CONTENTS

FOREWORD

This booklet contains reports written by Examiners on the work of candidates in certain papers. **Its contents are primarily for the information of the subject teachers concerned**.

BIOLOGY

GCE Advanced Level and GCE Advanced Subsidiary Level

Paper 9700/01
Multiple Choice

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

General comments

The mean score was 26.8 (67%) and the spread of scores was high, with a standard deviation of 6.7. Nine questions were answered correctly by 80% of more of candidates (**Questions 4**, **5**, **9**, **15**, **18**, **24**, **28**, **34** and **37**). Difficult questions were **Questions 2**, **20** and **30**, which were answered correctly by fewer than 40%.

Comments on specific questions

Question 2

Too many candidates think that the cell surface membrane is visible with a light microscope. The fact that a great majority think that an electron microscope is needed to see chromosomes and nucleoli suggests that candidates have little practical experience observing dividing cells using a light microscope.

Question 8

Option **B** was a popular incorrect choice even with some of the more able. Perhaps some candidates had in mind the breakdown of cellulose micro fibrils into individual cellulose molecules, but this would be achieved by the breaking of hydrogen bonds rather than by hydrolysis.

Question 13

Weaker candidates evidently had trouble with the mathematical expressions, option **B** being a popular incorrect response.

Question 20

Option **B** was more popular than the correct option, **D**. A majority of candidates did not apply knowledge of the fact that the DNA has already replicated before a cell reaches prophase.

Question 21

The popularity of option **B** is further indication of the uncertainty candidates have about when and how new chromosomes are formed.

Question 22

The high discrimination value shows that the more able candidates paid attention to the fact that the question is asking about tRNA anticodons, while the weaker ones chose the mRNA codon.

Question 25

The rather high proportion of candidates choosing option **B** evidently had little idea of the concept that all cells of a body have identical DNA.

Question 27

Fewer than expected of the more able candidates knew the answer, resulting in a low discrimination value. Too many of the more able do not appreciate that a cell which has no nucleus can neither synthesise proteins nor divide.

Question 30

The nature of the apoplast as being all the non-living water-conducting parts of a plant was not at all well known. The direct effect of the fungal growth would be blockage of the xylem vessels, which are part of the apoplast.

Question 38

Candidates who chose option **C** did not take into account that energy lost in respiration and used in other life processes has first been captured in photosynthesis.

Paper 9700/02

Paper 2

General Comments

There were many encouraging answers to all five questions especially **Questions 2** and **4** from the well prepared candidates, though disappointingly there were some low scores and even the more able candidates had some difficulty with **Questions 1 (b)**, **2 (c)**, **3 (c)(ii)**, **4 (d)**, **5 (a)** and **5 (d)**.

As in previous sessions, candidates continue to lose marks by not answering the actual question set. For example, in **Question 3 (c)(ii)**, where candidates spent far too much time *describing* the differences in the pattern of nitrate ion absorption by plants in batches **N** and **P**. The question required an *explanation* of these differences shown in Fig. 3.2 in terms of cyanide inhibiting ATP synthesis and therefore active uptake of nitrate ions in batch **P**.

Again, in answer to **Question 5 (b)**, where candidates were asked to use the data in Fig. 5.1 to *describe* the effect of pH on the activity of phosphatase, many candidates *explained* the effects with reference to H^+ ion concentration and denaturation, such information being required in **5 (c)** where candidates had to explain the low activity of phosphatase at pH 1.

Other candidates were far too imprecise in their answers. For example, in **Question 4 (c)(ii)**, candidates were asked to describe how TB is transmitted from infected to uninfected people. Candidates often mentioned coughing and sneezing, occasionally droplets in the air, but made no reference to these droplets being *inhaled* by the uninfected person.

Questions targeted at the Assessment Objectives in Group B proved to be a problem for many candidates. Candidates need more practice at the types of questions that address B4, B5, B7 and B8.

There were sufficient marking points to allow candidates to demonstrate their knowledge and understanding and most candidates appeared to have had sufficient time.

Comments on individual questions

Question 1

There were some high scoring answers to this question.

(a)(i) The vast majority of candidates named structures **A**, **B** and **C** on Fig. 1.1 as Golgi (body/apparatus), rough endoplasmic reticulum and mitochondria respectively.

