# BIOLOGY

## Overall grade boundaries

### Higher level

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 16 | 17 - 31 | 32 - 44 | 45 - 56 | 57 - 69 | 70 - 81 | 82 - 100 |

### Standard level

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 15 | 16 - 30 | 31 - 43 | 44 - 55 | 56 - 70 | 71 - 82 | 83 - 100 |

## Internal assessment

### Component grade boundaries

### Higher level

| **Grade:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range:** | 0 - 8 | 9 - 16 | 17 - 22 | 23 - 27 | 28 - 33 | 34 - 38 | 39 - 48 |

### Standard level

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 8 | 9 - 16 | 17 - 22 | 23 - 27 | 28 - 33 | 34 - 38 | 39 - 48 |

The vast majority of the teachers were using the new programme with its changes to the internal assessment.

Most schools used appropriate investigations Two problems persist, however; in some schools the complexity of the investigations is not up to IB standards and others are setting investigations for assessment that are too heavily directed.

The structured investigations often originate in collections of laboratory exercises that were not intended for use in assessment. Careful editing of the instructions is necessary if they are to be used for assessment. Some teachers are using these investigations without providing the instruction sheets to the moderators. The moderators are quite familiar with the material that is available and can spot when it has been copied by the students.

In many schools the new criteria are being applied rigorously but in a number of schools the teachers seem to be ignoring the descriptors of the different aspects. In these cases the moderators are forced to mark down.

The Group 4 Project can only be used for the assessment of Personal Skills and none of the other criteria. Fortunately very few schools this session seemed to be ignoring this rule.

**The IB has now published a document called Animal Experimentation Policy which is available on the OCC. This and the Ethical Practice Poster, also available on the OCC, will be applied to future Internal Assessment moderation. If necessary, please make adjustments to your Practical Scheme of Work**

## Clerical procedure

Earlier versions of the 4/PSOW form were being used by some teachers. This did not provide space for the moderator's and senior moderator's marks. The latest versions (available on the OCC) should be used.

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 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. They should be congratulated for their efforts and their students will reap the benefits. It is a lot easier for a moderator to support a teacher's marks when there are clear notes accompanying the sample.

There is a recurrent problem concerning the information provided by the teacher. This directly affects the progression of the moderation. Teachers MUST 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 DCP assessment. It is also necessary, however, for investigations where Design is being assessed and a significant number of teachers are not doing this. Furthermore, when Data Collection and Processing is being assessed the method (designed by the student or provided by the teacher) is required. When Conclusion and Evaluation is being assessed all the steps in the scientific process are needed for moderation.

Some teachers are not designing practical programmes with sufficient numbers of hours, others are maybe inflating the time spent on an activity.

Atypical candidates should be replaced in the sample. These would include students whose work is incomplete or transfer students where a substantial part of their work has been marked by another teacher.

When the only marks appearing on the 4PSOW form are the two marks required for the internal assessment, it causes concern amongst the moderators. There is no indication that the students were marked a number of times using the criteria. One wonders how these students receive the necessary feedback to improve their performance.

Some moderators commented on transcription errors between the marks indicated on the work and the mark on the 4PSOW form. This should be verified before it is sent.

Schools are sending photocopies of the student's work. Usually these are of good quality. The problem is that graphs and diagrams using colour can be confusing. It would be better to send the originals and keep back a photocopy.

## Areas of strengths

The variety of investigations, the duration and coverage of the practical programme were generally good.

The use of ICT in the areas of **1** Datalogging, **2** Graph plotting software and **3** Spreadsheets is good.

## Areas of weaknesses

Although the vast majority of teachers had learnt that there were new criteria they often presented very similar investigations to the previous programme. This was particularly apparent in those used to assess DCP, which has become more demanding.

Trivial, simplistic investigations that do not generate sufficient data to permit adequate assessment of data processing were sometimes used for assessment. If there is one significant area of weakness it is in the processing of data. Students are missing quite obvious conventional points (e.g. indicating uncertainties in their data) as well as limiting their processing to the calculation of a mean. Teachers are also missing these points and marking over generously. Sometimes teachers point out the errors to their students and still give full marks.

Where teachers apply the criteria rigorously and clearly the moderators make relatively small adjustments to the marks. Where schools where the descriptors of the aspects are ignored the moderation can reduce the marks quite severely.

Literature sources are not consulted when they could provide valuable background information in determining the initial research question and in the discussion of the results.

In some schools cross moderation between colleagues in biology is clearly not being carried out. Moderators have observed quite different standards of marking between colleagues presenting work in the same sample.

## Rules applied by the moderators

In the event of the teacher providing too much guidance to the students or ignoring the criteria the following scale is applied by the moderators:

| Criterion | Problem | Teacher awards | Maximum moderator can award |
|---|---|---|---|
| Design | Teacher gives the problem or research question. | c; c; c = 6 | p; c; c = 5<br>Students could have identified their own control variables |
| Design | It is clear that the students have been told precisely what apparatus and materials they require and have not modified it. | c; c; c = 6 | c; c; n = 4 |
| Data Collection & Processing | The students have used a photocopied data table with headings and units. | c; c; c = 6 | p; c; c; = 5<br>Student could have added uncertainties or relevant qualitative observations |
| Data Collection & Processing | The students have been told, on the method sheet, to draw a graph from their raw data and which variables to plot or process the data in a particular way. | c; c; c = 6 | c; n; c = 4 |
| Conclusion and Evaluation | The student 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 = 6 | c; n; p = 3 |

## The Criteria

**Design**

Some teachers are setting general themes with little scope for different investigations. The result is that the whole class of students selects the same variables and investigates the same system.

Little research is evident or investigations that are designed with little or no consideration of biological principles. It may be a small point but it would be useful for the student to give the scientific name of the organism being used or the organism that was the source of the material. The trivial name at least must be given.

The three categories of variables must be clearly identified. Students need to be taught what the different variables are and what their relationship is.

The new programme requires that the investigations assessed should contain quantitative data. Moderators have reported that there are a number of schools still presenting investigations that collect only qualitative data (e.g. microscopic observations of tissues or observations on dissections). They are inappropriate.

Even if the investigations are quantitative then they are frequently too simplistic. The range of values of the independent variable are insufficient to establish a trend, the number of repeats are insufficient to permit statistical analysis. E.g. testing the effect of pH on an enzyme using only an acidic environment a neutral environment and a basic environment will not establish an optimal pH.

