32 - 40

General comments

The comments on the G2 forms indicated that three-quarters of the teachers felt the paper to be of a similar standard while 15% indicated it was a little more difficult than last year's paper. Over 90% thought that it was of an appropriate level of difficulty. Most considered the syllabus coverage to be either satisfactory or good while essentially all respondents thought that the

wording and presentation of the paper was satisfactory or good. All teachers' comments on individual questions were considered carefully in grade awards.

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

Some candidates had difficulty in the data analysis questions in their options, particularly in the parts requiring a longer, more in-depth answer and in particular in response to the action verbs of objective 3, such as "explain", discuss", "evaluate" and "deduce".

- Option D: origin of membranes, process of speciation
- Option E: inhibition of postsynaptic neurons
- Option F: control of photoperiod in flowering plants, growth regulators, production of Flavr-Savr^{TM} tomatoes
- Option G: nitrogen cycle and the effect of plowing, use of biotic index, relationship between CFCs and ozone depletion
- Option H: partial pressure of gases, blood circulation in the liver.

There were candidates who had difficulty in stating relationship between variables or in calculating percentage differences. While some candidates expressed themselves well, others had great difficulty in using the appropriate terminology.

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

The majority of the candidates attempted to answer all parts of all questions and only questions for the two options that they had studied. Many demonstrated well developed skills in interpreting the graphs and data in a variety of formats, the drawings appeared to be generally of a better quality than in the past, of a reasonable size with clear labels. A good number of candidates show care in reading the stem of questions by high-lighting key terms, a very useful skill.

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

Option D

Question 1

The answers to (a) and (c) required the correct use of the units and many candidates lost marks by not including "per body mass", thus making their comparisons incorrect, such as stating that bird brains are larger than reptile brains.

(a) Few candidates received 3 marks for (a), giving only 2 valid comparisons at best.

(b) In (b) most answers included the mention of insufficient adaptation for flight.

(c) In (c) many repeated information from the stem without actually *evaluating* the hypothesis.

Question 2

(a) Many candidates lost the mark in (a) for not specifying the origin of organic compounds from inorganic matter, concentrating instead on the physical conditions of prebiotic earth. Others used terms such as living and non-living. A few even discussed bird brains, apparently considering this question as a continuation of the previous one.

(b) Some candidates confused this question with the endosymbiotic theory, while others had the general idea but did not specify the characteristics of phospolipids. A number of candidates involved RNA in the origin of membranes.

(c) Most candidates knew that the *2pq* of the Hardy-Weinberg equation is linked to heterozygocity but many missed the mark by not stating that it represents the *frequency/probability* of heterozygotes.

Question 3

(a) Most candidates were fairly knowledgeable about the evolutionary trends, but some lost marks by not focusing on *fossil* evidence, including discussion of muscle development or cultural evolution without stating the evidence. Others included developments from earlier periods of evolution, such as the development of binocular vision.

(b) The answers often showed very good comprehension, although few showed understanding of the importance of the isolation of gene pools and the changes in allele frequencies in a population. Unfortunately there were some candidates who confused speciation for species classification and taxonomy.

Option E

Question 1

(a) Most candidates answered (a) correctly although some lost marks for not calculating the difference.

(b) Most gave the relationship correctly in (b).

(c) In (c) the answers generally included possible reasons, such as long-tailed males being fitter or better carers, but few received two marks.

(d) Part (d) was even more discriminating and few candidates received 3 full marks. Some candidates did not focus on the data of the controls, but looked at overall results, and others lacked precision in their explanation of the data. Others demonstrated a lack of understanding of the significance of error bars indicating the difference (or lack thereof) between the means of the two control groups.

Question 2

(a) Most candidates could identify at least 2 of the parts of the brain.

(b) In (b) there was a wide range of answers, some showing excellent understanding, to others who were very confused about ion movement, inhibition, effect of drugs, etc.