(ii) In naming the region labelled **D** that separates the two sieve tube elements, knowledgeable candidates gave sieve plate, occasionally weaker candidates mentioned sieve pores and plasmodesmata.

(iii) Able candidates, in naming *one assimilate* that is transported in the phloem, mentioned sucrose/amino acids. A considerable number of candidates incorrectly named sugar, glucose, even starch.

(b) Candidates were required to *explain* how the structure of sieve tube elements helps the translocation of substances in the phloem. The best candidates made suitable reference to the lack of cytoplasm in the elements/pores in the sieve plates but often failed to link these to the lack of resistance to/permitting of continuous flow, preferring to refer to 'more space' and 'hollow'. Some candidates described the structure of phloem tissue whereas the question specified the structure of sieve tube elements. Others inappropriately described the mechanism of phloem transport with reference to mass flow. A few candidates, by their reference to lignified walls and the cohesion-adhesion theory, confused sieve tube elements with xylem vessels.

(c) Here candidates were asked to describe the role of companion cells in translocation in the phloem. Many answers made reference to active transport, not all mentioned mitochondria, even if they did refer to the provision of ATP. Only the best candidates made mention of H^+ pumping and the co-transport of sucrose. Many candidates inappropriately gave information about the functions of various structures seen in the companion cell.

Question 2

There were many good answers to this question, although only a small proportion of candidates gave fluent answers to **(c)**.

(a) Knowledgeable candidates, in stating how α glucose differs from β glucose as shown in Fig. 2.2, made reference to -OH/hydroxyl being below -H/hydrogen on **carbon atom 1**. Several candidates however were imprecise and made no reference to carbon atom 1 **(C1)**, simply stating that the -OH was on the bottom of the α glucose molecule.

(b)(i) Few difficulties here with the majority of candidates naming the bond **E** as a glycosidic bond with many encouragingly referring to a 1-4 glycosidic link. Occasionally 'peptide bond' was given as the answer.

(ii) In showing how a β glucose molecule is attached at the end of a growing polysaccharide chain, many candidates clearly indicated by annotation, the -OH on both the free molecule and the end of the chain in the diagram, the correct position of the oxygen bridge/glycosidic link, between **C1** and **C4**, and that water is eliminated. This is a common type of question.

Weaker candidates, despite the arrangement shown in Fig. 2.1, did not appreciate that, in order to form a glycosidic bond between 2 β glucose molecules, one glucose molecule must be upside down relative to the other, thus successive glucose units are linked/rotated 180° to each other. A significant number however failed to indicate the removal of water or indicate the position of **C1** and **C4**, either on the diagram or in words underneath. Many ignored the prompt diagram or decided to add extra unnecessary detail to the diagram.

(iii) Few difficulties here with the majority of candidates naming cellulose as the polysaccharide that is formed entirely from β glucose molecules. Occasionally starch and glycogen were incorrectly named.

(c) Candidates were required to *explain* the results of an enzyme investigation shown in Table 2.1. Only the most able understood what was happening in this experiment. These candidates appreciated that tube **F** was a control, to show that there is no breakdown of starch without an enzyme, that whilst amylase breaks down starch to maltose, a reducing sugar, maltase does not break down starch and that both enzymes are denatured when boiled. Only the best candidates included in their explanation any reference to specificity.

It was evident that a significant number of candidates had poor knowledge and understanding of the enzymes amylase and maltase and their association with the hydrolysis of the substrate starch to reducing sugars. Several incorrectly stated that amylase hydrolysed starch to glucose. In fact very weak responses made reference to starch and even maltase as non-reducing sugars with amylase a reducing sugar. Several candidates simply described in words the results already given in Table 2.1 when an explanation of the results was required. This part of the question demonstrated how difficult it is for many candidates to logically analyse results and to apply some knowledge.

Question 3

The standard of response in **(a)** and **(b)** was generally good though answers to **(c)** were frequently disappointing.