Standard protocols will, no doubt, be used by the students when they design their investigations. We are not expecting them to re-invent the wheel. HOWEVER these standard protocols must be significantly modified or applied to the student's own investigation. For example, if osmosis is being investigated and the student uses the method of change in mass of tissue to monitor the effect of solutions of different concentrations on a tissue, this is legitimate. If the investigation is simply to determine the isotonic solution of one tissue then it remains trivial and it repeats many textbook investigations. If the investigation is used to determine the effect of the salinity of irrigation water on different root crops, the investigation becomes more substantial.

In field work, the control of sampling procedures is almost totally ignored by the students. If a random sample is to be obtained how can it be ensured that it is random?

It is good practice for students to follow through their own designs. Some schools seem to have their students design an investigation that remains theoretical. The result is often an unrealistic investigation.

**Data Collection and Presentation (DCP)**

It may be that class data is required in order for the student to gain access to sufficient data for significant data processing and the determination of uncertainties. The moderators understand this, biological systems are often difficult to coax and slow to give data. If class data is to be used and DCP is to be assessed a number of precautions must be respected. The students must present their own data or clearly identify which is their own data in a pooled data table. The student must plan and produce their own data table. Copying a table from other students will be counted as collusion and the school's IA work will be subject to an enquiry. Teachers who provide the students with a pre-formatted data table can expect their students to be moderated down.

Despite the clear warnings in the subject guide, teachers are still providing instructions on how to present the data and how to process the data. Their marks will be moderated down. The classic investigations (e.g. mark and recapture, chromatography of leaf pigments, rates of photosynthesis using the sunken leaf disks, rates of reaction of catalase and osmosis) often create problems. Teachers are using standard textbook protocols without modifications. A little imagination and editing could easily solve the problem.

Moderators often had to reduce the marks of the teachers who had missed the following points:

- There were no quantitative data collected
- No uncertainties were given in the tables of data collected using measuring instruments.
- There were inconsistent decimal places in tables
- The decimal places did not correspond to the precision of measurements
- There were no associated qualitative observations. E.g. an ecological field investigation is incomplete without some kind of description of the site used
- Raw data were plotted in graphs that do not actually reveal anything (e.g. maxima, minima, optima or intercepts)

- Raw data were plotted when the mean should have been calculated and plotted (often the mean is actually calculated and then ignored by the student for graphing)
- There was no statistical treatment of the data when it was possible
- There was no presentation of uncertainties in graphical data either by using trend lines or error bars
- The error bars, when used, were not explained.

Complete may not mean perfect but when the mistakes are consistent they will have an impact on the moderated marks.

When calculations are made, it is important that the pathway to the answer is clear. This does not mean there has to be a worked example but a result that springs up out of nowhere will not be credited.

**Conclusion and Evaluation (CE)**

Investigations that lead to trivial amounts of data will lead to limited discussion of results and weak conclusions. Insufficient data will not reveal uncertainties and this has an impact on evaluation. So although each criterion is marked on its own merits there will be a knock-on effect through a poorly designed investigation that collects a limited amount of data.

Some teachers are using simulations instead of real biological investigations. These may be useful for training data collection and processing as they generate large amounts of data quickly. However they are not suitable for assessment, especially the assessment of this criterion. It is not possible to provide a biological explanation in these cases.

Overall literature values or the theoretical background were not consulted enough by the students. When they were consulted the sources were often not correctly cited. For guidance on the correct way to cite a reference, the guidelines in the Extended Essay Guide are very helpful.

Students in some schools show that they have developed a mature sense of criticism of the investigation. Their evaluation of their results is based upon a balanced critical analysis of the data. Students who have not developed this skill tend to remain superficial in their evaluation. The weaknesses they identify are hypothetical (“the seeds could have been dead”) without evidence to back it up. For weaker students the experimental weaknesses are restricted to having a limited amount of time or errors in their own manipulation that once again remain hypothetical (“I could have incorrectly measured the temperature”). Evaluation is a good discriminator of the high achieving students and teachers would do well to remember this when they are marking their students’ work.

Suggested modifications were sometimes superficial and yet marked over generously.

As stated above in clerical procedure, if the method and the data used by the student are not provided by the teacher then CE cannot be moderated.

**Manipulative skills**

There is evidence of the students being exposed to a sufficient range of investigations. This ensures that the manipulative skills can be assessed correctly.

**Ethics and Safety**

There was a significant increase in the number of moderators commenting on investigations that were unsafe or unethical. Inflicting pain deliberately on a fellow student to see what effect it has on heart rate is clearly inappropriate for both ethical and safety reasons. However, using fellow students for investigations into the effect of exercise on the heart rate can also be considered unsafe if the health status of the students is not determined first. Some schools are already expecting their students to use a proforma for the signed consent of the participants in experiments. This is good practice. The IB does not wish to inhibit investigations but it does want to stimulate a responsible attitude towards experimentation. The safety and ethics of science investigations has been reviewed. New guidelines have been issued.

Some examples of unsuitable work carried out in 2009 as part of the practical hours, or submitted for Internal Assessment or for extended essay included:

- Taking repeated blood samples from guinea pigs/rats
- Subjecting molluscs to severe dehydration leading to death
- Force-feeding of rats with caffeine
- Subjecting animals to pain by placing them on a hotplate
- Experimenting on fish, moving them repeatedly between tanks and precipitating the death of some individuals
- Adding repeatedly greater quantities of sugar to the water in which goldfish were kept, resulting in distress and death

**ICT coverage**

This was generally covered adequately by the majority of the schools.

Schools seem to have made an effort to equip themselves with the necessary materials to carry out data logging. However, the use of this material in investigations for internal assessment of the criteria was not always appropriate. Teachers and students are strongly advised to read the relevant section of the subject guide.

Graph plotting using software was perhaps the easiest and most widespread for schools to apply. However the signs are that the students still need to be taught the correct conventions of graphing. There is a tendency to use bar charts for everything amongst the weakest students, perhaps because it is the default setting. Legends (keys) are not always necessary and students do not seem to know how to de-select them. When they are needed the students often have difficulty labelling them appropriately – students often present the different curves as “series 1” and “series 2” When the students used scatter plot, a trend line was not always used when it was appropriate.

It might be an idea to train the students to plot graphs manually before using a graphing program.

The use of spreadsheets for data processing was less apparent in the sampled investigations. When spread sheet tables are inserted into document files the conventions of presenting tabulated data were often ignored or forgotten (e.g. Centring numbers, adjusting the number of decimal places, column headings).