Question 3

(a) There were excellent answers to this question, showing clear understanding of the conscious control of some reflexes. However, the question caused problems in

English and German scripts for the unfortunate misuse of the word autonomic *resources* instead of *reflexes*. Most candidates seemed to understand what was required, but others described the ANS, its parts and functions, but without reference to conscious control, or simply left it blank. After careful consideration of all the variations in the answers, the decision was taken at Grade Awards to give the full 3 marks to all candidates answering this question in English or German, regardless of the answer itself.

(b) This question was very well answered by many candidates, but unfortunately a few answered about human organizations instead of animals, completely off the topic and markscheme. Most candidates included the examples of honey bee workers, vampire bats or naked moles. Few candidates received the full 6 marks as the answers did not go beyond the specific examples and did not fully define altruistic behaviour or the specific benefit to the group or harm to the individual.

Option F

Question 1

(a) and (b) were well answered by some, but others misread the data or incorrectly calculated the percentage change.

(c) In (c) some were able to give 2 good methods of increasing yield, most commonly mentioning the use of organic fertilizer or manure.

(d) In (d) arguments were given both for and against sustainability, although some candidates had great difficulty giving any reasonable answer based on the data.

Question 2

In (a) the majority of the candidates were able to list two veterinary techniques to improve fecundity, but a surprisingly large number showed no knowledge of plant growth regulators and their role in producing seedless fruit in (b). A few listed names of regulators, but nothing about their role.

Question 3

(a) There were a few very complete answers, but many confused ones, and even scripts where the candidate had no idea at all about Flavr-Savr^{TM} technology.

(b) Although there were occasional good answers, others focused on human intervention in the control of flowering, discussing different techniques such as turning lights on and off, never touching on the biological control of the photoperiod.

Option G: Ecology and Conservation

Question 1

(a) Some candidates were able to state the relationship clearly, but others obviously had difficulty in reading the 3-D graph in spite of the fact that they have been used occasionally on past exams. Some candidates had great difficulty in expressing relationships, as they failed to identify the independent variable even this was clear in the introduction to the question. They could not establish a cause and effect relationship and only described the data. In both (a) and (b), relationships were often stated backwards – the effect of the dependent variable on independent one.

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(b) Some candidates accurately described the relationship of sand eel biomass and proportion of birds as the sand eel biomass changed, but never stated the overall relationship, thus missing one mark. Others were quite lost in this part of the question.

(c) Most candidates mentioned changes in regulation, overfishing and more control of size of net mesh.

(d) Many candidates readily answered this question, stating the obvious in regards to changes in the populations of sand eel biomass and other birds. Those who had struggled with the interpretation from the beginning also had difficulties here.

Question 2

(a) There some very good answers here but some candidates used far too general terms, such as big fish, small fish, a bird, etc. instead of having learned specific common names of specific examples and thus lost one mark, even if they described the mutual benefits. Others gave a correct example but omitted the mutual benefits.

(b) Some candidates had an excellent knowledge of the nitrogen cycle and the effect of aeration by plowing, but others were very vague, mentioning only the moving of materials in general. Some even stated that plowing either adds or removes bacteria to the soil.

Question 3

(a) There were some excellent answers here, but other candidates confused biotic indices with the Simpson index, or even the t-test, never linking their ideas to biotic index or measurements of environmental change.

(b) Some candidates provided complete, accurate answers but others were unable to describe the interaction of CFCs with ozone, gaining at best a mark for stating they were used in refrigerators. As always, there was some confusion with the greenhouse effect, the depletion of ozone in the stratosphere and production of CO_2.

Option H

Question 1

(a) Most candidates answered this well, but some misinterpreted the question and gave relative concentrations of ions first in the saliva and then in the plasma, never comparing the same ion in saliva and plasma. The relationship in (b) was generally well described but some did not give a detailed account of the changes in concentration with at low and high rate of flow and thus lost one mark. In (c) a pleasing number candidates correctly identified active transport, giving the reason of concentration gradients. Unfortunately, some did not give a reason so lost the mark, while others answer passive diffusion. Part (d) was the most discriminating part of the question and few got more than one mark. Those who got the mark suggested that the flow factor affected the time for absorption or uptake by the pump (in the case of active transport). Unfortunately, some who had answered (c) correctly described osmosis or diffusion while others tried to answer with regard to saliva production related to eating.

