BIOLOGY

Paper 9790/01

Structured

Key Messages

- In addition to spending time formulating their written responses, candidates should read through their answers to check that these are tailored to meet the requirements of the question.
- Unless instructed to limit their responses to a specific number of ideas (for example, 'Suggest two…' or 'State one …'), it is usually to the benefit of candidates to consider a range of relevant points in developing their responses. Taking into account the amount of credit that can be gained for the part-question concerned, together with the command word (e.g. state, outline, describe and explain), can help guide the candidate as to the depth and breadth of response required.
- Each question in ***Section B*** tends to assess a number of learning outcomes from across the syllabus. A good knowledge of the syllabus and an ability to see links between the topics covered will increase the confidence of candidates when tackling this paper.

General comments

A number of candidates performed extremely well on this examination paper, often displaying a level of knowledge and understanding that reflected additional background learning while providing responses that were expressed concisely and fluently. Many candidates answered questions directly, without any irrelevant information and made good use of scientific terminology. Weaker candidates who had prepared thoroughly for the examination were able to perform well in the more straightforward questions that required a good knowledge of the syllabus learning outcomes.

In ***Section A***, a number of candidates correctly answered all or most of the questions, not only demonstrating an excellent knowledge and understanding of a wide range of syllabus learning outcomes, but also showing a high level of skill in tackling questions of this type. In was noted that many candidates had taken the trouble to write down their thoughts in spaces on the paper and, in many cases, work on a process of elimination. A number of the questions involved more than one stage in the thought process.

In ***Section B***, all questions differentiated well, with **Question 23** proving to be the most accessible to candidates. **Question 24** covered a topical environmental issue and, although some candidates maintained high standards, other candidates gave less biologically rigorous responses that would have been more suitable in an article for a non-scientific audience. Candidates should use terminology appropriate to their level of learning. A few candidates who had given strong responses for the other questions found it quite challenging to organise their ideas when responding to the more open parts of **Question 24**, especially in parts **(d)** and **(e)**.

In general, candidates should consider that the number of lines provided for their response is an indication of the amount of writing expected. Most candidates made good use of the space available, although there were instances, such as in **Question 21 (e)**, where some candidates wrote very little and others continued to the end of the page. Some candidates continued a response elsewhere without giving an indication that they had done so, a practice that should be discouraged. Candidates should be able to respond to questions that ask them to consider the significance of biological phenomena as well as simply describe them. In **Question 21 (a) (iii)** there was a tendency for some candidates to describe anaerobic respiration in muscle, rather than explaining its significance.

All candidates attempted all parts to all questions and there was no indication that there was insufficient time to complete the paper.

Comments on specific questions

SECTION B

Question 21

This question used the enzyme lactate dehydrogenase as a theme to assess candidates' abilities to apply their knowledge and understanding of several learning outcomes from across the syllabus. In addition to formulating responses in continuous prose, candidates were required to use their knowledge to complete Fig. 21.1 and extract and interpret information provided in figures and tables.

(a) (i) Many candidates were able to complete correctly the reaction shown in Fig. 21.1. Common incorrect answers included identification of **A** as lactic acid, lactose or ethanal, and **B** and **C** as ADP (and Pi) and ATP respectively. A few candidates thought that water was required to produce oxygen.

(ii) The majority of candidates knew that the final stage of anaerobic respiration took place outside the mitochondrion. The candidates who did not give the correct answer here were commonly those that also faltered in **(a) (i)**.

(iii) There were some excellent responses. Concise explanations were provided, with points made in a linked manner using a logical order and correct scientific terminology. For full credit, candidates needed to avoid a text-book description of anaerobic respiration in muscle tissue and highlight the reasons why the conversion of pyruvate to lactate was so important. For example, stating that NAD was reduced in glycolysis would gain no credit, whereas stating that the regeneration of NAD was required in order for glycolysis to continue was creditworthy. There were some responses that began with an explanation of how a lack of oxygen would affect events occurring in the mitochondrion, and although usually correct, this was not directly relevant to the question. These candidates often went on to develop full responses but used up time (and space) unnecessarily by considering aspects not relevant to the question. Some candidates thought that ATP production only occurred as a direct result of the reaction, reflecting a lack of knowledge of the main stages of glycolysis, while others believed that more ATP was produced from anaerobic respiration than from aerobic respiration. A number of candidates stated incorrectly that pyruvate was highly toxic and needed to be converted to the less toxic lactate. For those candidates who thought in **(a) (i)** that **B** was lactic acid, there were also suggestions that the reaction occurred because lactic acid was toxic to the organism and lactate was less toxic. 'Produces energy' or 'makes energy' were incorrect descriptions included in the responses given by a number of candidates.