(a) There were many acceptable answers in completing the table to describe *one* role in living organisms for each of the ions, calcium, iron and potassium. The most common correct answers for calcium and iron were for the formation of bone/teeth and haemoglobin respectively. Only occasionally did able candidates further demonstrate their wider knowledge with reference to perhaps blood clotting/synaptic transmission/calcium pectate in the cell wall/middle lamella and reference to cytochromes for calcium and iron respectively. Candidates found potassium was the most difficult ion to describe an important role for in living organisms. Even some able candidates had difficulty with potassium where the commonest correct response was nerve function and only rarely in the activation of enzymes and even less frequently in stomatal opening/closure. Several mentioned the Na^+/K^+ pump without any qualification. Furthermore several candidates simply gave one word answers e.g. bone, nerve, without any reference to role or function.

(b)(i) In naming substances **L** and **M** as shown in Fig. 3.1, a part of the nitrogen cycle, good candidates gave urea (occasionally ammonia) and nitrites respectively. Weaker candidates often gave **L** as amino acids and **M** as nitrifying bacteria.

(ii) In naming the process by which ammonium ions are converted to nitrate ions in the nitrogen cycle, the commonest correct response was nitrification with occasional mention of oxidation by some candidates. Weaker candidates incorrectly gave denitrification or nitrogen fixation.

(c)(i) A significant number of candidates were able to show their working (e.g. 15 mg/20 hours) and therefore calculate the rate of absorption of nitrate ions in batch **N**, between 40 and 60 hours, as 0.75 mg per hour (mgh^{-1}). A few gave 3/4 as the final answer.

(ii) In explaining why the absorption of nitrate ions by the plants in batch **N** differs from that in batch **P**, the more able candidates, as explained earlier, understood that, because cyanide inhibits ATP synthesis in respiration, there would be no energy for active absorption by batch **P**, ions only being absorbed by diffusion, whilst ions in batch **N** could be absorbed by active transport (and diffusion).

The best candidates occasionally made reference to the idea of no concentration gradient in batch **P** after 10 hours though few explained this by reference to the rate of assimilation = rate of absorption.

Weaker candidates, as explained under **General comments**, simply described in words the two absorption patterns with many incorrectly believing that the lack of ATP in batch **P** seedlings meant less energy was available for protein synthesis and so there was a lower requirement for nitrate ions. Even better candidates went down incorrect routes by reasoning along the lines of cyanide producing anaerobic conditions, therefore denitrification reduced nitrate availability, whilst others indicated that cyanide damaged root hairs. A significant number of candidates thought they were still having to link their answer to the nitrogen cycle in **(b)**, with several candidates referring to the bacteria involved in the nitrogen cycle in their answers.

(iii) Candidates were asked to explain why the mean quantity of nitrate ions in *both* batches of plants decreased after 60 hours. Many candidates made reference to the lack of ions in distilled water, but only the best referred to ions being lost by diffusion down a concentration gradient out of the roots. Few mentioned the use/assimilation of the nitrate ions in amination/protein synthesis. Replacement of solution by distilled water was thought by some candidates to lead to dilution of nitrate ions either in the plant or outside. Incorrect answers involving water potential differences and osmosis were common.

Question 4

There were some excellent answers to this question.

(a) In naming structures **Q**, **R** and **S**, knowledgeable candidates gave cell wall, flagellum and (loop of) DNA respectively. Less able candidates often named **Q** as a cellulose cell wall and even the plasma membrane and a significant number referred to **S** as a vacuole/tonoplast membrane/mesosome. Some candidates labelled the flagellum **R** as 'tail'.

(b) In stating the names of three structures that are present in a phagocyte of a mammal that are not present in bacteria, the most frequent correct responses indicated the presence of a nucleus, mitochondria and endoplasmic reticulum amongst other correct responses.

(c)(i) In naming the bacterium that causes TB, virtually all candidates gave *Mycobacterium* or *M. tuberculosis*/*M. Bovis*. Weaker responses referred to "*Myobacterium*", "*Microbacterium*" and to *tuberculus*, or to *E. coli* and *Plasmodium*.

(ii) In describing how TB is transmitted to uninfected people, many candidates did refer to sneezing/coughing but, as explained under **General comments**, made no mention to air droplets being inhaled/breathed in by uninfected persons. There were many vague references to transmission to other people with incorrect links to infected cows milk and skin contact with infected individuals. Some candidates confused TB with HIV and wrote about HIV transmission.

(d) Only the most able candidates explained clearly why it is necessary to give people with TB a number of different antibiotics for up to a year, referring not only to antibiotics destroying the bacterium, which can be hidden from the immune system in the cells of the lungs, but made mention of avoiding the development of resistance to any one antibiotic and to preventing the leaving of a reservoir of infection.

