BIOLOGY

Paper 9790/01
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**C**
2	**C**	22	**D**
3	**D**	23	**D**
4	**C**	24	**A**
5	**D**	25	**C**
6	**B**	26	**A**
7	**D**	27	**A**
8	**B**	28	**C**
9	**A**	29	**B**
10	**C**	30	**B**
11	**C**	31	**B**
12	**D**	32	**B**
13	**A**	33	**C**
14	**D**	34	**C**
15	**D**	35	**B**
16	**B**	36	**D**
17	**C**	37	**C**
18	**B**	38	**C**
19	**A**	39	**D**
20	**D**	40	**B**

General comments

Ten questions were answered correctly by all the candidates. These were **Questions 1**, **2**, **6**, **19**, **20**, **31**, **32**, **33**, **37** and **38**. Comments on some specific questions follow.

Comments on specific questions

Question 3

Candidates who chose **A** (two condensation reactions) did not realise that the condensation reactions include those to make the nucleotides as well as the two that occur between the nucleotides to make the short chain of three nucleotides.

Question 4

Most candidates chose the correct option; gramicidin cannot be a non-polar lipid since sodium ions do not flow through lipids. Any added lipid would not change the impermeability of the membrane to ions.

Question 5

Candidates who recalled the graph showing the effect of a competitive inhibitor on the activity of an enzyme made the correct choice. Option **B** was a popular choice even though at high concentrations of the substrate the competitive inhibitor has no effect on V_{max}.

Question 7

Candidates who chose **B** did not realise that histones are not associated with DNA in bacteria.

Question 8

Candidates were unsure about the stage in the cell cycle that is influenced by the lack of extracellular growth factors so causing cells to enter the G_0 phase. **A** and **C** were chosen as well as **B**.

Question 9

Half of the candidates chose the correct response, with the rest choosing options **C** and **D**.

Question 10

Candidates chose **A** and **B** as well as **C**. **A** shows the closing of the atrio-ventricular valve and **B** the opening of the semi-lunar valve.

Question 11

Candidates who chose option **A** did not spot that it is protein channels for anions that allow movement of hydrogen carbonate and chloride ions across the red blood cell membrane. Hydrogen carbonate ions are formed at a much faster rate in red blood cells than in the plasma due to the presence of carbonic anhydrase, so **B** cannot be the correct answer. Option **D** was a popular choice. However, any increase in chloride ions would make the water potential more (rather than less) negative.

The accumulation of hydrogen carbonate ions within the red blood cell lowers the water potential so there is a net inflow of water; this makes **C** the correct answer.

Question 12

Options **B** and **C** were popular choices although these are both correct statements. Candidates should read questions carefully, making particular note of emboldened words, to ensure an appropriate response to questions like this one where identification of the incorrect statement is required.

Question 13

Half the candidates thought that glucose is too large to enter the Bowman's capsule; they should know that glucose is filtered readily through all capillaries, not just those in the glomerulus.

Question 14

Recalling a diagram of the structure of a molecule of IgG antibody would have helped candidates decide that **D** was the correct option. Both chains (polypeptides) contribute to the variable regions of the antigen-binding sites of these antibodies.

Question 15

The diagram was a good test of candidates' understanding of the orientation of proton movement in mitochondria and chloroplasts. Most candidates realised that **D** is the correct option, but **A** was also chosen. In chloroplasts, ATP is synthesised on the *outer* surface of the thylakoid so it becomes available to the Calvin cycle within the stroma. In mitochondria, ATP is synthesised on the *inner* surface of the inner mitochondrial membranes so requires channel proteins to leave for the cytosol.

Question 16

Candidates who chose **C** with the RQ of 1.40 used the value for oxygen (59) as the numerator in the equation rather than the denominator.

Question 17

Some stronger candidates incorrectly chose **A**, perhaps by reading photorespiration as photosynthesis. The graph is the evidence to show that water is the source of oxygen in photosynthesis.

Question 18

None of the candidates chose the correct response, **B**, which was the only option that could account for the fact that there are four different phenotypes; all of the other three options were selected. One gene with a pair of co-dominant alleles would give three phenotypes, not four, so **A** can be ruled out. The column for offspring makes no mention of their sex but the offspring of the fourth cross, which is the reciprocal of the first cross, gives a very different outcome. This may have made option **C** tempting but sex-linkage of a single gene (on its own) could not result in the number of different phenotypes recorded. Option **D** could also not explain the existence of three coat colours (dark grey, light grey and albino) without co-dominance at one of the gene loci.