(b) This question expected more than a description of the structure of globular proteins. The best responses highlighted the important aspects of enzyme structure with regard to the metabolic role of enzymes, including the nature of their specificity. These gave a balance of relevant points, emphasising how the structure was suited to the role, and were able to gain full credit. Many candidates were knowledgeable about the levels of organisation of proteins, although fewer showed an understanding that it was the interactions of the R-groups, or side chains of amino acids, that allowed the different bond types to hold in place the tertiary structure of enzymes. There were a few candidates who realised that the globular nature of the enzyme, with the hydrophilic R-groups facing the watery cytosol, was an important feature that enabled enzymes to take part in cellular reactions. Credit was awarded to candidates who chose to respond from the point of view of a named enzyme.

(c) There were many knowledgeable responses for this part, some of which included most of the expected points. Stronger candidates realised that all cells would contain both genes and hence suggested mechanisms that would result in their differential expression. Some candidates attempted to answer from the point of view of exon splicing, which was not relevant to this question. A few thought that there were different genes in different cell types and a number did not make clear the distinction between the isoenzyme type and the involvement of the *LDH-A* and *LDH–B* genes. There were a number who erroneously stated that DNA was a polypeptide instead of a polynucleotide.

(d) (i) A number of candidates gave sufficient information to gain full credit, and higher quality responses were easy to follow and covered all the main points of the events that lead to a heart attack. Good answers described the coronary arteries in terms of 'narrowed lumen', rather than 'blocked' or 'narrower', and linked this to a decrease in blood flowing to the 'cardiac muscle', rather than blood

flowing 'to the heart'. Candidates that covered all the details were also precise in stating that a lack of supply of glucose and oxygen to the cardiac muscle would lead to the heart attack, rather than just leaving the answer at a lack of 'nutrients' or just stating that 'less blood' would reach the muscle. Candidates should have named the coronary arteries as the location of the atheroma. There were some responses where it was not clear whether the candidates understood that restricted blood flow was to the heart tissue rather than the heart chambers. Other candidates described the reduced blood flow as occurring in 'coronary capillaries'. A number described in great detail the events leading to atheroma formation, which was not required. Some candidates were vague in their description of a thrombus, stating that it was a section of atheroma, while others gave confused descriptions of an embolism but stated that this was a 'thrombosis'. A number linked atheroma formation to high blood pressure, but went straight on to state that this would cause the heart attack, rather than explain that this would add to the atheroma and hasten the decrease in the diameter of the lumen of the coronary artery.

(ii) Many candidates could clearly see the use of the test for LDH isoenzymes and referred effectively to the information provided in Table 21.1 to support their answer. Most understood that the concentrations in the blood were significant, and a few also pointed out that an analysis of results would require a comparison to the 'healthy' or 'normal' plasma concentrations. A number of candidates gave an additional point pertinent to the question, which gained credit. Some candidates gained little or no credit. A small number thought that tissue damage would cause different isoenzymes to be synthesised while others did not notice that the LDH isoenzymes were being analysed from blood samples and suggested testing for LDH types at the site of injury. A minority of candidates did not read the question sufficiently carefully and only gave suggestions of how a test could be carried out to obtain results.

(e) This question differentiated well. The candidates who gained full credit planned their response so that all aspects of Fig. 21.2 and Table 21.2 were covered and responded correctly to the instruction to 'comment'. Many candidates realised that the DNA triplet base sequences shown could be read, with the replacement of 'T' for 'U', from Table 21.1 and realised that this sequence was from the coding or non-template strand. Correct detail needed to be extracted from the provided data, and so candidates who took care in extracting information to use in their responses were able to gain credit. Precision was essential; for example, statements such as 'there are three different amino acids' needed to be qualified with further information so that it could be ensured that the candidate had made the correct observations. There were a number of candidates who made very valid additional comments which were able to be credited. Responses that gained partial credit tended to focus on only one aspect, for example by stating all the similarities and differences in the DNA sequences and not making a comment on the degenerate nature of the genetic code or the corresponding amino acid sequences. A relatively high proportion of candidates concentrated on describing differences in the DNA triplets or mRNA codons as mutations or as base substitutions. As no information about the molecular evolution of the gene coding for lactate dehydrogenase had been provided to the candidates, speculations about mutations were not required in the answer. Credit was not given to candidates who suggested that the difference in amino acid sequence would produce an enzyme with a different function. Some candidates worked out the RNA complementary copy of the base sequence shown and then got confused in their use of the genetic code in Table 21.2, while some thought that the tenth triplet represented a stop codon, despite being told that Fig. 21.2 showed the first ten amino acids of polypeptides M and H.