Weaker candidates may well have appreciated the need to avoid the development of resistance to one type of antibiotic, but they usually did not address the significance of treatment lasting for up to a year. A significant number of candidates made mention of 'immunity' rather than 'resistance' in their responses, and made incorrect references to antibodies, memory cells, antigens, viruses and "TB being killed".

Question 5

Overall a sound level of response.

(a) A surprising number of candidates found it difficult to state the two ways in which the activity of an enzyme can be measured – namely by the rate of disappearance/appearance of the substrate/product respectively. Many candidates in their answers referred to factors affecting the rate of enzyme activity, varying the pH, enzyme and substrate concentration, even temperature, misunderstanding the question completely. There were many references to 'lock and key' and 'induced fit'. Some candidates clearly remembered carrying out practicals based on the idea and described, for example, the disappearance of the black colour when testing for starch or measuring the volume of gas collected.

(b) Many candidates (see earlier under **General comments**) explained the effect of pH on the activity of the enzyme phosphatase in addition to or instead of describing the effect as shown in Fig. 5.1. The best candidates made suitable reference to increasing activity up to the optimum of pH 5 with decreasing activity as pH increases above this optimum. Many candidates simply gave figures for each pH without describing the trend.

(c) In explaining the very low activity of phosphatase at pH 1, many candidates made reference to the enzyme being denatured, with a change in the active site. The most able made further reference to the high H^+ ion concentration breaking ionic/hydrogen bonds and altering the tertiary structure of the enzyme, changing the shape of the active site. Only occasionally did candidates indicate the effect on R groups of amino acids (in active sites). Very few candidates fully addressed the question, failing to explain that, some enzymes remained active/all enzymes partly active at pH 1, and so there was some (low) phosphatase activity.

(d) A significant number of candidates were able to show the results that might be expected if the experiment detailed in the question was repeated at a temperature of 20°C. These candidates were able to draw a curve on Fig. 5.1, having the same shape with the same optimum of pH 5 as the original curve, but peaking between 2.0 and 3.0 units on the *y*-axis. Furthermore these candidates clearly indicated the curve would start at pH 1 and finish at pH 9 below the original curve and above the *x*-axis. Many candidates however simply drew a curve lower than that given without any consideration of the significance of a temperature reduction of 10°C and/or were very imprecise as to the start and finish points. A few candidates calculated and plotted each point correctly, using their knowledge of Q10.

(e) Many candidates explained how competitive inhibitors affect the activity of enzymes by referring to such inhibitors having a similar shape (not structure) to the substrate, fitting into the active site and therefore blocking the entry of the substrate. Many candidates however did not link this with decreased product formation or the inhibitor being less effective at high concentration of substrate. There is still confusion amongst weaker candidates regarding the position of the active site. Many still believe it is on the substrate, others had the substrate binding with the inhibitor.

Paper 9700/03

Practical 1

General comments

The quality of answers was very high from many Centres with a significant number of candidates scoring in excess of twenty marks from a possible twenty five.

The paper appeared to discriminate well between candidates, allowing the vast majority of candidates to demonstrate their knowledge and practical skills. Very few candidates scored less than ten marks.

There was no evidence that candidates suffered due to a lack of time.

Comments on specific questions

Question 1

Examiners were aware that some candidates may have experienced difficulty with part **(a)** of this question. As a consequence of this, the mark scheme was modified such that parts **(a)(i)** and **(a)(ii)** were marked together. This, along with the addition of several other marking points, such as crediting a technique e.g. 'stirring' and allowing an 'error carried forward' from part **(a)(i)**, enabled candidates who were not able to make up a molar solution, to receive credit on this part.

(a)(i) The vast majority of candidates performed well on this part and correctly calculated 6.8 g as the answer.

(ii) Most candidates scored both marks on this part. Credit was given for a correct technique such as ensuring the solid had dissolved, and for an explanation of how the calculation in part **(i)** had been carried out. This was credited, even if the calculation was in error in part **(i)** but the method of calculation was correct in **(ii)**. Examiners were therefore confident that no candidate was unfairly penalised for not knowing how to make up a molar solution. However, it was encouraging to note just how many candidates did in fact know the correct procedure for making up the solution and were credited accordingly.