Question 2

(a) Most mentioned the role of controlling blood plasma concentration or a variation of the theme, but some confused osmoregulation with temperature control, or hormone production.

(b) Many candidates got the 2 marks here, describing the monitoring of CO_2/pH and the control of ventilation rate.

Question 3

(a) Although many candidates showed a good understanding of the circulation of blood through the liver, some were side tracked into describing the functions of the liver instead of specifying the blood vessels and flow.

(b) There were some excellent answers on acclimatization to altitudes, although a large number of candidates confused it with adaptations of people living at high altitudes. There was a general knowledge of problems of gas exchange at high altitude, but some difficulty using the term *partial pressure* of the gases and confusion between *affinity* and *saturation* of hemoglobin.

Recommendations and guidance for the teaching of future candidates

- Candidates should be encouraged to use subject-specific vocabulary in their answers.

- Candidates need more practice with data analysis using previous exams, paying attention to accuracy of reading data. Units should always be given with an answer to a calculation or when quoting data from a graph. Varied presentations of data, particularly 3-D graphs should be used as they required considerable practice to master their interpretation. More practice is recommended on interpreting causality between variables.

- Candidates need guidance in how to consider the depth of their answer and the mark allocations. In the data question, the action verb must be considered, as well as incorporating evidence given by the data itself. If a question is worth six marks, at least six statements must be made. The sequence of the statements should be carefully considered, as well as using examples to illustrate an idea. Throughout the two year programme candidates should have plenty of opportunity for writing extended response answers.

- Candidates should have studied the whole syllabus two options and attempt to answer only those two. It is apparent that some candidates are answering ones simply because the data analysis looks easier, but they gain no marks on the content portion of the option.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 10	11 - 14	15 - 17	18 - 21	22 - 24	25 - 30

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General comments

G2 forms did not show consensus among teachers about this paper. 60% of those who commented felt that it was of a similar standard, but 17% thought is was a little easier, 17% a little more difficult and 6% thought it was much more difficult. Despite this, more than 90% thought that the level of difficulty was appropriate. Teachers were mostly very happy with the presentation of the paper, happy with the syllabus coverage and fairly happy with the clarity of the wording. The statistics for the paper showed that most questions discriminated effectively and in some cases very effectively, so teachers' fears about the clarity were not supported.

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

Some questions performed in a predictable way and no comments need to be made about them. The comments that follow relate to questions where candidate performance was very good or very poor or questions that aroused comment from teachers on G2 forms.

Question 1

The examining team often try to ensure that the first question on the paper is relatively straightforward, but this question proved to be the second hardest on the paper, though it discriminated well. More candidates chose the incorrect answer D than the correct answer C. This suggests confusion between absolute surface area and surface area to volume ratio. This is a rather mathematical area, which it is understood some candidates will not find easy.

Question 2

This question was answered more poorly than expected. It is difficult to know what the common mistakes were but they were probably mostly mathematical or related to SI units.

Question 4

This continued a run of rather difficult questions at the start of this paper, as this question was the most difficult on the paper, with far more candidates choosing the incorrect answer D than the correct answer A. The examining team considered carefully whether the question was fair and decided that it was, especially as the discrimination index was quite high for a question that so few candidates got right. To help candidates with similar questions in the future, candidates should be encouraged to read all of the possible answers very carefully as one word in an answer can totally change the meaning. The word *whereas* is an important one when distinctions are being made and candidates should be familiar with it, even if not working in their first language. Answer D is incorrect because plant cells have both a cell wall and a membrane, so the presence of a membrane in an animal cell does not distinguish plant from animal cells.