Question 22

In this question, candidates were presented with a familiar bacterial pathogen, *Helicobacter pylori*, and were assessed on their knowledge of the pathogen as well as other areas of the syllabus that could link with the organism. This meant that stomach histology, the nature of antibodies and the immune response, enzyme action, antibiotics and natural selection were also assessed.

(a) A few candidates correctly identified the name of each cell in the gastric gland and the product secreted. To maximise opportunities for the candidates, on this occasion an error in naming the cell was allowed to be carried forward when considering the correct product secreted. The majority of candidates had gaps in their knowledge of the histology of the stomach, and there were a considerable number of tables that had boxes that were left blank. **A** and **B** were commonly incorrectly named as a goblet cell. A number of candidates had partial knowledge of cell types and secretions, but did not know which cell type was responsible for the particular secretion; in these cases, the correct terms seemed to be placed in a haphazard manner in order to complete the table. Some candidates named the epithelial cell as an endothelial cell.

(b) A correct suggestion of transmission of *Helicobacter* stated how the pathogen could pass from an infected person to an uninfected person. Candidates who considered the location of the pathogen in the body were able to suggest various ways for the pathogen to leave the stomach of one person and be ingested by another. Some candidates forgot that they had been informed in the introduction that the pathogen colonised the lining of the stomach and suggested aerosol or droplet infection. Failure to sterilise equipment in endoscopy can lead to gastro-gastro transmission, more commonly occurring in countries where facilities are lacking. Therefore, candidates who suggested the possibility of contaminated surgical equipment transferred between patients were credited on this occasion. A number of candidates gave incomplete responses and were able to gain partial credit by reference to the ingestion of contaminated food.

(c) This question presented candidates with an unfamiliar diagnostic test that required application of knowledge and understanding. Many demonstrated an excellent grasp of the information provided and gained full credit. Key to the test was the specific nature of antibodies and the visualisation of results using an enzyme-catalysed reaction. The best responses made the distinction clear between the two antibody types and explained that the serum antibody would act as an antigen to the anti-human antibody. The significance of the coloured product was well explained and linked correctly to the presence of serum antibody and infection by *H. pylori.* All candidates answered all sections, with most correctly explaining the rinsing in step 3, rather than step 2. There were a number of responses that were less well organised.

(d) A high proportion of candidates realised that the diagnostic test described in **(c)** was an indirect one, testing for the presence of antibodies. By using their knowledge of immunology, they realised that anti-*H. pylori* antibodies would still be present in the circulation. Weaker responses suggested that the antibiotics contained antibodies or gave confused accounts of anti-human antibody entering the body and causing problems.

(e) (i) Most candidates did well on **(e) (i)**, with some gaining full credit. These candidates applied their knowledge of natural selection to this example and also considered the various mechanisms by which genetic material could be transferred to other bacteria. Some responses gave partial statements that were unable to be credited without further qualification. For example, realising that antibiotic resistant bacteria would survive in an environment with antibiotics needed to be qualified by the fact that antibiotics were acting as a selection pressure and that the differential survival that resulted enabled the bacteria with the mutation conferring resistance to pass this on to their offspring. Very few candidates considered all modes of transfer and plasmids were rarely mentioned.

(ii) Candidates made a good attempt at answering this question. Most offered more than one suggestion. The most common correct responses were to realise that protoctists are eukaryotic, that they do not have a cell wall composed of murein (peptidoglycan) and that they have different ribosomes. Some candidates noted that the Protoctista contains organisms with and without cell walls.

Question 23

This question, based on cystic fibrosis, provided the opportunity to assess candidate knowledge and understanding of aspects of gene technology.

(a) A good proportion of candidates gave two relevant suggestions for features of a virus that would make it a suitable vector for gene therapy. The best responses gave a short correct statement about the virus further qualified by a link to cystic fibrosis. For example, stating ‘able to target specific cells’, was further qualified with, ‘such as the epithelial cells of the respiratory tract’. Some candidates did not consider carefully the question and gave general features of viruses that were not qualified sufficiently to gain credit.

(b) This question asked candidates to consider the treatment of cystic fibrosis by gene therapy. Most displayed a sound knowledge and many gained full credit. Some candidates wrote about the limitations of gene therapy in preventing cystic fibrosis, explaining how the therapy was targeted at somatic and not germ-line tissue, which was not required. Weaker responses suggested that the viruses should have the machinery to allow viral replication, not realising that this would result in the destruction of the host cells.

(c) Candidate knowledge of the function of the CFTR protein varied. Some demonstrated background knowledge and gave information beyond the requirements of the syllabus. Knowledge that the gene product was a membrane protein with a role in the transport of chloride ions was sufficient to gain credit and a description of how the transport of chloride ions out of cells would lead to healthy mucus production gave some candidates full credit. The role of ATP in altering the conformation of the protein for transport was known by some candidates, but not required to gain gull credit. Reference to active transport was ignored. Some candidates included in their response information about the effects of the faulty CFTR protein, which was not relevant to the question.