Some schools are not fulfilling the requirement for a range of ICT applications to be used in their practical programme. It is the use of databases and computer modelling/simulation that are most often missing.

**The Group 4 Project**

It needs to be repeated for some schools, the Group 4 Project can ONLY be used for the assessment of Personal Skills. Indeed it is the only occasion when it is assessed. The Group 4 Project CANNOT be used for the assessment of Design, DCP, CE or Manipulative Skills. In the next session schools that use the Group 4 Project inappropriately will be sanctioned.

**Recommendations for the teaching of future candidates**

- Read feedback from the previous session and act upon it.
- Consult the Online Curriculum Centre (OCC) for teacher support material (TSM)
- Apply the internal assessment criteria rigorously.
- Ensure that the open-ended theme that you set has enough scope to provide a variety of research questions.
- Give the students experience in identifying independent, dependent and controlled variables.
- Be sure that investigations used for assessment produce quantitative data.
- Encourage the students to make additional observations about their experiment.
- Ensure that the investigations have the potential to generate sufficient data for substantial processing.
- Teach the students that plotting graphs of raw data is often insufficient.
- Encourage the students to carry out research into the background literature both before starting an investigation and once the results are complete.
- Avoid using simulations for assessment, especially CE.
- **Do not** use the Group 4 Project for assessment of D, DCP CE or MS. Only use it for Personal Skills. Inappropriate use will be sanctioned in subsequent sessions.
- Make sure that you are using the most up-to-date version of the 4/PSOW form (available on the OCC).
- Check to be sure that all the parts of the 4PSOW form are completed correctly.

# 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 - 31 | 32 - 35 | 36 - 39 |

## General comments

Of the 27 G2 reports received by the time of grade award, thank you to the centres who submitted them. 76% thought that the paper was of a similar standard to that of last year and 19% though it was a little more difficult. However, more than 96% of teachers thought that the level of difficulty was appropriate. Most teachers thought that the syllabus coverage, clarity of wording and presentation were satisfactory to good. Only 4% of the teachers thought that the paper was poor in presentation. There were many discriminating questions on this paper and a small number of questions that performed less well. Question 33 was cancelled due to a typographical error.

## 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 7

This question was well answered by most of the candidates, especially the better ones. It would have been better to say that base pairing preserves the sequence rather than prevents mutation of DNA.

### Question 9

Surprisingly this turned out to be the most difficult question in the exam. There were an equal number of candidates choosing options A, B and C. Many good candidates got the correct answer.

### Question 11

Although some teachers complained about testing plant reproduction in this question, it turned out to be a very good discriminator. There was no need to understand how a plant carries out mitosis, just the process of mitosis itself.

### Question 13

Most candidates answered this question correctly. There were some complaints on the G2 reports submitted about the fact that there are different quotes in different text books about the number of genes in the human genome. What most books state is that it was originally believed there would be millions of genes and eventually only about 25 000 were discovered. All the other numbers in the distractors were a long way from this number.

**Question 18**

This question proved to be complicated for good candidates and turned out to be a bad discriminator. This was probably due to the fact that the distractors were correct statements, although they were not the correct answer to the question.

**Question 21**

This question had one of the best discrimination indices of the whole exam. Some teachers pointed out that C could also be a correct answer, as what is being asked is the route followed to supply the heart muscle with oxygen. C however misses out steps therefore A is the best and correct answer.

**Question 23**

This question seemed to be a bit complicated for many candidates but it turned out to be a good discriminator.

**Question 30**

There were some complaints about this topic not being in the guide. The assessment statement is 9.1.4 *Identify modifications of roots, stems and leaves for different functions: bulbs, stem tubers, storage roots and tendrils.* This question had one of the best discrimination indices.

**Question 33**

This question has been cancelled due to a typographical mistake.

**Question 36**

There has been a complaint about the topic not being specified in the guide. The command term "suggest" is to propose a hypothesis or other possible answer; students are expected to understand the meaning of the term.

**Question 39**

Although this was considered a very difficult question, it was an excellent discriminator.

# Higher level paper two

## Component grade boundaries

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 10 | 11 - 20 | 21 - 27 | 28 - 38 | 39 - 49 | 50 - 60 | 61 - 72 |

## General comments

There were 24 G2 forms received, fewer than last year. Many thanks go to the centres who submitted them. 90% of the replies thought that the paper was at least as demanding as last year's, with all the replies describing the difficulty of the paper as appropriate (96%) or too difficult (4%). 92% thought that the syllabus coverage was at least satisfactory, with the other 8% thinking that the questions were too heavily weighted towards Human Physiology. All were pleased with the presentation of the paper and the clarity of wording. Teachers are urged to submit G2 forms as comments from them provide very useful feedback and are discussed as part of the Grade Award process.

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

- Percentage change
- Active and passive immunity
- Monoclonal antibodies
- Gene linkage and function of tRNA
- Structure and function of the placenta.

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

Well prepared candidates tackled question 1 well, with a clearer understanding of the action verbs. The theory of how recombinants form and the transmission of the HIV virus were well known. The standard of diagrams showed a continued improvement.

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

**Question 1**

a) Over half of the candidates failed to calculate the percentage increase of 200%.

b) The majority of candidates made the correct conclusion about insulin levels. However the second mark was often missed through lack of reference to the enzyme.

c) The action verb 'distinguish' was poorly understood, with too many candidates simply restating the figures. Surprisingly the mark for stating that the concentration was always higher for the IDE -/- mice was rarely seen.

d) Many candidates missed the fact that **both** blood glucose concentration and insulin concentration are elevated in type II diabetes (stated in the introduction to the question), as happens in the IDE -/- mice, so they are a good model.

e) Weaker candidates did not read the question correctly, also writing about exercise which was not required.

f) As in part e, weaker candidates did not distinguish between the correct bars, answering for the control mice.

g) Most gained a mark for saying that exercise does stimulate uptake. However only the better candidates took this further to say that the combined effect of insulin and exercise were far better than the insulin alone.

h) A surprising number of candidates were not able to state beta cells and the pancreas.

i) Most gave glucagon (although not always spelled correctly) some also correctly gave adrenalin/ epinephrine or cortisol.