Question 21

Options **A** and **C** were chosen by the candidates.

Question 22

Successful candidates realised that the endosperm is the only structure given in the options that forms at fertilisation and will have the allele, p. Option **C** was chosen by candidates who forgot that the endosperm is triploid.

Question 23

Option **B** was selected as well as option **D**, which was the intended answer. Examiners considered the case for **B** and concluded that there was slight ambiguity here – a fact that was taken into account when grading the paper.

Question 24

Half the candidates chose option **B**.

Question 25

None of the candidates chose option **C**. Candidates had not appreciated that antibiotics are only applied to the new varieties of genetically engineered crops during early development stages to allow selection of transformed cells. Once the new varieties have been developed and are grown in fields as crops, antibiotics will not be applied to the fields. This is, therefore, not a reason for favouring elimination of such marker genes.

Question 26

Some candidates chose option **C** rather than option **A**, forgetting that the central 'skeleton' of a polypeptide is CCNCCNCCN, etc.

Question 27

The base in W is a purine and so could be adenine or guanine. The diagram does not show the hydrogen bonds that are about to form so it is impossible to tell which of these two it is. Cytosine is the base in X since it is a pyrimidine and there are three hydrogen bonds between it and what must be guanine on the template strand. The base in Y is a purine and must be adenine since it bonds to the complementary base through two hydrogen bonds.

Question 28

Some candidates did not realise that all of the first three statements apply to eukaryotes, and chose options **A** and **D**.

Question 29

All the candidates realised that statement 5 is incorrect and so ruled out options **C** and **D**. Some, however, chose **A** instead of **B**. They had not appreciated the significance of the universal genetic code, or that the function of codons that act as 'start' and 'stop' codons is restricted to transcription only.

Question 30

Some candidates forgot that homologous chromosomes pair during meiosis, not during mitosis, which makes option **B** the correct answer and not options **A** or **C** which were also chosen.

Question 34

If a Rhesus negative person naturally has anti-Rhesus antibodies there would be a response during the first transfusion of Rhesus positive blood. As a result, this rules out statement 1. Antibody production begins during an immune response which would be triggered by the first encounter with the Rhesus positive blood so that rules out statement 4. This makes **C** the correct answer; candidates also chose **A** and **D**.

Question 35

Most candidates chose option **B**, but **A** was also selected. FAD is reduced during the Krebs cycle not during glycolysis.

Question 36

Statement 1 must be incorrect since all elk are grazers, and statement 2 can be discounted since this would only affect one of the herds. Statement 5 cannot be correct since it is clear that short jaws are disadvantageous and cannot therefore be favoured by directional selection. The inclusion of the phrase '...only a few dozen elk left' in the second sentence is the clue that this is an example of the founder effect. Candidates chose options **A** and **C** as well as **D**.

Question 39

Candidates selected option **B** as well as option **D**.

Question 40

None of the candidates selected the correct answer, **B**. Option **C** was a popular choice, perhaps because candidates did not realise the implications of the 'molecular clock' in the question. It is important that candidates read questions carefully in order to select the responses that apply to the particular question asked.

BIOLOGY

Paper 9790/02

Structured

Key Messages

- Candidates should give answers using the terminology relevant to each topic. Credit was lost by some candidates as a result of poor use of appropriate terminology.
- Descriptions of experimental results, whether given in the form of a graph (as in **Question 2**), or in a table, should always be supported by relevant data quotes.
- Even though there is no credit given for quality of expression on this paper, candidates should always pay close attention to spelling, punctuation, grammar and handwriting. Credit may be lost if the Examiners cannot understand the answers given.
- Candidates need to know about the different branches of biology. It was clear in **Question 2** that some were unsure about references to *physiological* behaviour.

General comments

It was encouraging to note that candidates engaged positively with the plant biology content of **Question 5**, with the result that this was one of the higher scoring items. However, candidates' responses to the assessment of genetic engineering in **Question 3** indicated that this was not as well understood as expected at this level.

Some of the answers were not as accurate as last year, and were suggestive of an insufficient grasp of the relevant terminology and underlying concepts.