(d) (i) This was well known by most candidates. Those that did not gain credit gave 'endonuclease', which was not a precise enough answer.

(ii) This was well known by most candidates. The most common incorrect response was centrifugation.

(iii) Almost all candidates correctly identified the enzyme as (DNA) ligase.

(e) Many candidates had a vague idea of what was added in process **C**, but only a few were able to gain credit by stating that gene probes or DNA probes were added, or provide an accurate description of a gene probe. Examples of responses that did not gain credit were 'fluorescent tags', 'fluorescent markers', 'DNA markers', 'radioactive DNA', 'radioactive markers' and 'fluorescent markers'. Some descriptions were of gene sequencing, while others included adding antibodies or enzymes.

(f) This was very well answered by most candidates and many gave detailed accounts of the polymerase chain reaction.

Question 24

This question gave candidates the opportunity to address the learning outcomes of the syllabus that touch upon environmental concerns, using reef-building corals as a theme.

(a) (i) Almost all candidates had noted that zooxanthellae were algae and had made the link to photosynthesis and the requirement for light.

(ii) This was generally well answered, although quite a few candidates answered from the point of view of benefits to the coral, rather than to the zooxanthellae. The best responses made suggestions that were qualified. For example 'provides protection from predators' would gain credit, compared to 'provides protection', which would not.

(b) Most candidates realised that loss of the zooxanthellae would mean that the coral could not rely on the assimilates produced as a result of photosynthesis. Fewer noted the protective effect that algae provide to the coral from the harmful effects of sunlight.

(c) (i) A reference to 'shallow' was made in the introduction to the question and many candidates used this information to make the link to increasing water temperature. Some stated that the corals were in tropical regions, which did not answer the question.

(ii) Many of the responses made reference to an increase in bacterial numbers with an increase in sea temperature. Those candidates that did not gain credit gave answers such as 'bacterial thrive' or 'the temperature is optimum for bacteria' without giving further detail. A considerable number of candidates did not have a good understanding of what was required and wrote about increasing temperature as a factor increasing enzyme action.

(d) There were no responses that considered all the levels of biodiversity mentioned in the relevant syllabus learning outcome, and most concentrated on species biodiversity. Candidates who remained on task based their response around the reef-building corals. Stronger responses covered loss of species whereas weaker responses used vague terms such as 'affected' and 'creatures'. Some responses gained additional credit for points that were actually related to reduced ecosystem biodiversity, although the term was not used. A good number of candidates confused levels of biodiversity with feeding levels.

(e) A few candidates were able to explain accurately what was meant by a keystone species, and used this as an introduction. A number supported their answer with examples of keystone species; the candidates who did this generally produced higher quality responses. Many gave responses that were more vague and reflecting a gap in their knowledge of this section of the syllabus.

BIOLOGY

Paper 9790/02

Long Answer

Key Messages

Success on this paper relies on the ability of candidates to draw on detailed knowledge and understanding of the syllabus and apply this in familiar and unfamiliar contexts. It also relies on a good synoptic understanding that informs extended writing to develop a consistent argument.

In addition, candidates need to be able to plan experimental work, drawing on their experience of the practicals listed in the syllabus. Analysing and interpreting data presented in a variety of forms, including the use and understanding of statistical tests, are also important skills.

General Comments

There were many examples of good responses to individual questions although, in the case of a significant minority of candidates, performance was affected by gaps in knowledge and understanding of parts of the syllabus material. Answers to the planning exercise in **Question 4** sometimes demonstrated incomplete understanding of the osmosis practical involving plasmolysis in onion cells. Many candidates understood the mechanics of carrying out statistical tests but found it difficult to apply an understanding of probability in biological contexts. There were many pleasing essays in ***Section C*** in which candidates displayed not only a detailed and balanced knowledge, but the ability to think synoptically and to develop effective argumentation.

Comments on Specific Questions

SECTION A

Question 1

This question relates principally to learning outcomes 3.1 (f, g and h). There were some good answers.

(a) Few candidates emphasised the role of the concentration of LDLs in the blood as the factor leading to the build-up of plaque. There was also little mention of the role of blood pressure and thrombosis. Few gave any information about statins as enzyme inhibitors and some confused the role of statins with that of warfarin.

(b) Many candidates showed a good understanding of the nature of placebos and why they are important in eliminating psychological factors in drug testing, although not all were able to explain this clearly.