(b)(i) Most candidates scored both marks on this part by correctly calculating the mean length and then converting this into a percentage change. Where errors did occur, it was usually in converting the mean length into a percentage. A very few candidates rounded up to whole numbers. It was felt at this level that candidates should be able to give answers correct to one decimal point and failure to do so was not credited.

(ii) Candidates gave some very good answers to this question. Credit was given for a wide range of suitable answers such as covering the Petri dish, ensuring the strips were covered in solution, using more strips and ensuring the widths were the same. In fact any good answer received credit. In order to ensure that candidates were not penalised in part **(a)(i)** and **(a)(ii)** credit was even given for stirring the solid or ensuring that it had completely dissolved, as long as this marking point had not been given in part **(a)(ii)**.

(c)(i) Most graphs were well drawn with clear well-plotted points. Credit was given for the correct orientation of the axes, all points plotted correctly, and drawing a line of best fit. A few candidates failed to fully label the axes with the correct units, or used a varying scale. However, these errors were few and far between with most candidates scoring full marks.

(ii) Few errors were made on this part. Occasionally candidates gave answers to several decimal places, which could not possibly have been worked out with any accuracy. However, most answers were accurate and gave the correct units. Candidates who failed to give the units, did not score.

(iii) This question proved to be a little more difficult for some candidates. Good answers referred correctly to the water potential and then went on to state that this would result in water entering the potato cells by osmosis. All too often candidates failed to read the question and wrote about what would happen if the potato strips were in sucrose solution. This was a classic example of where some candidates lost unnecessary marks because they failed to read the question carefully.

Question 2

(a) Although candidates were told in the stem that frog's blood was unlike human blood, several candidates refused to believe that it contained a nucleus. As a labelling mark was awarded for two correct labels, many candidates only labelled the cytoplasm and thus failed to obtain this mark. It was also surprising how many candidates labelled the cell membrane as the cell wall and thus failed to score. Credit was also given for drawing the nucleus in the correct proportion to the rest of the cell, and drawing the cell oval shaped.

(b)(i) Candidates drew a variety of different white blood cells and most were credited with two or three marks. Credit was given for drawing a shaded, large or lobed nucleus and then giving the cell its correct name. Candidates were remarkably good at being able to identify the correct type of white cell.

(ii) Credit was given in this question for using the correct units, and most candidates managed to score this mark. However, the second mark was for determining the correct diameter of a white blood cell and even though a wide range (9 – 20μm) was accepted, many candidates failed to obtain this mark.

(iii) Most candidates scored two marks on this part. However, all too often the ratio was given the wrong way round. Providing that the candidate had shown correct working in the two boxes, this was credited, but all too often candidates did not clearly show how they had calculated the ratio and thus an incorrect ratio could not be credited with at least one mark from their working.

(iv) This part proved to be a nice easy finish for most candidates who correctly identified two clear differences. It was also pleasing to see that the vast majority gave both sides of the argument e.g. "frogs red blood cells contain a nucleus but human red blood cells do not". Those candidates who simply said that the frog's blood cell had no nucleus, were not credited.

Paper 9700/04

Paper 4

General comments

The paper showed a large range of marks; there were a large number of high scoring candidates, however, there were a number of low scores. ***Section A*** seemed difficult for many candidates despite the fact that many of the questions were recall of information. ***Section B*** showed some very high scores, **Question 6** being the most popular.

Comments on specific questions

Section A

Question 1

(a) Candidates were asked to describe the photoactivation of chlorophyll. However, many attempted to describe the whole of the light dependent stage. Very few candidates referred to the absorption of red and blue light, the antenna complex and the transfer of energy to the reaction centres. Most candidates were familiar with the light energy exciting the electrons which pass to a higher energy level.

(b) There were some confused answers to this part. Very few candidates referred to the splitting of water into H^+ and OH^-; some attempted to write an equation but this was often incorrect or unbalanced. Most candidates made reference to the electron replacing that lost from the chlorophyll. Few stated the fate of the H^+ and OH^-.