Comments on specific questions

Question 1

This question was set in the context of the section on the syllabus that gives details of the origin and early evolution of life on Earth. Examiners expected candidates to be familiar with the concepts tested in **(a)(iv)** and **(c)**, but a lack of confidence was evident in candidates' responses.

(a) (i) No candidate correctly identified all three gases. Other gases were often given, such as nitrogen, oxygen, carbon dioxide and hydrogen sulfide, some of which may have been used in later experiments but not in Stanley Miller's original experiment described in the question. Hydrogen, methane and ammonia were all suggested but no candidate gave all three.

(ii) Some candidates suggested amino acids here. Another common response was 'lipids', which was accepted, although organic acids would have been a better answer.

(iii) The role of the powerful spark was identified correctly.

(iv) This part essentially asked for roles of water in the context of the origin of life on Earth. An understanding of the roles of water is fundamental in biology, but this was not well answered. Most candidates stated that water takes part in chemical reactions; some referred to its solvent properties and to its specific heat capacity. It was expected that candidates across the ability range would find this question accessible.

(b) **(i)** Fig. 1.2 shows a time line of the early history of the Earth. The candidates did not state the significance of carbon-12 in 3.9 billion year old rocks as evidence for the fixation of carbon or the idea that no abiotic process can cause enrichment of rock with C-12.

(ii) Better answers were given here for the presence of fossil stromatolites indicating the origin of prokaryotes.

(iii) Presence of steranes was not as well known although some candidates stated that it shows evidence for the origin of eukaryotes. None spotted the link between steranes and cholesterol.

(c) Candidates explained the term chemoautotrophic but did not give any further details including the oxidation of electron donors, such as ammonia and hydrogen sulfide.

Question 2

The answers to this question on the excretory system of mammals tended to focus insufficiently on the application of underlying understanding.

(a) The descriptions of the data shown in Fig. 2.1 were very varied, but often lacked use of comparative data to support qualitative statements. Similarly, explanations were not very clear.

(b) There was very little detail offered for the explanation required here. The relative lengths of loops of Henle were identified, but not much more. There was confusion over the role of sodium pumps and no information was included about the counter current multiplier effect.

(c) This was a straightforward question in which candidates had to identify that ADH is not released in the posterior pituitary glands of the gerbils given the $0.25\,mol\,dm^{-3}$ solution, but is released by the glands of gerbils given the other concentrations of sodium chloride. This explains why the posterior pituitary gland of these gerbils had significantly less ADH. There was no mention of the detailed mechanisms of water and urea reabsorption in collecting ducts. Water potential terminology was rarely used and often in the wrong context.

(d) For those candidates who correctly interpreted the term *physiological*, this part of the question was approached particularly well. However, the implications of this distinction were not always appreciated. For example, having large, thin ears is not a physiological adaptation, but an increase in blood flow through large thin ears to promote heat loss is. Behavioural adaptations, such as being nocturnal and living in burrows, were commonly referenced incorrectly. Concepts of thermoregulation were not applied correctly.

Question 3

Some credit was easily accessible from an interpretation of Fig. 3.1 but candidates sometimes lacked confidence to make the most of this.

(a) The function of the promoter region in T cells was not explained in any detail. Most candidates understood the idea of starting transcription. Transcription factors were rarely mentioned.

(b) This question involved translating information from Fig. 3.1 into text. There was some confusion over the use of ligases, which are not involved in cutting DNA. Base pairing was mentioned but not explained and the exact nature of introns and exons was not explored. Answers went outside of the scope of the question to include the movement of mRNA from the nucleus to the cytoplasm.

(c) Candidates knew about non-coding regions and some knew that only exons are translated. However, these candidates did not develop their answers to show what might happen if introns were translated as well as exons, and the subsequent impact that this would have on protein structure and function.

(d) Suggestions for the roles of the 'cap' and poly-A region were variable. Some candidates suggested that they prevent the premature breakdown of mRNA, direct mRNA to ribosomes and indicate the end at which translation begins. These were all credited.

(e) The explanations of the role of monoclonal antibodies in identifying different CD proteins were insufficiently clear and detailed. There was some confusion between the use of monoclonal antibodies to identify the different CD proteins and the role of antibodies in an immune response.