(c) Most candidates concluded correctly that statins bring about a statistically significant reduction in the risk of cardiovascular disease. However, many then proceeded to undermine this conclusion by suggesting that the data were still unreliable and that the reduction was too small to be taken seriously. Many candidates did not recognise that the data showed that statins had a greater effect on reducing strokes than on other cardiovascular problems. In fact, there was a 33% reduction in strokes (from 6% to 4%). Some claimed that the sample size used was too small to produce reliable results when, in fact, the sample size was not specified. Although most candidates had knowledge about simple statistics many did not really understand what they meant.

Question 2

For candidates with a sound understanding of classical genetics, including sex linkage (learning outcome 1.6 (i)) and the use of the chi-squared test (learning outcome 1.6 (j)), this question offered the opportunity to gain high marks. Understanding, rather than simple learning, was tested by using the unfamiliar contexts of plumage colour and sex determination in birds, in which the female is the heterogametic sex.

(a) (i) Most candidates were able to complete the calculation of the chi-squared value.

(ii) Many candidates recognised that the difference between the observed and expected ratios was not significant, but many did not show understanding that this supported the conclusion that the observed results *were* a valid approximation to a 3:1 ratio.

(b) (i) Those candidates who understood the genetics of sex linkage and how it can be solved by a genetic diagram with a Punnett square, were able to develop effective responses. Candidates were able to apply the facts that females are WZ and males are ZZ male. Some used unconventional symbols which proved difficult to follow. This question exposed some candidates' lack of understanding.

(ii) Most candidates who succeeded in part **(i)** were able to engage successfully with this final part of the question, although not all appreciated that there are two ways by which the purple males could be produced.

Question 3

This required an understanding of photosynthesis, C3 and C4 plants, and photorespiration (learning outcomes 4.2 (f), (h), (i) and (j)), recognising patterns in data and arguing the likely effects of global warming on the distribution of C3 and C4 plants (learning outcomes 2.3 (e) and 5.1 (d)).

There were some good answers from able candidates but it was clear that many candidates did not understand this topic in sufficient depth to make effective use of the information provided.

(a) Most candidates scored both marks. Some candidates provided answers that were not specific enough for credit. For example, the term triose phosphate was sometimes used instead of glycerate 3-phosphate or a suitable alternative.

(b) This question required a comparative approach to the recognition of patterns in the data. Many of the examples given by the candidates were not comparative or did not make use of figures from the graph with sufficient precision.

(c) This question was built around the competition between oxygen and carbon dioxide for rubisco. C3 plants are photosynthetically inefficient due to photorespiration while C4 plants are adapted to reducing photorespiration. Thus, in this investigation C4 plants were at an advantage when carbon dioxide concentrations were low. There were some good answers but greater understanding of this part of the topic would have benefited most candidates.

(d) This question explored how C4 plants are not only well adapted to low carbon dioxide concentration, but also to survive dry conditions through their lower rate of transpiration.

(e) The final section asked candidates to consider the differing responses of C3 and C4 plants to water stress and low carbon dioxide concentrations and relate these to rising atmospheric carbon dioxide concentrations, increasing temperatures and changes in rainfall patterns. There were some good answers to this part of the question although few candidates achieved full credit.

Question 4

This question provided candidates with a context of two varieties of onions, one better adapted to higher salt concentration in the soil than the other. Most candidates realised that this was related to one of the core practicals (practical learning outcome 1.1 (viii)) in which the solute potential of onion cells is measured by immersing onion epidermal strips in a range of different salt or sugar concentrations, such that the concentration causing 50% plasmolysis can be estimated.

Many candidates appreciated that the vacuolar contents of the cells of the two varieties would differ in solute potential. However many suggested that the cells of the salt tolerant variety would have a higher solute potential rather than a lower, or more negative, one. Many candidates did not describe details of this experiment with sufficient precision. For example, only some candidates determined percentage plasmolysis; others measured cell size or even lengths of pieces of onion. Relatively few described how to draw the relevant graph and even fewer showed how this might be used to estimate the concentration giving a mean plasmolysis of 50%. Many candidates mentioned using a *t*-test although it was not clear that this would be used to compare the solute potential of the two varieties. Very few candidates described the use of a table to find the solute potential of the bathing solution that caused 50% plasmolysis.

SECTION B

The three questions in ***Section B*** explored an ecological theme and were all synoptic, leading candidates through a series of related topics. There were five interwoven sub-themes within this section:

- speciation (learning outcomes 2.3(c), (g) and 2.4 (a)),
- conservation of biodiversity (5.2 (d), (h) and (i)),
- adaptation (5.1(d) and (e)),
- quadrat sampling, such as one might encounter on a field course (practical learning outcome 5.2(i)),
- flowering plant reproduction (4.3 (b) and (d)).