Question 10

Some teachers felt that the term *replication fork* was not likely to be understood by candidates and that the idea of a left to right or right to left direction of movement was also difficult to understand. About 20% of candidates gave either answer A or B, suggesting confusion between replication and transcription or DNA and RNA. Of the remaining candidates only about half got the direction of movement of the fork correct, but the discrimination index for this questions suggests that it was mostly the stronger candidates who got the direction right. The direction is right to left, because the next pair of bases to be separated are to the left of the last pair to have separated.

Question 11

The examining team agreed with the comment made by several teachers that the term *sense strand* is not expected at SL. However the question had a very high discrimination index and even without understanding this term there are no obvious reasons for choosing the popular incorrect answers of A and B, apart from misunderstandings of the nature of the triplet code, or errors of calculation.

Question 16

This question was common with question 10 of the HL paper and comments are included in the HL report. It performed satisfactorily on the SL paper and more than 70% of candidates answered it correctly.

Question 18

This question was answered particularly well, indicating a good level of understanding of the ethics of reproductive cloning.

Question 20

This was common with question 13 of the HL paper and comments are included in the HL report. It is one area of the programme where knowledge often seems to be poor and teachers could therefore give it greater emphasis.

Question 21

This proved to be the easiest question on the paper, with over 90% of candidates answering it correctly and showing good knowledge of the formula used to calculate a mean.

Question 24

Some teachers objected to the description of the gall bladder being surrounded by the liver, but although this may not be shown in two-dimensional textbook diagrams, the examining team were satisfied that it is an accurate description of the three-dimensional position of the gall bladder.

Question 28

This was common with question 20 on the HL paper and lengthier comments are included in the HL report. Nearly half of candidates answered the question correctly and the discrimination index was good.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 15	16 - 21	22 - 27	28 - 34	35 - 40	41 - 50

General comments

In section B the overall quality of responses and diagrams in particular appeared to be of a better standard than in May 2007. The diagrams appeared improved with more appropriate subject content this year.

The range of raw scores extended from 1 to 50, with many candidates scoring in the mid 20s to mid 30s.

G2 forms were received from 67 teachers. 82% of respondents found the paper to be of a similar standard to the previous year, with only 6% believing it to be more difficult. 97% of respondents considered the paper to be of an appropriate level of difficulty. 80% of teachers regarded coverage and clarity of wording as good. 90% of the respondents rated the preparation of the paper as good. G2 forms are always read and considered at the beginning of the Grade Award process so detailed completion of them is most helpful in the process of awarding grades.

The general performance of candidates was very well spread across the mark range. The scripts of some schools had very good performance, but others had difficulty achieving a good range of marks.

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

Section A

Here some candidates had problems in describing and deducing results from the graphs in the first question. In the question 2, a number of candidates had problems in distinguishing between resolution and magnification, and to identify structures in the electron micrograph showed. Furthermore, in the following question some of them had difficulties to explain the properties of water, and to identify elements of the aerobic cell respiration and photosynthesis processes. Finally, in question 4, a surprising number of candidates had serious problems in explaining the variability promoted by sexual reproduction, and the variety of different cells obtained from the differentiation process.

Section B

Here most of the questions of asked candidates to explain processes or make detailed connections. Many of the candidates were not able to give the complete information required in these questions. The most commonly answered question was 5, followed by 6 and finally 7. As in the past, candidates find the longest parts of these questions (worth 8 marks each) the most difficult. They should carefully consider these parts before attempting the question. Most who chose question 7 were strong on enzyme function but weak on gene technology. Candidates showed variable drawing skills, with many untidy and poorly labelled diagrams denying candidates marks.

Much as a small number of candidates did show impressive construction of answers, a large majority still reflected a lot of weakness in this area; particularly in structuring answers in section B. Linking of relevant ideas to form a fluid flow of ideas within at least 2 parts of a question still remained a challenge to many.