**Question 2**

a) Many tried to answer this part without mentioning antibodies. Better candidates were able to distinguish between the two as asked.

b) The topic of monoclonal antibodies was not well known by the candidates of many centres. Well prepared candidates gained the two marks, although some lost a mark for fusing antibodies rather than B lymphocytes with the tumor cell.

c) With some very weak candidates this part gave them nearly all of their marks.

d) As with part b, some candidates did not know why antibiotics are ineffective against viruses

**Question 3**

a) This was surprisingly poorly known, with only the better candidates being able to state that the genes are located on the same chromosome.

b) As was shown in part c, the candidates seemed to know the theory of crossing over and recombination. However part b showed that very few really understood the products. In addition, in spite of comments from last year's report, the format used in the syllabus and the instruction of “using a similar format”, most did not.

c) This was well answered- the theory was known.

d) Weaker candidates seemed to recall that tRNA had something to do with ribosomes, amino acids and protein synthesis, but were unable to explain any further and gain some marks.

**Question 4**

a) Most of the diagrams were of a pleasing standard. Marks were lost by drawing an oblong rather than a bacillus shape, including eukaryotic organelles and showing the flagellum as an extension of the cell wall, rather than embedded within it.

b) In a ‘distinguish’ question, points should be contrasted, rather than writing about passive movement and then active movement.

c) There were a few comments from the G2 forms about the difficulty of gaining nine marking points. Better candidates obtained these with ease. Many of the better candidates' answers incorporated clear, annotated diagrams. Weaker candidates tried to use half- remembered diagrams without any explanation and failed to gain many marks.

**Question 5**

a) Most candidates who answered this question knew about the structure of the sarcomere, and the diagrams were generally good.

b) If the candidates could draw the sarcomere they could also explain muscle contraction.

c) There were many full and complete answers, although many weaker students became confused between the sodium and potassium ions, and although many remembered the -70mV, they did not mention that the inside of the axon is negative. Most were able to explain what happened at the synapse, but often failed to say what a synapse is.

**Question 6**

a) Weaker students failed to remember that the curve is a graph and should therefore have axes. The y axis was frequency labelled incorrectly as 'population growth' or similar instead of 'number of individuals'. Better candidates obtained all four marks for drawing and labelling lag phase, exponential/log growth, transitional phase and plateau phase

b) The process of spermatogenesis was well known.

c) Many candidates become confused between the amniotic sac and the placenta. Marks were lost for imprecise statements about what actually passes between the mother and fetus and how it is transferred.

**Question 7**

a) Many candidates missed out on one of the thermal marks as they omitted the large specific heat capacity. Very few students failed to gain a mark in this section.

b) Apart from the few candidates who inexplicably wrote about hydrophytes, the question was well answered.

c) Only very few candidates scored full marks in this section. There were few correct mentions of ultrafiltration, and many some candidates who described it correctly were more determined to describe the reabsorption of glucose and salts rather than water. The role of ADH was well understood, although weaker candidates were confused as to its actual site of action.

## Recommendations and guidance for the teaching of future candidates

This was the first November examination based on the new syllabus. There were instances where answers suggested that certain sections of the syllabus had not been covered in some centres, for example linkage and crossing over from the AHL genetics topic and the production and uses of monoclonal antibodies. The syllabus should also be made available to the candidates as a revision aid.

Even experienced teachers should revisit the syllabus regularly so that any changes are incorporated into their teaching. For example many candidates incorrectly described hydrophytes in great detail (instead of xerophytes) in Question 7, when they are now not on the syllabus.

As in previous years many candidates seem incapable of answering in the space provided, requiring several extra answer sheets. Whilst some candidates have very large writing, and others will always want to add another sentence, the space provided should be an indication of the maximum length of response. Many students seem to repeat the root of the question before starting their answer, thus using up a significant number of lines. If an answer is continued on an extra sheet then the candidate must indicate this at the end of the space provided for the question or run the risk of the continuation being missed by the marker (due to the rigorous checking procedures this is very rarely a significant problem but it could happen). It was encouraging to see well prepared candidates who collected their thoughts by writing a few key words in the margin before starting to answer, or used their reading time wisely with a highlighter.

# Higher level paper three

## Component grade boundaries

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 4 | 5 - 9 | 10 - 14 | 15 - 19 | 20 - 24 | 25 - 29 | 30 - 40 |

## General comments

There were 28 G2 forms received. Thanks again to the centres who submitted them. 79% of the replies thought that the paper was at least as demanding as last year's, with most of the replies describing the difficulty of the paper as appropriate (86%) and the larger proportion of the remainder considering it too easy (7%) and a few too difficult (4%). 93% thought that the syllabus coverage was at least satisfactory. All but 3% were pleased with the presentation of the paper and all with the clarity of wording.

Options and D and G were the most commonly chosen Options. Option E was frequently chosen as was option H. Very few chose Option F.

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

- Option D. Explaining natural selection and evolution and details of biochemical evidence for the common ancestry of living organisms.
- Option E. Using data to suggest why the activity of the helpers affects the probability of survival of the breeding female, altruistic behaviour and brain death.

- Option F. Drawing and labelling filamentous cyanobacterium and gene therapy.
- Option G. Fishing; international measures to promote conservation of stocks.

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

There were many schools that were highly competent in data analysis and notably in calculating percent changes. There were, however, still some schools where candidates were restating data rather that interpreting data.

Detailed recalled knowledge in the longer answer sections was often good. The main areas of difficulties seemed to lie in the new areas of the programme.

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

In contrast to E3, the longer question on H3 scored very well by most of the candidates. Nearly all could state increase in $CO_2$, breathing centre, lower pH, chemoreceptors and carotid receptors. Fewer named lactic acid as a by-product and the drop in pH due to this. H2 (a) and (c) were covered very well. Many scored full marks.

E1 (a), (b), and (c) were easily completed by most students but in E1 (d) many did not read the key word "evolution" in the question and simply explained altruism.

D3 also had some problems. This question is not new and has been asked a few times in recent years. Many students still do not understand or read the key word "biochemical" and consequently answer in terms of fossils or homology or something else. This should be stressed during class instruction.

**Option D Evolution**

**D1**

a) (i) The trend required was often seen, the change in the variation of the data however, was rarely stated.

b) (ii) Few answered well here in applying the theory of evolution and natural selection to explain the reduction in proboscis length.

c) This was mostly very well answered with many students successfully suggesting that the proboscis length would increase over time due to the distance of the seeds from the outside of the fruit.