Question 5

(a) Many candidates answered this question effectively but some lost marks for lack of precision in making specific points.

(b) Many candidates understood allopatric speciation in terms of geographical isolation, lack of gene flow and natural selection and were able to provide effective responses.

Question 6

(a) (i) Most candidates recognised that random placing of quadrats avoids bias.

(ii) This question was well answered and many candidates scored full marks. The idea that all the species responded to nutrient input but that the Shetland mouse-ear eventually succumbed to competition was well understood and well explained.

(iii) Many candidates appreciated the kind of control needed, but scored only one of the two marks available through lack of precision in their descriptions. The changes in the permanent quadrat probably were caused by the eutrophication, but to prove this point plots need to be subjected to eutrophication in controlled conditions alongside untreated controls and recorded over a period of time.

(b) This part of the question was based on learning outcomes 5.2 (h) and (i) – the SLOSS debate. There were some useful suggestions but many candidates did not appear to be familiar with these learning outcomes.

Question 7

(a) Most candidates recommended attempting to interbreed Arctic and Shetland Mouse-ear and see whether the offspring were fertile. A few candidates noted that the fertility of offspring in plants often involves testing the viability of seeds. Few, however, described DNA sequencing or other alternatives in enough detail to gain further marks. Candidates in general did not have a well-rounded appreciation of the species concept.

(b) (i) The majority of candidates seemed to be unfamiliar with the concept of the ring species. There were some correct descriptions, occasionally illustrated with relevant diagrams showing gene flow around the northern hemisphere.

(ii) This question tested how well candidates understood the ring species concept. Few realised that, if the concept is valid, the migration would restore gene flow throughout the ring and prevent further speciation.

(iii) Many candidates did not recognise the significance of the fact that plants are non-motile so that gene flow is restricted to pollen and seed dispersal, often over very short distances, whilst gulls are able to fly so that gene flow is much less restricted.

SECTION C

The essays in this section were generally of a good standard.

To do well in an essay candidates have to:

- choose the essay title which, for them, gives the greatest scope to write in full on all the aspects of the question,
- decide which areas of the syllabus are relevant to the essay so that sufficient breadth can be covered,
- identify the 'big idea' behind the question and ensure that each paragraph contributes to the development of this idea.

A good essay addresses each aspect of the topic in a balanced way using selected information from the syllabus and beyond, to provide support and evidence for the main argument. Ten marks are for balance, argumentation, communication skills and spelling and grammar.

Question 8

Candidates were required to draw on knowledge and understanding of both plants and animals. Some candidates tended to write in detail about one aspect of reproduction (usually covering plant pollination and fertilisation very thoroughly), but touched on other aspects only briefly or not at all. Other candidates provided detailed sections on more than one separate aspect but did not integrate them into a discussion of the overall theme of adaptation to life on land.

Question 9

Many candidates addressed this essay title in a well-balanced way, and achieved good marks. Some candidates wrote at great length about DNA replication without linking this to the importance of stability and limited change, and therefore restricted their access to the marking points.

Question 10

Some candidates made useful comparisons between rapid responses to stimuli in animals and plants such as the Venus fly trap. Candidates who scored well linked the different aspects of the question together in a balanced way and then argued that the function and roles of the nervous system are related to the fact that most animals move from place to place and react quickly to environmental changes.

BIOLOGY

Paper 9790/03

Practical

Key Messages

- Centres should check all the requirements for the examination. If any substitutions are needed these should be made clear in the Supervisor's Report. It is important that any slides supplied are checked carefully before the date of the examination. If they are not of a high standard then Centres should contact Cambridge immediately for replacements.
- In relation to the conduct of the examination, it should be stressed how important it is that Centres follow closely the requests made in the Confidential Instructions under the heading 'Responsibilities of the Supervisor during the Examination'.
- In ***Section A***, candidates should read the questions carefully before starting their practical work. They should anticipate questions on interpretation of data using knowledge of relevant learning outcomes. While carrying out the practical, candidates should be thinking about the relevant topics and how to use them to interpret their results.
- Candidates will almost always be expected to make drawings from the microscope of prepared or temporary preparations. It is expected that candidates will have used these microscopes over the two years of their course and that they will therefore be familiar with their operation. Candidates will often take measurements from specimens and calculate magnifications of their own drawings. These magnifications are not the same as that of the microscope from which observations have been made, e.g. x400. Magnifications should be derived using eyepiece graticules. These may be used in association with stage micrometers (the use of stage micrometers for this purpose is an assessable skill), but unless otherwise stated it is acceptable for candidates to make use of a known calibration (at a particular magnification) of the graticule divisions, providing that this is stated in their answer.
- Candidates should be able to construct tables to summarise comparisons between biological specimens. These should include a column for features to ensure the table makes direct comparisons.