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

Section A

Here most candidates were able to process the data provided. This year the data seemed well accessible to most candidates. Most were able to appropriately identify organelles in electron micrographs and provide precise explanations of the properties of water as a habitat.

Section B

Diagrams where drawn were well done and most candidates appeared to understand the verb in the question and what the answer required. The diagram of the fluid-mosaic model of the plasma membrane was well done, as was the explanation of active and passive transport and listing of alveolar features.

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

Question 1

The response to this question was generally impressive. A good grasp of data-interpretation skills was clearly evident.

Most of the candidates were able to answer questions: 1(a), (b) and (c) very well. A few candidates did not realise that the action verb "calculate" used in the stem of 1(d) requires candidates to show working, but most showed their working and calculated the correct answer.

(e) (i) When candidates are asked to compare in a question such as this they should discuss they key similarities and differences quoting the key data from the question.

(ii) In part (ii) they were required to provide support for their suggestions. A majority of candidates were able to achieve two marks for each part of this question.

(f) When answering a discuss question, candidates should be providing a range of supported arguments for their suggestions rather than the sweeping, unsupported statements. Many candidates linked body mass and strength in answers, but not always in a clear fashion. Many started giving advantages of higher body mass in one species and then of lower body mass in the next. They combined this with changing from advantage to disadvantage across the two species to produce some difficult to read answers.

Question 2

(a) The difference between "magnification" and "resolution" appeared well understood by many candidates. But the use of the terms "pixels" and "zooming" to refer to resolution and magnification was quite common. Such terms are not appropriate.

(b) Knowledge of electron photomicrography was rather wanting. A reasonable number of candidates were referring to the nuclear membrane as plasma membrane and the mitochondrion as either chloroplast or rough ER.

(c) The Mitochondria as a site of *aerobic* respiration was missed by many candidates. Candidates who did not get (b) II correct were awarded marks here for the correct function of the incorrect structure listed in (b) II.

(d) A surprisingly large number of candidates could not distinguish between prokaryotes and eukaryotes. Some had the correct answer, but no reason and missed a mark.

Question 3

(a) Knowledge of the properties of water as a habitat was well expressed generally.

(b) Surprisingly, a majority of the candidates could not trace the origin of oxygen released during photosynthesis in plants. Many cited ATP, rather than water.

Question 4

(a) Very few candidates could relate meiosis and crossing over to genetic variation in species. The aspect of random fertilization proved elusive to almost all.

(b) Taxonomic hierarchy was impressively answered.

(c) Differentiation of cells proved tricky for many candidates. Other than mentioning that cells specialize, most found it hard to bring out the element of some genes being expressed and others suppressed.

Section B:

Most candidates attempted Q5. Relatively fewer tried Q6 and Q7.

Question 5

The response to this was question was commendable. Knowledge of fluid mosaic membrane structure was very good. Most of the candidates could draw and label the membrane appropriately. More difficulties were observed when candidates named the membrane proteins. In part (b) active and passive transport also appeared well understood, though there was some confusion with passive and active transport proteins. Active transport was understood and explained better than passive by most candidates. In part (c) most candidates achieved full or nearly full marks touching on the alveoli and gaseous exchange, though large surface area was often attributed to the alveolus rather than the lung. Candidates who attempted this question generally scored fairly well.

Question 6

(a) The structure of the blood vessels was outlined well, though some candidates lost marks here as they referred to e.g. the arteries, rather than the artery walls as being thick.

(b) The role of phagocytes in body defence was not answered well. For some reason, many candidates merely focused on endocytosis, leaving out the many others.

(c) This was the worst done part of the question, with the vast majority of candidates who attempted the question appeared not to understand *how* sickle cell anaemia confers resistance to malaria. Few mentioned heterozygotes and homozygotes within the context of malaria resistance and early death respectively. Most candidates simply stated that sickle cell anemia made individuals "resistant" to malaria. Few candidates were able to link the scenario correctly to natural selection or evolution. Alarmingly, candidates occasionally confused sickle cell disease with AIDS.