(f) The reasons for using hybridoma cells to produce monoclonal antibodies were known only by some candidates.

Question 4

This question covered aspects of ATP and chemiosmosis.

(a) This part of the question was expected to have been straightforward. Candidates at this level should know that ATP is not a high energy compound and does not have high energy bonds. Furthermore, although ATP is a cell signalling molecule, it does not pass easily through cell surface membranes and is certainly not transferred from cell to cell in this way to provide energy. The question asked about ATP's suitability as an energy currency and such points as its small size and the ease with which the terminal phosphate is removed are relevant. Movement across membranes obviously occurs, since much ATP is synthesised within mitochondria. The transfer of ATP across mitochondrial membranes occurs through ATP-ADP translocase molecules in the inner membrane, although this is not relevant to this question. Several candidates did not achieve any marks for this question, highlighting the need for greater focus on the role of ATP.

(b) **(i)** Candidates were good at identifying the precise locations of the membranes shown in Fig. 4.1.

(ii) Candidates were less successful at drawing arrows to show the direction of proton pumping across cristae, thylakoid membranes and bacterial cell surface membranes.

(iii) Candidates did not seem to have an overview of the principles of chemiosmosis, which is highlighted in the syllabus.

(iv) The role of ATP synthase was known quite well by some candidates who referred to a proton gradient, the harnessing of kinetic energy and the phosphorylation of ADP.

Question 5

Encouragingly, candidates responded well to this question on plant biology.

(a) All candidates identified suitable advantages of self-pollination in terms of perpetuating well adapted genotypes and ensuring that pollination occurs where there are few plants.

(b) **(i)** There were good answers to this part in which candidates gave advantages of attracting pollinators without offering an edible reward.

(ii) This part was not well answered as candidates tended not to appreciate the significance of the question. Some did realise that there is a greater chance that the next flower visited is the same species, so reducing wastage of pollen and increasing the chances of successful pollination.

(iii) Candidates gave good answers stating the disadvantage of using the sexual deception strategy of pollination. Most stated that if the numbers of the specific insect species decreased there would be much less pollination.

(c) This question prompted a variety of interesting ideas for assessing the success of pollination mechanisms. More lateral thinking was required here. Candidates referred to 'offspring' when terms such as fertilised ovules or seeds would have been much more appropriate.

Question 6

This question required specific knowledge from the syllabus and candidates who had developed this knowledge should have achieved highly. Candidates' responses tended to indicate a greater need for more detailed engagement with the content.

(a) **(i)** Identification of the parts of the brain in **(a)** was not as accurate as expected. The cardiac centre is located in the medulla oblongata or the brain stem.

(ii) **J** and **K** are cerebral hemispheres and cerebellum respectively. 'Front lobes' alone was not accepted for **J**.

(b) This question required an explanation of the roles of the autonomic nervous system in controlling the heart rate. This was not well understood by candidates, indicating an area requiring further work. Words such as 'messages' and 'signals' are not expected in answers at this level. These terms should not be used to refer to nerve or electrical impulses.

(c) Answers to this question on synaptic transmission and the activation of the second messenger cAMP were better, but not as detailed as expected at this level.

BIOLOGY

Paper 9790/03

Long Answer

Key Messages

In addition to rigorously examining factual information, Paper 3 requires candidates to interpret nuanced questions and to have developed a range of study skills which will equip them for further study. It is recommended that candidates preparing for this paper should pay attention to the following:

- learning factual information accurately and presenting it with clarity
- selecting information to target the question with precision, whilst avoiding the irrelevant
- using technical terms with sufficient precision to distinguish subtle differences in meaning
- using command words as pointers to determining what a particular question requires
- using knowledge and understanding to understand the significance of new information and to make connections between new ideas
- recognising the big ideas behind a question before deciding how to respond to it.

General comments

A Pre-U examination is intended to test both detailed knowledge and the application of such knowledge in familiar and unfamiliar contexts. This paper tests candidates' ability to select and synthesise information from across the syllabus and to solve problems.

Candidates working at this level should be able to respond appropriately to the different command words used so that they address the requirements of each question. For example, questions prefaced by *describe* or *explain* invite straightforward factual information with understanding, whilst *discuss* requires a balanced argument. Questions beginning with the command word *suggest* invite the candidate to consider information which might be open to more than one interpretation.