(c) There were many superficial answers to this part on the formation of ATP in the chlorophyll. Most candidates made reference to the flow of electrons down the electron transfer chain and the formation of ATP from ADP and inorganic phosphate. Far fewer appeared to be familiar with the pumping of the H^+ across the membrane, the proton gradient set up across the thylakoid membrane and the flow of protons down the gradient via ATPase. A number of candidates referred to both cyclic and non-cyclic photophosphorylation. A few confused this with stages of the Calvin Cycle or Kreb's Cycle.

(d) Few candidates gave an acceptable suggestion as to the advantage of having photosystems, the electron transport chain and ATP synthase as part of the membrane. The candidates did not appear to understand the question and the most common answers referred to the fact that they provided a large surface area. The Examiners were looking for the fact that they allow increased efficiency of the process as they are close together and there is a short diffusion distance.

Question 2

This appeared to be a relatively straight forward question, however, many candidates had difficulty with it and there were some low scoring responses. There was often confusion between pumps and channels, the direction in which the different ions were moving and where one stage ends and the next one begins.

(a) The candidates were asked to outline how the resting potential from A to B is maintained. A number of candidates referred to the fact that a Na^+/K^+ pump was involved but failed to mention that it is an active process using ATP. The majority of candidates had the Na^+ being pumped out and the K^+ being pumped in, but a number had the ions going in the opposite directions. Very few mentioned the fact that the membrane is more leaky to K^+ than Na^+. A number of candidates referred to the inside of the axon being negative but made no comparison with the outside.

(b) In describing how depolarisation is brought about, many candidates gained full marks making reference to the opening of the Na^+ channels and the diffusion of Na^+ into the axon, bringing a change in potential across the membrane. However, a small number also had the K^+ channels opening and the K^+ diffusing out of the axon.

(c) Once again, there was some confusion as to which ion channels were open and which were closed. A number of candidates mentioned the restoring of the resting potential but relatively few mentioned the hyperpolarisation.

(d) Very few candidates made statements that were not comparisons. A small number appeared to be unfamiliar with this basic comparison. A common mistake was to refer to hormonal communication being via hormones, whilst the Examiners were looking for chemical versus electrical.

Question 3

Many candidates saw this question as a comparison between the two runners which it was not. This was not a high scoring question.

(a) Candidates were expected to describe the relationship between blood lactate concentration and relative workload for the distance runner, by describing the shape of the graph. Expected answers were reference to the fact that there was no increase below 40 arbitrary units and it was most rapid above 60 arbitrary units. Credit was also given for correct reference to figures. Many candidates made sweeping statements such as '*lactate increases with work load*' or '*lactate is proportional to workload*'. Some candidates appeared to be relating workload to the lactate concentration in terms of cause and effect. When graphs are given, candidates should be encouraged to quote figures.

(b) A number of candidates were able to state in detail the stages involved when describing how the lactate that appears in blood is formed. Reference being given to glycolysis, the pyruvate being converted to lactate in the presence of lactate dehydrogenase, and the pyruvate acting as a hydrogen acceptor. Few made reference to this taking place when there is a shortage of oxygen to the muscles. However, there were some candidates who seemed unaware of the chemistry of anaerobic respiration.

(c) The concept of the oxygen debt seemed to be unfamiliar to a large number of candidates. Some stated that the lactate provided oxygen, others that the accumulation of lactate was equivalent to the oxygen debt or that the lactate accumulation followed the development of an oxygen debt. Very few referred to the fact that the lactate must be oxidised and therefore extra oxygen would be required and that this is the oxygen debt.

(d) In suggesting why the build up of lactate occurs at a higher workload in the distance runner, many saw this as a comparative question and failed to refer to the onset of anaerobic respiration as a result of an insufficient oxygen supply.

Question 4

It was encouraging to see that a large number of candidates have a good knowledge and understanding of basic genetics. For many candidates this was a high scoring question.

(a) The majority of candidates were able to correctly state the genotypes of individuals **A** and **C**. However, a small number considered it to be sex linked and used '*X*' and '*Y*'.

(b) There were a small number of incomplete genetic diagrams, the main downfall was not linking the genotype and phenotype of the offspring obtained and therefore not identifying the individual with sickle cell anaemia. It would appear that a number of candidates do not understand the term 'probability' and gave a ratio.

Question 5

In general this was a low scoring question. A large number of candidates did not answer the question in the correct context, but made general comments on evolution and natural selection.