Question 7

(a) Many candidates were able to describe the lock and key model of enzyme action, but seemed not to understand what this meant in terms of enzyme action. Enzyme

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specificity came out well in answers, though the relation between enzyme action and substrate concentration was not properly expressed by many candidates.

(b) The concept of gene technology with regard to restriction enzymes and DNA ligase was very poorly answered. Most candidates appeared ignorant of plasmids and what *E.coli* is. This ranked alongside Q6(c) as the trickiest question for candidates. Clearly knowledge of genetic engineering was minimal.

(c) Digestive enzymes were understood well by most candidates, though many were unable to name the products of the specific enzyme action on the substrate.

Recommendations and guidance for the teaching of future candidates

- Read and use ALL information provided in the question. If you can, re-read it quickly and try to apply it in responses.

- Teachers should try to familiarize candidates with the meaning of the action verbs. Incorporate these wherever possible in local school testing and assignments.

- Candidates should be succinct in their answers, writing their answers on the spaces provided.

- Teachers should work with candidates how to link relevant ideas in an essay to provide a coherent sequence of thought, and review the criteria needed to gain bonus marks.

- When calculating data, measure figures as accurately as possible and always show working.

- Use pencil for drawing and ruler for labelling lines

- Candidates should consider their section B choices carefully and respond to the question to which they can confidently attempt all sections.

- Teachers could train their candidates more, or at length, on aspects of quality response to questions in section B. Many candidates miss out on the quality marks on offer since many just waffle.

- Teachers could also spend some more time on the section of the syllabus dealing with genetic engineering and natural selection. It appears these are usually rushed through without due regard to in-depth understanding by the candidates.

- Teacher should give candidates the opportunity to view and label as many electron micrographs as possible.

- Some candidates had difficulty answering question 1(f) It would help if teachers could emphasise the need to use knowledge to interpret data. Teachers should instruct especially weaker standard level candidates to focus on standard level details of particularly difficult topics like respiration. Teachers also need to emphasise the need for show their calculations when asked to calculate.

Standard level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 11	12 - 15	16 - 20	21 - 25	26 - 30	31 - 36

General comments

68 G2 forms were received from teachers, of which most found the standard of SLP3 to be very similar to last year and the level of difficulty appropriate. Syllabus coverage and clarity of wording was perceived to be either satisfactory or good. The choice of options appeared to be more evenly spread than in previous years. Options C and F appeared to be the least popular. The standard of performance showed a wide spread, with few very low and few very high marks being awarded. Candidates had been fairly effectively targeted at this Standard Level. It was however a little disappointing to see some candidates who obviously had had a poor experience, benefiting little from the course and producing very low marks. In this sample, there appeared to be less of a discrepancy between marks scored by very good and average candidates within different options. Drawings seemed to be of higher quality and accuracy, although many were still of cause for concern. There were fewer candidates this year leaving parts of questions completely unattempted. Overall, the paper seemed easier and better answered than in the past.

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

Candidates did not appreciate the difference between the action verbs: 'evaluate', 'discuss', 'explain', 'outline' and 'compare'. Many candidates had difficulty in understanding and comparing data from graphs and charts. They tended to simply describe patterns or re-write data without any analysis or processing. Many candidates showed problems on data interpretation questions, mainly when negative numbers appeared as in Option G, Question G1.

Options B and C required candidates to produce a labelled diagram. The standard of drawing was extremely variable. It was difficult to tell whether this was due to a lack of knowledge, a lack of skill or both. Labelling was done rather carelessly so it was difficult to judge to which structure the label referred. It was surprising to note that few candidates could calculate a percentage. However the calculation of a mean caused fewer problems. It was difficult to pick out any general strengths and weaknesses in biological knowledge. Many answers tended to be 'centre specific', i.e. candidates from one centre producing good answers, candidates from another centre producing very poor answers to the same question.