The contexts for ***Sections A*** and ***B*** were a mixture of the familiar and the unfamiliar. While candidates coped well with some of these, they rarely developed or extended their ideas beyond a limited range of responses. The Examiners expect able Pre-U candidates to use their knowledge of all the syllabus topics and wider reading to elaborate on their ideas. ***Section C*** gives them the opportunity to do this in depth, although in this session candidates did not develop their ideas sufficiently to match the mark scheme descriptors at the higher levels.

Comments on specific questions

Section A

Question 1

Most candidates scored well on this question, especially part **(b)**. The questions prefaced by *suggest* and *explain* invited them to respond to information about the hawksbill turtle using some familiar concepts. Examples of good answers to part **(a)** included having a mouth adapted to cope with a food source with sharp crystals and toxins. In part **(c)**, some candidates referred to genetic diversity, although few were able to qualify the point further in order to access further marks. For example, they could have stated that small populations with limited genetic diversity are less able to adapt to changes in the environment. Some stated

that the chances of males and females meeting is much reduced. The most demanding part of the question proved to be part **(d)**. Some candidates suggested that tracking could be used to protect the habitat of the hawksbill turtle without an indication of how this could be done. For example, tracking would indicate the range of habitats occupied by the turtle and therefore enable comprehensive conservation strategies to be developed.

Question 2

This was an accessible question which allowed most candidates to attain good marks, although it tested the understanding of a difficult concept – the fluid mosaic model. Names of proteins, such as channel and carrier proteins, were credited in **(a)**, as were associated processes such as active transport. In **(b(i)** most candidates included the idea of the fatty acid chains being bent, rather than straight, and therefore not being closely packed in. Some candidates attempted to answer part **(b)(ii)** without using the word *diffusion* which often made a clear explanation difficult. In **(c)**, more able candidates recognised the importance of intermolecular forces in the ability of molecules to move freely. Some candidates confused proteins with phospholipids in their explanations.

Question 3

Part **(b)** was the most discriminating part of this question and only the stronger candidates were able to answer in sufficient detail.

Most candidates gained credit for the idea that the reaction of human proteins with chicken antibodies was the maximum achieved. Some more able candidates recognised that the antibodies were highly specific with respect to human proteins.

Candidates were able to give good descriptions of the relationships between humans and chimpanzees, recognising their closeness, whilst humans and dogs were phylogenetically more distant. Some candidates attempted to make suggestions about the relationship between chimpanzees and dogs, but these were not credited as it is not possible to suggest the proportion of proteins shared between the non-human mammals. The use of an annotated phylogenetic tree to illustrate the answer would have been credited if seen.

Question 4

Phonetic spellings of Purkyne and Purkinje were accepted in **(a)**; however, abbreviations such as AVN were not credited because the question asked for the *name* of the structure.

Candidates should be aware that the sino-atrial node (SAN) does not emit nervous impulses. A variety of terms are acceptable, such as waves of depolarisation or electrical impulses. The Examiners were surprised to find candidates using the term 'signal' when they meant impulse. Most candidates gave the idea of a delay in the transmission of impulses at the AVN, although few were able to relate this to the filling of the ventricles before their contraction. This sequence of events in **(c)** needed to be written clearly to gain all of the credit available.

It is more usual for heart rate to be expressed as beats per minute, although credit was awarded in **(d)(i)** where candidates had expressed heart rate in beats per second, as long as this was accompanied by the appropriate unit (beats per second or beats s^{-1}). The time taken for a single beat was not credited.

Candidates identified atrial fibrillation in **(d)(ii)**, but were not able to suggest reasons for the atrial fibrillation and develop answers relating to the malfunction of the SAN. Candidates made a good attempt to use the information given in the ECG trace in Fig. 4.2.

Section B

Section B introduces unfamiliar biological information and, by means of three linked questions, invites candidates to apply knowledge and understanding from several parts of the syllabus in a synoptic fashion and to explore a thread running through several related topics. These are important study skills for a candidate preparing for higher education.

Most candidates were able to perform well on **Question 5** but found **Questions 6** and **7** increasingly challenging. In some cases, candidates appeared to find it difficult to apply their knowledge effectively and to use it to enable them to explore what might have been unfamiliar information.