**D2**

a) Many candidates did state a reasonable definition of both sympatric and allopatric speciation. Few though gained the second point stating that both involved reproductive isolation.

b) Those that knew the correct definition did well.

c) The main pieces of evidence supporting the endosymbiotic theory for the origin of eukaryotes seen were double membranes and the presence of circular DNA.

d) The most popular answers here were those of humans having an opposable thumb and stereoscopic vision. Many though only gained one mark point here with the answer of opposable thumb.

**Option E Neurobiology and behaviour**

**E1**

a) (i) Most candidates correctly identified an increase in the mean mass of the chicks in the presence of the helpers.

(ii) Most candidates correctly identified that female survival increased in the presence of helpers.

b) Many candidates correctly stated the percentage decrease in mean egg volume. Some were reluctant to round up to one decimal point. A few used an alternative method for this calculation.

c) No candidate used all the data. That is, no candidate used the smaller mean egg volume to explain that this may mean that the breeding female would be using less resources as the egg volume was smaller. Many incorrectly wrote of helpers protecting the breeding female from predators- as this did not use the data in any way. Marks were awarded if data was used, and most did suggest that with the helper the female may use less energy and that this may increase survival.

d) Very few candidates applied the theory of natural selection here. Although many did correctly state the meaning of altruistic behaviour, which was the starting point leading towards the idea of selection pressure.

**E2**

a) The majority of candidates used correct terminology in describing the transmission of a nervous impulse involved in a withdrawal reflex.

b) Most candidates correctly answered a definition for a taxis response being directional, but then had difficulty in describing a kinesis response. Those answers just stating that kinesis was not directional were not accepted.

c) Many wrote that tetrahydrocannabinol (THC) had an inhibitory effect at the level of receptors- this was largely well answered.

**E3**

This was by far the most poorly answered question in the paper.

Although many candidates could describe the pupil reflex, the details of brain death, the role played by the brain stem and the cerebrum were not known. The application of the pupil reflex to establish whole brain death, brain stem damage or cerebrum damage was not known. No candidate gained over two marks here and only very general answers were seen.

**Option F Microbes and biotechnology**

Few candidates answered this option.

**F1**

a) (i) Of those that chose this option, most correctly answered here.

b) Of those that chose this option many had difficulty in finding the answer of 5 piglets as many were misinterpreting the data.

c) The main point from the mark scheme mentioned in the answers seen was that probiotics seemed to increase survival rates of piglets. A few suggested an improvement in body mass. No other mark scheme point was seen.

d) Of those answering this option, only a few suggested that antibiotics would not be suitable against any other disease, other than bacterial disease. Again only a few suggested that antibiotics may then be passed on in foodstuffs leading to possible eventual bacterial resistance to these.

**F2**

a) Of those answering this option most answered that Gram-positive bacteria have thicker walls that Gram-negative, thus suggesting that Gram-positive bacteria have more peptidoglycan.

b) Of the few candidates answering this option, most cited *Nitrobacter* as an example of a chemoautotroph.

c) This was very poorly answered.

**F3**

This part of the programme had often not been studied in detail. The candidates were not answering the question asked; especially in the area of safety which was largely not known. The only suggested answer was that gene therapy may lead to cancer. Conflicts of interest were not known and ethical arguments were very general. Indeed ethical arguments was the only area often covered but with lack of depth of expression. Many answers gave religious arguments concerning gene therapy but these were not answering the question asked about the risks of gene therapy.

**Option G Ecology and conservation**

**G1**

a) (i) Almost all candidates stated a decreasing trend although few mentioned the fluctuation in the data seen. There were some candidates simply restating data and this gained no marks.

(ii) All candidates made reference to global warming being the reason for the reduction in ice cover.

b) (i) Many candidates gave good trend here suggesting that the mass of chicks did increase with increasing ice cover, up to a certain point and following this, the mass decreased, thus gaining 2 marks. This showed good data interpretation skills even if it may go against their logic.

(ii) The best candidates had clearly read the information given at the start of the question about the Brunnich`s guillemots feeding on Arctic cod, characteristic of Arctic waters. The best candidates did answer that if there was less ice (due to global warming) that there may be less cod, so less food, so decrease in chick mass, which was very pleasing to see. Others did suggest some good logical answers concerning changes to habits, but these answers did not really include all the data given, although marks could be awarded if they did made sense.

c) Many candidates did successfully suggested that with global warming there would be a decrease in chick mass (due to less cod). This meant that these candidates were really using the data given.

**G2**

a) (i) The definition of biomagnifications was mostly very well answered.

(ii) Named examples of biomagnifications were often successfully given e.g. DDT or mercury. However, other than suggesting that these toxins enter the body in water or food, the reasons for the biomagnifications were not seen. Only very vague answers were seen. No details of exactly why an accumulation in any one step of a food chain was seen, e.g. accumulation in fat stores.

**G3**

The answers here were often mediocre. The most popular mark points seen were:

- Limiting areas where fishing can take place;
- Decrease total net size ( including then the use of drag nets);
- Increasing mesh size to let immature fish through;

The methods to promote the conservation of fish stocks were acceptable, but methods used to measure conservation of stock were often poor. Some answers though did include required knowledge of age of landed fish as a mark point. Few could reliably suggest ways of monitoring catches; many did suggest capture-mark-recapture, but then went on to correctly criticise this as a method being restricted to e.g. lakes. Others wrote about electric-counting, which is limited to rivers.

The main problem seen here was the use of correct vocabulary concerning fishing and fishing efforts, maximum sustainable yields and so on.

**Option H Further Human physiology**

**H1**

a) Overall, the calculation of a percentage of the group with *H. pylori* was calculated correctly.

b) Many did state that a higher percentage of those with stomach cancer have *H. pylori*. Few then went onto to also discuss the median. Many did though suggest that from the data, a high level of antibodies does not mean that gastric cancer will always result.

c) Some did suggest that a reduction in HCl production would disrupt the digestion of proteins, but only a few gained marks by giving reasons why this may happen and relating this to enzymes and protein digestion.

**H2**

a) (i) Too many candidates wrote villus (or villi) instead of microvillus (or microvilli) here.

(ii) Most candidates successfully answered epithelial cell.

**H3**

Many candidates, that had studied this in detail, could explain how and why ventilation rate varies with exercise in detail, with many candidates gaining four or five marks here.