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

Option A

Question 1

(a) Most candidates were able to identify Vitamin B12 as the nutrient with the lowest percentage deficiency in ten year-olds

(b) Many candidates failed to compare the data for vitamin D in three breakfast eating habits correctly because of misinterpretation of the table provided. They treated the percentage values as the percentage of candidates with different eating habits rather than the percentage of ten year-olds eating less than two thirds of the RDA among candidates with different eating habits. Many candidates recalled what was written in the table instead of comparing the different data.

(c) Many candidates misunderstood the table considering that values given corresponded to children eating those quantities instead of eating less than 2/3 of the RDA.

Question 2

(a) Most candidates could define nutrient, except some forgot to mention that a nutrient forms part of the diet.

(b) (i) Almost all candidates could list sources of proteins in human diets.

(ii) Only some candidates stated that amino acids are the products of protein digestion. The answer was in general vague as regards the use of them in the human body.

(c) The majority of candidates explained the importance of fibre in the diet with in-depth explanation, although some candidates gave answers without biological jargon, such as "fibres clean the guts".

Question 3

(a) Most candidates distinguished between vegans and vegetarian.

(b) In general no problem, except for the fact that for some candidates lack of calcium is more important than calciferol as a cause of rickets. Most vegetables contain calcium, so this is not a major problem for vegans.

(c) A few candidates gave very vague explanations of why malnutrition could be caused by economic or environmental conditions.

Option B

Question 1

(a) Almost all candidates gave correct answers, although some failed to place the units, thus lost the mark.

(b) Comparison on active and passive recovery was in general correct.

(c) Although some candidates did not acknowledge the work "evaluate", most candidates answered this question correctly.

(d) Many candidates answered pancreas, but most correctly answered liver as the organ which breaks down lactate.

Question 2

(a)

Many incomplete answers. Few candidates failed to achieve the two marks, as usually only one role of adrenalin was mentioned.

(b) For many candidates the verb compare was not clear as they tended to mention characteristics for one category without reference to that same characteristic in the other category. Few candidates placed the compared characteristics on the same line of the table provided.

Question 3

(a) Only few correct answers. Although better than other years, drawing is still an important difficulty for most candidates.

(b) Very few correct answers. Many candidates explained how the myosin and actin fibres were involved in muscle contraction instead of explaining how this is controlled by the nervous system.

Option C

Question 1

(a) Surprisingly, many candidates could not distinguish between chemical and non-chemical products of respiration

(b) Most candidates failed to analyse the data, they simply described the information on the graph without arriving to any conclusion.

(c) Many candidates were able to realize that decreasing the temperature would slow down the process of maturation, but most failed to realize that lowering the oxygen concentration or shortening the transport distance could also help.

Question 2

(a) Very few candidates compared the structure of both organelles.

(b) Chemiosmosis seemed to be one of the hardest topics for candidates to answer correctly. A few scored full marks, most only one or none

Question 3

(a) Most candidates knew the light-dependent and light-independent reactions.

(b) The shape of the spectrum was correct in general. Almost all of them showed two peaks but the axes were sometimes incorrectly labelled or not labelled at all. Some candidates drew the photosystems instead.

(c) Many candidates knew what a limiting factor was but they forgot to refer to the fact that the factors such as carbon dioxide and temperature should be in excess.

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Option D

Question 1

(a) No problems

(b) Very few correct answers. Many candidates used the total age as 60 days instead of 59 (as stated in the stem)

(c) Almost no correct answers. Most candidates failed to realize female maturity was the important issue in this question

(d) Many candidates scored full marks in this question, although many responses did not indicate why natural selection would favour each.

Question 2

(a) In general candidates identified the ways in which living organisms have been preserved.

(b) Most candidates did not know what a biochemical variation meant, many of then referred to ^{14}C half life.

(c) Most candidates referred to Wallace's Line, without clear explanation or description, so they scored few marks.