General comments

This was the first series for the assessment of this new style Practical Examination. ***Section A*** had one practical task for which candidates were advised to take about 90 minutes. This allows time for candidates to read and annotate the instructions carefully and make decisions about the practical tasks, including presentation and analysis of the data to be collected. Candidates also have time to collect replicate results, decide on controls and implement their decisions. In this investigation, some candidates carried out one or two repeats for each light intensity and calculated a mean.

Much of the traditional biology in this syllabus can be taught through the medium of practical work. Few candidates had the required level of skills to perform at the highest standard expected.

Comments on specific questions

SECTION B

Question 1

This question required candidates to carry out the Hill reaction with suspensions of chloroplasts in melting point tubes. The independent variable that was investigated was light intensity, using a constant light source with filters that varied in their percentage light transmission. Almost all candidates were able to gain suitable results although standards of data presentation, analysis, interpretation and evaluation were sometimes not as high as to be expected at the end of a two-year course.

(a) Some candidates missed this question on labelling the electron micrograph of a chloroplast, again emphasising the need for candidates to make use of time at the start of the examination to read through the paper carefully. Candidates should be aware that answer lines are not required for all questions. Many candidates scored full marks by labelling three structures.

This part question set the scene for the investigation and for parts **(f)**, **(g)** and **(h)**.

(b) The three steps taken during the preparation of the chloroplast suspension were often explained well. The release of hydrolytic enzymes when homogenising the leaf tissue was mentioned by some candidates. Explanations for the use of sucrose were sometimes vague. Candidates did not make it clear that the water potential of the sucrose solution had to be the same (or nearly the same) as that of the chloroplasts or the leaf cell contents. This is to prevent the chloroplasts from bursting. Rarely did candidates mention the movement of water into the chloroplast if water were used instead of a sucrose solution.

(c) A variety of controls were chosen, although it was not always evident that these were used during the investigation. Some candidates stated that these were controls that they *would* use if time allowed. There was sufficient time and apparatus to use appropriate controls, including a tube without chloroplast suspension, a tube with boiled suspension and a tube with fresh suspension kept in the dark.

(d) This question assessed candidates on the manipulation of apparatus and collection of data. Candidates should know how to present their results and any derived variables in a single table following the usual conventions. Many tables demonstrated this, but there were some that were very poorly presented. Among the errors noted were the following:

- not including the independent variable (light intensity) but just listing the filter numbers
- giving units (often %) in the body of the table rather than only in the column heading
- giving simple uninformative column headings that referred only to ‘time taken’ and ‘rate’ rather than ‘time taken for colour change’ and ‘rate of photosynthesis’.

The results often followed the expected trend, although some candidates did not calculate the rate of photosynthesis but left their results as ‘time taken’. Most candidates calculated 1/t, with some multiplying their answers by 100 or 1000 to give reasonable numbers to plot on their graphs. Some used another number as their multiplication factor but, so long as it was the same for each calculation, this did not matter.

(e) Nearly all candidates recognised that a line graph was required, but graphs varied considerably in standard. Axes were occasionally drawn incorrectly with rate or time on the *x*-axis rather than the percentage light transmission, as given in Table 1.1. The axis for rate was often scaled correctly although there was some awkward scaling that made plotting points very difficult. Candidates were expected to test for decolourisation of DCPIP in the dark and therefore be able to include the origin as a point on their graph.

(f) Many candidates did not match the detail of their responses to the requirements of the question and the mark allocation and, consequently, responses were frequently weaker than expected on the evidence of responses to other questions. Candidates were expected to describe their results and then use the information provided on pages 2 to 5, together with their knowledge of the light-dependent stage of photosynthesis, to explain the decolourisation of DCPIP and the effect of light intensity on the rate at which this happens. Marks were also available if candidates found that the rate reached a plateau or near plateau. It was expected that this would prompt a discussion of limiting factors, but it was notable that this concept was hardly mentioned.

(g) The candidates were asked to suggest how a chloroplast suspension could be treated in order to use an electron acceptor that does not cross the chloroplast envelope. The suggestions were many and various; any method that is used to break open animal cells or organelles was accepted. Candidates often thought laterally to other parts of the syllabus. The leaf extract had already been put into a blender, so this was one suggestion that was not accepted.

(h) Candidates who had used their knowledge of the light-dependent stage in part **(f)** were often on secure ground here in explaining how the use of DCPIP allows this stage to be studied without any influence from the light-independent stage. The most able candidates gave answers in terms of the role of NADP in both stages. While the links between the two stages were often appreciated, many responses lacked the necessary detail about NADP to answer the question.