## Recommendations and guidance for the teaching of future candidates

- All teachers must be sure that time allows for candidates to study two topics.
- Candidates must have practice in reading and interpreting the questions.
- Practise interpretation of data-especially trends.
- Practise percentage and percentage increases or decreases.
- Use correct terminology e.g. aortic body rather than aorta.

The general level of the papers seen here exceeded those seen in June.

# Standard level paper one

### Component grade boundaries

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 7 | 8 - 12 | 13 - 17 | 18 - 20 | 21 - 24 | 25 - 27 | 28 - 30 |

## General comments

Of the 34 G2s received by grade award, thank you to those who submitted them. 59% considered it similar in difficulty to last year's paper, 22% thought it was a little bit easier and 19% suggested that it was a little more difficult. G2 forms gave a generally favorable response to this paper, with 97% reporting that it was appropriate in terms of level of difficulty, with the remainder considering it too easy. All felt that this year's paper had good or satisfactory syllabus coverage, clarity of wording and presentation.

## 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**

Although many candidates answered this question correctly, some candidates got confused and answered distractor D.

**Question 8**

Surprisingly this was the hardest question on the paper. Most considered oxygen an organic compound. Many also considered carbon dioxide as organic, when assessment statement 3.2.1 clearly states it is not.

**Question 12**

Although some teachers complained about the testing on plant reproduction in this question, it turned out to be a very good discriminator. There was no need to understand how a plant carries out mitosis, just the process of mitosis itself.

**Question 14**

The notation in this question was not the usual sex linked notation. It would have been difficult to write it in this way as this would have made the question too easy. Nevertheless, the question turned out to be a good discriminator while still not proving too difficult.

**Question 16**

Most candidates answered this question correctly. There were some complaints on the G2 reports submitted about the fact that there are different quotes in different text books about the number of genes in the human genome. What most books state is that it was originally believed there would be millions of genes and eventually only about 25 000 were discovered. All the other numbers in the distractors were a long way from this number.

**Question 23**

This question turned out to be quite a good discriminator.

**Question 25**

This question seemed to confuse the candidates. Many went for B instead of D, although assessment statement 6.2.4 clearly states that the function of the medulla and nerves in the control of heartbeat should be known.

**Question 28**

This turned out to be a very difficult question, where many candidates believed C was correct instead of D.

# Standard level paper two

## Component grade boundaries

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 6 | 7 - 12 | 13 - 20 | 21 - 27 | 28 - 35 | 36 - 42 | 43 - 50 |

## General comments

There were 30 G2 forms received. Many thanks go to the centres who submitted them. 81% of the replies thought that the paper was at least as demanding as last year's, with all the replies describing the difficulty of the paper as appropriate (97%) or too difficult (3%). All thought that the syllabus coverage was at least satisfactory. All were pleased with the presentation of the paper and the clarity of wording. Teachers are urged to submit G2 forms as comments from them provide very useful feedback and are discussed as part of the Grade Award process.

Achievement on this paper appeared to surpass that of past papers. Perhaps the paper was easier or, better still, candidates were better prepared. In Section A, responses to the data-based question were reasonably competent, but there were conceptual gaps in the content relating to translation and sexual reproduction.

In Section B, an overwhelming number of candidates selected Question 5 which covered the familiar topics of membrane structure, transport across the membrane, and the properties of water in relation to life. Avoidance of Question 6 may have been due to part (b) *Outline anaerobic cell respiration in plant cells* and avoidance of Question 7 because of part (b) *Describe a technique used for gene transfer*.

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

### Section A

The role of tRNA in translation, the role of LH after ovulation and sexual reproduction relating to species variation.

### Section B

Karyotyping details, gene transfer and effects of genetic modification using a named example.

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

### Section A

Many candidates had some knowledge of how to construct a food web, DNA structure, and the digestive system. Most candidates were able to identify the uterus in the diagram.

**Section B**

Although the quality of the diagrams of the fluid mosaic structure of a plasma membrane and the human ventilation system varied greatly, many were adequate for maximum credit. The properties of water and control of blood sugar produced many (near) complete answers.

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

**Question 1**

a) Weaker candidates often missed the reference to "total." This oversight resulted in answers about changes in individual limpet species rather than a single answer describing the effect on all the species added together.

b) Often the food web was correctly constructed for maximum credit. For those who missed marks, there were various errors in the feeding relationships such as: grouping the limpets together instead of showing individual species (just the opposite mistake from the previous question), showing arrows in the wrong direction, or just showing lines without arrows.

(In both 1(a) and 1(b), the mistakes seemed to be caused by careless reading of the questions.)

c) Very few candidates noted the decline in the population of *L. strigatella* when oystercatchers were excluded. Answers frequently mentioned the increase in the number of *L. digitalis* with reference to more predation and less food. Less habitat for *L. strigatella* was rarely, if ever, described.

d) Almost everybody correctly placed the X but much fewer the Y.

e) This question was answered well by most candidates. The popular answers were that the (overall) population declined and that in many locations the population had not changed. Only a few candidates mentioned that the population never increased or that the greatest decrease was in the most northern/western locations.

f) Again, this question was generally answered well. Most candidates mentioned greater predation of limpets, less availability of food or water pollution. Some talked about warmer air/water but then dropped the idea by not including any specific effect on limpets. In contrast, some candidates suggested that warmer water might inhibit reproductive behaviour, thus gaining a mark. A few other candidates gained a mark by suggesting loss of habitat.

**Question 2**

a) (i) Most were correct.

(ii) Less success was seen here. A number of students mistakenly wrote phosphate bonds or peptide bonds. 'Covalent bonds' was commonly stated for the mark and, sometimes, even the more sophisticated answer of phosphodiester linkage was given. Occasionally, candidates reversed hydrogen and covalent for parts (i) and (ii) and lost both marks.

b) Easy marks for many candidates. However, some misread the questions and described differences in the physical/molecular structure of DNA and RNA molecules. Rather than restricting answers to nucleotide differences, double and single strands were described resulting in no credit.

c) This question was worth only two marks but explaining the role of tRNA during translation could easily have been worth more. A few candidates wrote stellar answers that far exceeded the two mark maximum. The marking points most often awarded were that tRNA attaches to an amino acid and that tRNA has an anticodon complementary to the mRNA codon. Many candidates provided inaccurate information.