Question 5

Candidates clearly understood the question in **(a)** and gained credit for explaining that using a patient's own stem cells would avoid the problems of tissue rejection. Some more able candidates were able to suggest that there would be no need for anti-rejection drugs to be taken, although often without developing this idea to gain further credit by explaining the benefit of an uncompromised immune system. Candidates clearly knew the definition of the terms multipotent and totipotent in **(b)**, although sufficient clarity and detail was lacking in most answers.

Candidates knew the names of a wide range of cells within bone marrow although some candidates confused different names for the same cell type indicating a lack of precision.

Question 6

Candidates knew ways in which genes are put into animal cells and they were aware of the methods used to identify the cells that take up genetic material. The Examiners accepted the use of fluorescent marker genes and antibiotic resistance genes that candidates should know in the context of modifying bacterial and yeast cells. However, candidates did not describe these methods clearly.

The Examiners were looking for the use of microinjection and viruses as the main methods for inserting genes into mammalian cells, although the use of plasmids was allowed. They also accepted the use of fluorescent marker genes as a means of detecting that DNA had been successfully introduced.

The candidates were aware of the role of transcription factors and of telomerase reverse transcriptase (TERT), but only the more able were able to apply this knowledge in understanding the substance of the information in the passage.

Question 7

This question required candidates to apply their biological understanding of the topic to examine a controversial subject from a bioethical point of view. In **(a)**, candidates identified the source of DNA but missed full credit by not stating that mitochondria would have been in the cow cell. More able candidates stated that there would be bovine surface proteins on the early embryonic cells meaning that implantation would be unsuccessful making it impossible to develop into an adult. In **(b)**, candidates were expected to decide whether they considered the procedure to be ethical and then to present a case supported by biological knowledge.

Part **(c)** required candidates to make links between stem cells as being potentially useful, and cancer cells, normally thought of as a serious problem, since both are relatively undifferentiated cells capable of dividing. The better candidates did suggest that a predisposition towards cancer might thus be present in the stem cells. Some were tempted to write all they knew about cancer cells without applying their understanding of cancerous cells in a targeted fashion and without making links with stem cell properties. This application of biological understanding which goes beyond reproducing factual information is challenging and candidates need opportunities to develop this key skill.

Section C

Section C offers a choice of essays which require the selection of appropriate knowledge and understanding. Appropriate recall alone is insufficient to access higher marks. As in ***Section B***, candidates need to address the underlying 'big idea' embedded in each question in order to achieve higher levels. They need to frame an argument, marshal evidence in support and synthesise ideas from different parts of the syllabus. On the whole, candidates did not appear to identify a 'big idea' or the main themes of their chosen title before writing. The mark scheme for this section rewards breadth, communication, argumentation and selection of appropriate material from across the syllabus.

Question 8

Candidates who attempted this question struggled to appreciate that it was about the concept that oxygen in the atmosphere was derived and is maintained by photosynthesis, that oxygen in the air makes aerobic respiration possible and that this recycles carbon dioxide. C4 plants are adapted to the current low concentration of carbon dioxide in the atmosphere, especially in places with low rainfall. As carbon dioxide concentration rises and rainfall patterns change, this may influence the distribution of C3 and C4 plants.

Question 9

A more structured framework was provided for this demanding question, but only candidates with a good understanding of classification and evolution were able to develop this significantly. There was very little in the candidate responses about modern methods of classification and different views of the species concept.

Question 10

This question was the most popular essay choice, although most candidates focused too narrowly on particular aspects of the topic rather than the whole subject of the question. Some wrote mainly about xylem and water transport and others mainly about blood circulation. Few presented any kind of argument or balanced attempt to discuss unifying concepts such as diffusion rates, surface area to volume ratios, mass flow and the fundamental differences between animals and plants.

BIOLOGY

Paper 9790/04

Practical

Key Messages

- Centres should check all the requirements for the examination. If they need to make any substitutions they should make these 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 the highest standard then Centres should contact Cambridge immediately for replacements.
- In relation to the conduct of the exam, 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'.
- Each Supervisor should provide a set of results that are supplied to the Examiner along with the scripts.
- Candidates preparing for the practical examination for the new syllabus should take special care over the presentation of drawings made from the microscope. Candidates should have sharp pencils, rulers and clean erasers in order to make high quality drawings. They need practice at preparing drawings of the tissues listed in the syllabus following the accepted rules for making low power plan diagrams and drawings of cells under high power.
- The steps involved in carrying out practical procedures, determining magnifications or actual sizes and carrying out statistical tests should always be made clear.