Question 3

(a) Many candidates gave an incorrect answer, usually referring to *Homo sapiens*.

(b) Here answers were not very clear. Vague terms were used, little biological knowledge was shown in this area.

(c) Most answers were incomplete.

Option E

Question 1

(a) Almost all correct answers, although many candidates did not pay attention to the highest point for the natural extract

(b) Although lots of candidates gained the three points, here again very few paid attention to the highest value for the female extract.

(c) Most candidates deduced it was a taxis. Some forgot to say why, so did not score a mark.

(d) In general answers were correct, although some responded olfactory instead of chemoreceptor.

(e) Here most candidates suggested to use synthetic sex pheromone but with no reference to the dose to be used. Some candidates did not realize the question was on pest control and answered about behaviour modification instead.

Question 2

(a) Almost all drawings were clear and correctly labelled. Some candidates clearly did not study this topic well enough. Only a few candidates drew a front view of the eye, so there were not enough labels to score full marks.

(b) Here again there was a problem with the verb distinguish, the differences were not compared.

Question 3

(a) Concepts did not seem to be very clear. In many answers it was difficult to determine whether or not candidates recognized that the adaptive behaviour must have a genetic component to be naturally selected.

(b) In general, this question was well answered.

(c) Most candidates could list animals with social behaviour.

(d) Here again lots of correct answers appeared.

Option F

Question 1

(a) Most candidates scored full marks in this question.

(b) Most candidates were able to interpret the radial graph properly.

(c) In general this question was well answered, although some candidates failed to evaluate the data and only repeated information obtained from the graph

Question 2

(a) In general well answered.

(b) Most definitions of net assimilation rate were correct.

(c) Some candidates believed auxins caused the bending of the plant.

(d) Most candidates were able to explain how plant productivity can be optimized in greenhouses.

Question 3

(a) No problems with this question.

(b) Most candidates only scored one mark in this question as they only explained one method used by veterinarians instead of two.

Option G

Question 1

(a) Only few realized that the reason for the changes was human impact.

(b) (i) Almost all correct answers

(ii) Almost all correct answers

(c) Almost everybody could observe the effect on grasses and legumes, but only very few analyzed the impact of machines used.

(d) (i) Most candidates realized that water in artificial snow might contain dissolved minerals or that the plants were more irrigated.

(ii) Most candidates realized that the data did not support the hypothesis.

Question 2

(a) Almost all correct answers.

(b) For many candidates it was not clear the principle as they did not consider a full niche overlap.

(c) In general, answers were correct but in some cases incomplete.

Question 3

(a) Many candidates did not know how the index is calculated, what it indicates, or what it could be used for

(b) Many correct answers, although some candidates still confuse in situ with captive breeding.

Recommendations and guidance for the teaching of future candidates

- Make sure it is clear for candidates what action verbs are, what each of them means and how to use them. Practise questions to ensure that candidates know the difference between "state", "compare", "evaluate", "explain" etc.

- Use a highlighter to emphasis key words in a question e.g. "using the data" and "explain how" or underline them.

- Analysis of data is an acquired skill. Candidates should be offered the possibility to practice much more data manipulation and interpretation using past papers to be trained to answer data based questions. They should practise reading values from graphs. Candidates are throwing away marks by either (apparently) visually estimating values or by hand drawing crooked lines.

- Much more practice with drawing is needed. Always use a pencil for drawing so erasing is possible. Good examples of drawings such as chloroplasts and mitochondria should be shown to candidates so they know what is expected.

- Make candidates aware of the meaning and importance of the mark in between brackets given to each question. Candidates should be persuaded to tailor their answers to the marks available, i.e. a four mark question demands a detailed answer with at least four separate points stated by the candidate.

- Candidates should also be persuaded that the quality of answer not the quantity is important. Many candidates ramble on for many pages of extra sheets without credit Candidates should not rewrite the question. Train candidates on calculations. Candidates should be told that attempting all options is poor examination technique.