**Question 3**

a) The stomach was correctly mentioned by most students, but a few mentioned the pancreas and even the liver.

b) Many candidates gave generic descriptions of enzyme properties without any application to digestion, such as speeding up the process. Acceptable answers frequently included the breakdown of food particles/molecules and the notion that the products had to be soluble or small enough to be absorbed.

c) Not answered particularly well. For those who were correct, absorption of water/vitamins was usually cited. A few mentioned temporary storage of feces.

d) This question required an explanation involving structure and function. The problem for a number of candidates was that they gave accurate structural details, but neglected to include any reasoning, that is explaining how the structural feature aided absorption. For example, the pencil shape of the villus provides a high surface area to volume ratio which makes absorption easier/faster. For those candidates who supported their answers with reasoning, maximum credit was easily obtained.

**Question 4**

a) Almost all candidates could identify the uterus.

b) An extremely difficult question for most candidates as evidenced by many blank answer spaces. The role of LH after ovulation was just not known. The corpus luteum was rarely mentioned.

c) A common knowledge among candidates was their understanding of independent assortment and crossing over. However, for the latter event, some candidates only mentioned the process without any comment on what it accomplished.

**Question 5**

a) Many drawings were of reasonably good quality and gained at least three marks. Glycoprotein was a challenging structure for candidates to draw. Often the glycoprotein did not show anything resembling a carbohydrate chain attached to the protein. Also, the phospholipid bilayer was somewhat problematic. Sometimes, peripheral proteins were drawn in the hydrophobic region and, quite often, cholesterol molecules which should have appeared in the hydrophobic region were not totally embedded there. It was good to see that candidates almost always showed two-tailed phospholipid molecules. It was a rare candidate who indicated any reference to membrane thickness.

b) A few candidates did well on this question, but it was disappointing to see the lack of comparison skills among most candidates. Interpretation of the command terms **distinguish** and **compare** needs clarification for students, so that clear answers with opposing criteria are given and expected. Virtually all candidates wrote separate paragraphs about active and passive movement with indirect or incomplete pairings of ideas.

c) Though it was apparent that candidates knew many correct ideas, the lack of a clear systematic approach to answering prevented some candidates from gaining more marks. The key to success here required direct pairings of ideas through a single well-developed paragraph or through a table format with paired ideas aligned in columns.

d) Candidates showed a wide range of understanding of how the properties of water are significant to living organisms. Every marking point was eventually awarded by the examiners. There was limited use of the terms latent heat of vaporization and specific heat, though candidates could receive the mark using other wording. Those who did use the terms only gained credit if the terms were qualified such as “high specific heat.” Just saying that water has specific heat was insufficient. Unfortunately, mistakes such as “water is soluble” were seen too often. Sometimes, a named property of water was linked to a wrong significance.

**Question 6**

a) In the diagram of the human ventilation system, alveoli needed to be shown as an inset to gain their mark. This was consistent with the Teacher’s notes for A.S. 6.4.4 in the Subject Guide. Many candidates included intercostal muscles but it was difficult to show them clearly. Abdominal (wall) muscles were not shown. The quality of the ventilation diagrams was generally lower than for the membrane diagrams. Correct labels must correspond to recognizable structures.

b) Uncertainty as to the type of anaerobic respiration found in plants may have put off some candidates since, for A.S. 3.7.3., the Teacher’s notes only mention yeast and humans. Nonetheless, some candidates gained full marks knowing those aspects common to both pathways. Also, candidates may have associated yeast with plants, thereby describing the alcohol fermentation pathway. At least one candidate was able to cite waterlogged roots as a place where anaerobic respiration would occur in plant cells.

c) Many candidates did quite well on this question, showing good knowledge and understanding of homeostasis. The mark scheme provided ample opportunities for many high scoring answers. Negative feedback was frequently included but ‘controlled by both nervous and endocrine systems’ was rarely seen.

**Question 7**

a) Few candidates could give much accurate information about karyotyping. Especially overlooked was the importance of selecting cells undergoing mitosis and stopping mitosis at metaphase. Candidates did better in describing an application. Most often, abnormalities in chromosome number or the example of Down syndrome was given.

b) Candidates tended to do either very well or quite poorly on describing gene transfer. Those who blundered often confused gene transfer with cloning.

c) Those few who could name an example of genetic modification often struggled to identify specific benefits or harmful effects resulting in generalizations and fictitious accounts. Many answers were incomplete or vague.

## Recommendations and guidance for the teaching of future candidates

Exam questions need to be carefully read and fully understood before answering.

Candidates should not start off answers in Section A by re-writing the question in the 'name good English.' There is not the space.

Teachers should discourage drawings on graph paper or the use of coloured pens/pencils/highlighters which can obscure answers. It is difficult to read poorly written or poorly drawn answers so neatness should be emphasized.

Candidates should practise drawing and labelling diagrams. Since the diagrams to be known are easily determined from the assessment statements, this preparation should not be too difficult.

For questions involving the command terms distinguish or compare, candidates can be encouraged to establish a table of comparison. Three columns should be drawn. On the same line crossing each column, the aspect being considered should appear in the first column and then the paired examples which may be contrasting or similar, depending on the command term, would appear side-by-side in the next two columns. This format of presentation makes candidates focus on the question.

Stress the importance of including named examples in answers when this is specifically required in the question.

As in suggestions on previous subject reports, teachers are reminded to have their candidates practise with past papers, practise construction for Section B, and to learn the particular meaning of each of the command terms.

# Standard level paper three

### Component grade boundaries

| **Grade**: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range**: | 0 - 4 | 5 - 9 | 10 - 12 | 13 - 17 | 18 - 22 | 23 - 27 | 28 - 36 |

## General comments

The 33 teachers who completed the G2 form were satisfied with the paper overall. Thanks again to those who submitted them. 78% considered this paper to be of a similar standard compared with last year's paper, 4.5% thought it a little easier and 13% a little more difficult. 4.5% did not give their opinion. Most respondents believed this paper to be of the appropriate level of difficulty and only 9% thought it was more difficult.

All of respondents felt that clarity of wording was either good (48%) or satisfactory (52%) and most felt that presentation and syllabus coverage were good.

Option A, Option E and Option G were very popular choices among candidates whereas Option F was attempted by few candidates. Some of those candidates who chose Option F had not been taught this option and had no relevant biological background.

In general, candidates demonstrated reasonable achievement with very few questions left unanswered. Compared to the past; exam performance by candidates this year was slightly better. There were few poor scripts and many high quality answers. Comprehension was generally good.

Some questions generated long answers. Often some essential information was forgotten or unnecessary details were added. Some scripts included repetitious answers.