General comments

This Practical Examination consists of two Sections. ***Section A*** has two practical tasks, one of which involves the use of a microscope. ***Section B*** has a Planning Exercise and two data analysis questions. The paper tests many skills from planning, experimentation and data presentation to analysis and interpretation.

This is the last practical paper of the current syllabus. Comments on ***Section A*** are pertinent to the practical examination (Paper 3) in the new syllabus; the planning exercise and the data analysis questions from this paper are in Paper 2 in the new syllabus.

This paper was demanding on time and requires candidates to have plenty of experience of practical work and organisation of time.

The analysis of the cotton fibres in **Question 1** using the reducing sugar and non-reducing sugar tests was not carried out very systematically. The fact that some samples might contain reducing sugars **and** non-reducing sugars was not generally realised so that candidates did not always conduct both tests on each sample.

Furthermore, the Examiners were not looking for standard laboratory descriptions of the practical work and there was no need to identify all of the variables involved. The question only required candidates to record their results and conclusions; Examiners can use the displayed results to identify the steps that have been carried out, where necessary.

Presentation of data in tabular form was slightly better than presentation of drawings. However, standard rules about the construction of tables were not always followed. For example, one candidate recorded the sequence in which a precipitate was seen in the Benedict's test but did not give a key or suitable column heading to explain the numbers (1 to 5) used.

The Examiners had difficulty in deciphering the handwriting of some of the candidates, and drawings were often too small; candidates must make use of the space provided and show sufficient detail in a form that is clearly identifiable.

Comments on specific questions

Question 1

This question provided a context in which to use the tests for reducing sugars and non-reducing sugars. The candidates were provided with all the reagents and materials they needed to carry out these two tests and most realised from the presence of hydrochloric acid, sodium hydroxide and filter paper that they should use the non-reducing sugar test. Some used this test, but did not also test for reducing sugars.

The instructions did not require candidates to record a structured report on the practical work that they used. There was no requirement to present a table showing the independent variable, the dependent variable and the control variables, for example. Nor was there any requirement for any description of the tests. However, it was important that candidates explained the results that they presented. They could have done this by using suitable column headings and, if they used symbols [such as +, ++ and +++ or numbers (e.g. 1 to 5)], gave a key to indicate what these meant. Most candidates simply gave colours although it was not always made clear that these were *final* colours after testing with Benedict's solution. Grey is not a colour that appears when using the Benedict's test.

The Examiners looked for evidence of the two tests rather than descriptions that they had been carried out. Each table of results should include *all* the results obtained for the two tests and may also include the deductions as well. Almost all the marking points could be awarded for a well constructed table. As a result of not including this, candidates did not consider the cumulative effect of testing for *both* reducing and non-reducing sugars and realise that some solutions contained both.

Question 2

The candidates were provided with slides of the testis (**T1**). Candidates had to make labelled and annotated drawings, take measurements and use these to calculate the mean diameter of the seminiferous tubules. All the candidates drew clear cross sections of the tubules in part **(a)**, but they found drawing the high power detail much more challenging. Often, clear, continuous lines were not used to show tubules, cells or nuclei. Rulers should be used for the straight lines required for labelling.

(a) The candidates made a low power plan drawing of the section of testis showing five seminiferous tubules and the tissue between them. All candidates drew the required number of tubules. They should have been able to see interstitial tissue and some blood vessels. The relative thicknesses of the tubules were shown adequately, although candidates were often unsure about the arrangement of the different layers within each tubule. All knew not to draw cells in low power plan diagrams. Words printed on the examination paper should be copied correctly; one candidate lost a mark for identifying a seminiferous tubule as an 'emminiferous tubule'.

(b) This question required the use of a graticule to measure the diameter of the five tubules. The calibration of the graticule was rarely made clear so the Examiners had to look carefully at the results recorded and allow errors carried forward to reward correct procedure. The candidates generally calculated the standard deviation for their results correctly, although one managed to calculate a standard deviation greater than the mean value. Diameters were expressed in millimetres or micrometres.