(i) As a whole, the candidates identified many of the limitations listed in the mark scheme. However, few gained full marks for this question, often because they wrote at length about two or three limitations instead of writing more concisely about a greater range. Improvements were usually appropriate, but needed to include sufficient detail to make the benefit clear. For example, 'put in a colorimeter' was not accepted unless supported by further information, since a melting point tube cannot simply be removed from beneath its filter and placed into a colorimeter. Candidates need to be more discerning to ensure that a standard solution to a particular problem is appropriate in the context of the specific experiment. If not, further detail will be required to demonstrate the improvement.

SECTION B

Question 2

The theme of this question was gas exchange. Most of the question dealt with the gas exchange surface of fish. This section tests candidates' powers of observation and their skills in recording these observations in drawings, tables and prose. Most of the drawings of whole specimens of fish gills and microscope slides of secondary lamellae were not of the standard expected. This emphasises that time needs to be spent on training candidates in these skills.

(a) The candidates were asked to make a drawing of a gill taken from a mackerel. Marks were available for the presentation of the drawing and for showing relevant detail, such as its V-shape, the varying lengths of the primary lamellae and detail of the gill bar. Drawing marks were often awarded unless clear and continuous lines were not used. Annotations to describe the appearance of the gill were often inadequate and some were little more than labels. Hand lenses were provided so candidates should have been able to observe the secondary lamellae along each side of the primary lamellae. If asked to give a magnification, it is always a good idea to write down the actual size and show any working, even if not requested.

(b) Drawing some secondary lamellae under high power was much more demanding and the standard of drawing varied quite widely. However, marks were gained for very simple drawings and no labels or annotations were required (although they can always be given even if not requested). It was sometimes difficult to follow the candidates' explanations of their calculations of magnification. Candidates should always state clearly the calibration of the eyepiece graticule and then make it clear whether they are measuring in the smaller or larger units on the graticule. Most candidates indicated clearly the length or width of their drawing in millimetres, which is good practice.

(c) Secondary lamellae are often depicted diagrammatically as semi-circular in shape, but some candidates thought that they were square or rectangular. These alternative approaches were acceptable providing that the subsequent calculations required were correctly developed. Assuming a semi-circular shape, the length of the secondary lamellae from the slide can be used as the radius of a circle. The formula for area of a circle can then be used to calculate the surface area of *both* sides of a secondary lamella. A few candidates stated correctly that the depth of the secondary lamella would have to be measured as well.

(d) (i) Most candidates gained a mark for suggesting why the researchers calculated the surface area of the gas exchange surfaces as 'surface area per gram' in Table 2.1. Correct answers were variants on the 'to make valid comparisons' idea. 'To make a fair test' is not acceptable at this level.

(ii) Most candidates wrote almost exclusively about mackerel, with little or no reference to the other species for which data was presented in Table 2.1. Some candidates did not mention any species at all. It is good practice to make effective use of information provided and this includes exemplification from the data provided. Most candidates showed understanding of the link between gas exchange and activity and, to a lesser extent, to habitat. Mackerel are fast swimming open water fish, while monkfish are less active bottom dwellers.

(e) The final two parts of this question asked candidates to make comparisons. Even though only part **(e)** asked for these in the form of a table, the comparison between gas exchange in mackerel and a small mammal in part **(f)** was best presented in a table.

In **(e)**, candidates were asked to compare airways, blood vessels and alveoli in slides of lung tissue. This tests knowledge of lung and blood vessel histology and, for candidates familiar with these areas, was a straightforward task. However, relatively few candidates demonstrated the knowledge expected to support their somewhat vague observations.

Tables were often not very well drawn. It is expected that candidates will present direct comparisons between the biological specimens concerned. Often comparisons between the three structures had to be teased out from the tables. More able candidates constructed a table with a column for features. This makes it much easier to include concise information within the table, for example by use of ticks, crosses, single words and short phrases.

(f) Marks were available in this question for comparisons between gas exchange in the mackerel and a small mammal. Most candidates would have benefited from better organisation of their answers. Those who drew another table and filled it with direct comparisons tended to score more highly than those who wrote notes or used bullet points. As the candidates had spent time looking at the gas exchange surfaces of the two vertebrates, candidates were expected to include some relevant observations made during the examination.

The data for Table 2.1 came from the following paper:

The dimensions of fish gills in relation to their function.
G. M. Hughes (1966).
The Journal of Experimental Biology: 45, 177–195.

Further useful information including illustrations is available in:

The fine structure of the secondary lamellae of the gills of *Gadus pollachius*.
G. M. Hughes and A. V. Grimstone (1965).
Quarterly Journal of Microscopical Science: 106(4), 343–353.

Both are available for free on the internet.