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

Although some understanding was shown, many candidates struggled to answer some questions, especially the impact of an introduced alien species used as a biological control. Many did not give examples introduced for biological control. Other gave very vague answers.

In Option B, many candidates failed to evaluate the data that acidosis in muscle was not due entirely on $H^+$ production. In Option E very few candidates realized that a smaller egg volume was an advantage to breeding females and in Option G most candidates failed to see the implication of ice coverage on the availability of Arctic cod as a food source.

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

The structure of fatty acids, role of myoglobin, allosteric inhibition, Miller-Urey experiment and neuronal response to stimuli were questions where candidates showed competence.

The graphs and tables were generally understood despite the fact that, in some cases, the graphics were not easy to interpret in relation to the questions.

There has been a slight improvement in the presentation of drawings, but there is still some work to be done for further improvement.

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

**Option A Human nutrition and health**

**A1**

a) Many candidates answered the comparison well, but many others simply stated numbers instead of comparing.

b) This question was generally answered well. Many candidates realised that this value could be an indicator of anorexia because it was very low, but there was a control person who had this same value.

c) Generally answered well.

d) Many candidates failed to answer this question correctly.

e) Many candidates failed to give the units for BMI.

**A2**

a) (i) Many candidates just mentioned marasmus or kwashiorkor, but this was just restating the stem, as these terms mean “deficiency of proteins”. Symptoms of the disease were expected.

b) (ii) Some candidates scored maximum marks by giving accurate information. Others only mentioned one reason for obesity, so only scored one mark.

c) Often answered well. Some candidates only discussed the problems of getting fresh food.

**A3**

Most candidates scored full marks on this question.

**Option B Physiology of exercise**

**B1**

a) Usually answered well.

b) Few candidates got the two marks. Few realized there must be another source of $H^+$.

c) Many candidates failed to realise that the graph will level off due to muscle fatigue.

**B2**

a) Some very poor diagrams were seen. The structure of a skeletal muscle was drawn by many of the candidates, without showing the sarcomere.

b) Many candidates knew that myoglobin is used as an oxygen store.

**B3**

a) Very few candidates were able to score full marks in this question.

b) This was an easy question for most candidates.

c) There were some very good answers, but there were also some very vague answers.

**Option C Cells and energy**

**C1**

a) Most candidates answered this question correctly.

b) Most candidates answered this question correctly.

c) Many of the candidates obtained one mark, although many did not seem to understand the functional difference between the two photosystems.

**C2**

a) Most candidates wrote collagen.

b) Many candidates forgot to distinguish between the secondary and tertiary structures of proteins. This command term requires showing the differences between them, not just a description of one of them.

c) Allosteric inhibition was well understood by a number of candidates.

**C3**

a) Most candidates answered this question correctly.

b) Candidates failed to understand the role of oxygen in respiration. They explained how oxygen is necessary for aerobic respiration, but did not understand why.

c) The presence of cristae to increase surface area was among the most common correct answers regarding the features of mitochondria relating to their structure. Other features were hardly mentioned.

**Option D Evolution**

**D1**

a) Many candidates answered this question correctly.

b) (i) Most candidates gained full marks in this question.

(ii) There were some very good answers to this question, although some candidates failed to explain how the change in proboscis could have occurred.

**D2**

a) Most candidates answered this question correctly.

b) Some very good answers, but, most often, candidates only explained the endosymbiotic theory, without outlining the pieces of evidence for it.

**D3**

a) As in most compare questions, candidates failed to make comparisons and just described each type of speciation.

b) (i) Not many candidates could successfully state one species in the genus *Australopithecus*.

(ii) This was in general badly answered.

c) Although there were some weak answers, many candidates answered this question correctly.

**Option E Neurobiology and behaviour**

**E1**

a) (i) and (ii) Most candidates answered these questions correctly.

b) Most candidates were able to calculate the percentage decrease correctly.

c) Most candidates were able to answer that there were less resources from the mother to rear the young.

**E2**

a) (i) This was answered well by a few candidates who adequately compared rod cells with cone cells. A frequent misconception among some candidates was that each cone cell is sensitive to all three colours (red, green and blue).

b) Most candidates answered this question correctly.

c) Most candidates knew four examples of sensory receptors.

**E3**

a) Most candidates could outline conditioned and unconditioned responses. Many candidates however failed to show the differences between them.

b) Many candidates explained the effect of THC correctly.

**Option F Microbes and biotechnology**

This option was the least chosen by candidates.

**F1**

a) Most candidates produced successful answers.

b) Most answers were correct.

c) Many candidates did not understand that the command term evaluate means to assess the implications and limitations. Most candidates were only able to comment on the improvement in survival and in gain of body mass.

**F2**

a) Candidates could successfully state which pathogen was shown, but few gave correct reasons.

b) Candidates either answered this correctly or did not answer it at all.

**F3**

a) Generally well answered.

b) Also well answered.

c) Many candidates knew this answer.

**Option G Ecology and conservation.**

**G1**

a) (i) Most candidates were able to detect the fluctuation in data, but few saw an overall decreasing trend.

(ii) Most candidates, if not all, had this answer correct.

b) (i) Most candidates answered this question correctly.

(ii) Most candidates were able to detect one reason for the relationship (mostly change in habitat affecting chick growth). Very few realised that the change in temperature influences the fish populations, thus affecting food availability for chicks.

c) Most candidates answered this question correctly.

**G2**

a) Most candidates could state an example of a herbivore and the plant it fed on.

b) This was often not answered well.

c) Some candidates mentioned the energy loss from one trophic level to the next. Few explained what caused this loss.

**G3**

a) This was usually not well answered. Many candidates missed the points, as they did not mention an alien species introduced as a biological control measure.

b) Outlining the effect of UV light on living tissue was usually well answered.

## Recommendations and guidance for the teaching of future candidates

- Teachers should guide candidates to answer the options they have been taught in class and not to attempt other options just because the graph or other data looks easier.
- Lots of use should be made of past papers and mark schemes for exam preparation.
- Continuously provide candidates with practice in analyzing various types of data. Ideally, data would be related to the options being studied.
- The space provided should be enough for all the answer, so extra sheets should only be used in the case of really large handwriting.
- Candidates must know the meanings of all the command terms and develop their answers based on the command term starting a particular question.
- Candidates should be given practice in reading the questions carefully and being aware of linkage between a part (i) followed by a part (ii).