(c) There was mixed success at identifying and drawing Sertoli cells. Most candidates appreciated what they should be looking for and drew cells of approximately the right dimensions that reached the outer lining of the seminiferous tubule. Nuclei were also often in a basal position. Details of the nuclei of surrounding cells were not shown well. They tended to be drawn as circles without any indication as to their appearance or the stage of spermatogenesis involved.

Question 3

The Planning Exercise involved designing a procedure to compare the activity of the enzyme urease free in solution with urease that had been immobilised in calcium alginate beads.

As there are now at least three planning exercises available for Centres to use, it was anticipated that these candidates would set out their plans to match the mark schemes. This could be done by using suitable headings, such as hypothesis, strategy, justification, variables, risk assessment, method, presentation and analysis of results. Some candidates did use headings although not systematically all the way through their plans. The method is much better if written as a series of numbered points rather than continuous prose and

it was encouraging to see this in some scripts. Risk assessments should always include hazards specific to the investigation linked to the appropriate precautions.

Candidates were often confused by practical procedures that they must have carried out during their course. For example, there were references to 'algal balls' rather than 'beads of urease' and some plans involved carrying out the procedure over a range of temperatures, which was not required. The planning was not as systematic as those written by last year's candidates.

There was little attempt to standardise or even consider the quantity of enzyme used in the two reactions. Admittedly this would be difficult to do, especially when planning without the benefit of carrying out some trials, but not impossible. Candidates may identify variables that they do not know how to standardise and can say that these should be 'taken into account' when analysing the results. These uncontrolled variables are particularly important in investigations of ecological topics.

In describing the quantities and concentrations to be used, candidates should not use the word 'amount'. It is not clear whether they are referring to volume, mass or concentration unless they also use the appropriate unit. Much greater precision is required in describing the preparation of the materials to be used than was evident on these scripts.

The use of pH papers or pH meters to follow the change in pH over time was not always described carefully enough. Few candidates explained that the procedure should be repeated, means calculated and then a suitable statistical test applied to the results. This was unexpected considering the use of the *t*-test in **Question 4**.

Candidates wanted to include a final graph, although they were often unsure what it should show.

Question 4

This question gave information on reproductive strategies of the hedge sparrow, *Prunella modularis*.

(a) The candidates were given data on five different reproductive strategies of *P. modularis* and asked to summarise the data shown. Candidates identified some of the main points revealed in the table, although they should not simply state the data for each reproductive strategy, but identify patterns or trends. The most obvious observation that reproductive success was improved if males were involved in feeding the nestlings was often missed.

(b) This question required candidates to use the data provided to perform the *t*-test. Although Table 4.2 gave three other analyses, candidates did not always follow these to analyse reproductive strategies 1 v 3 and 4 v 5 successfully.

(c) Candidates were better at justifying the use of the *t*-test in this investigation. They knew that it was for finding out whether the difference between the means was significant.

(d) This question offered opportunities for the candidates to evaluate this study by suggesting limitations. Some pointed out that there were only seven nests used for one of the strategies. The large standard deviation (and therefore large error bars) was noted. The fact that this study was only done in one location in what must be a small area was also suggested. All these points gained credit.

Question 5

This question involved analysing the data from a conjugation procedure to map four gene loci on a bacterial chromosome. Once candidates had analysed the data in Table 5.1 on the growth of bacterial colonies of different strains, the rest of the question involved following instructions to find the sequence of the genes. The only difficulty was deciding that bacteria that had gained the allele for synthesising histidine do not require histidine in the medium on which they are grown.

(a) (i) The candidates identified that mutant type **C** lacked the active enzyme for synthesis of histidine.

(ii) Suggestions as to why type **E** grew on all the media provided were not as detailed as the answers to **(i)**.

(b) (i) The graphs showing the numbers of colonies were drawn well.

(ii) The candidates extrapolated their graphs successfully and therefore obtained correct results for the time of gene transfer. Bacteria that grew on medium **3** (minimal medium plus histidine) were those that contained the *trp* gene and **not** the *his* gene. This means that the first gene to be transferred is *trp* followed by *his*, *amp* and the gene for lactase.

(c) In marking the positions of the genes on the chromosome, the Examiners were concerned with the relative sequence and not the actual positions. With more marks available, both aspects could have been rewarded. The gene for lactase is transferred at about 35 minutes, which means that its position should be marked just over half way around the chromosome.