(a) The fact that they were desert pupfish mislead a number of candidates. They referred to the fact that they might have evolved to live on land with legs, lungs and even wings. Some explained how the four species would continue to survive, having not read the question carefully. Very few referred to geographic isolation/allopatric isolation preventing interbreeding and the lack of gene flow. Some candidates realised that the conditions would vary in the different pools and therefore different characteristics would be selected for in different pools.

(b) Not many candidates were able to describe how environmental factors can act as stabilising forces of natural selection in an isolated pool after the initial evolution of a new species. Very few mentioned the fact that the conditions remain the same within each pool, and gave the idea that the extreme phenotypes are selected against, therefore only those well adapted will survive.

(c) There appeared to be confusion between the possible fate of individuals and species. Few made reference to niche and competitive exclusion, the fact that different species may be restricted to different areas or to the fact that one species may be more adapted than all the other species.

Section B

Question 6 was the most popular, but both questions were relatively high scoring. The candidates appeared to have a good knowledge and understanding of these topics, especially Kreb's Cycle and the use of recombinant DNA technology.

Question 6

(a) A large number were able to describe in detail the main features of the Kreb's Cycle. Most candidates used a diagram plus a written account. If the information was clearly indicated on a diagram credit was given. However, some diagrams showed lack of arrows, including arrows to show the reduction of NAD/FAD and the formation of ATP. A number of candidates had difficulty in showing how acetyl CoA joins with oxaloacetate.

(b) This part was well answered by a large number of candidates referring to the fact that NAD is a coenzyme which carries electrons and protons from glycolysis and Kreb's Cycle to the electron transfer chain. It was realised that here it was reoxidised with the production of ATP.

Question 7

(a) The candidates were asked to describe the use of DNA technology in the synthesis of human insulin by bacteria. Several candidates lost marks by not referring to which RNA was being isolated and where it was being isolated from. Others mentioned the isolation of DNA and its insertion into bacteria which was incorrect. Other incorrect references were made to the bacteria being the vector and the use of the enzymes involved. Very few candidates referred to the method of insertion into the bacteria and the identification of the modified bacteria. However, there were some very detailed accounts of the process involved using mRNA coding for insulin from the beta cells of the islets of Langerhans in the pancreas.

(b) The candidates in general came up with at least four reasons as to why there was an advantage of treating diabetics with human insulin produced by genetic engineering. The most common answers referred to '*less risk of contamination*', '*less risk of allergic reaction*', '*fewer side effects*', '*reference to ethical reasons*', '*the fact that it is cheaper*' and '*it can be produced in large amounts*'.

Paper 9700/05

Practical 2

General comments

Even though the candidates seemed to find the paper slightly more difficult than last year, the quality of answers was high, with several candidates scoring well in excess of twenty out of a possible thirty marks.

The paper appeared to discriminate well between candidates but allowed all candidates to demonstrate their knowledge and practical skills.

There was some evidence that a few candidates did not carefully read the question and thus unnecessarily lost marks. Candidates would be well advised to read questions most carefully before starting to write their answer.

There was no evidence that candidates suffered due to a lack of time.

Comments on specific questions

Question 1

(a)(i) It was intended that this part should be a planning exercise based on a simple experiment. However, many candidates made life more difficult for themselves by extending the experiment into using different concentrations of the enzyme or using different temperatures or pH. Although this was not penalised in **(i)** it was in **(ii)**. Good answers referred to using specified volumes, adding iodine to the mixture at fixed time intervals and correctly identifying an end point. It was unusual for candidates to obtain full marks on this part, as there were several common errors. These included candidates not using constant volumes, or thinking that iodine once turned blue/black, would revert to brown once the starch had been hydrolised by the enzyme. It was pleasing to see that a large number of candidates correctly referred to repeating the experiment and obtaining a mean, and also included some idea of a control such as using a boiled enzyme.

(ii) In this part candidates suffered for failing the read the question carefully. If candidates chose to make the table unduly complicated because they extended the investigation in **(i)** they were limited to a maximum of two out of four marks. It was felt unfair to penalise the candidates in **(i)** because of the number of marks on offer. Good answers included data within the table, a heading that referred to complete hydrolysis and units such as minutes in the header of the table. It was surprising how often details such as these were missing with candidates simply writing data into unlabelled boxes. Another common error included candidates who had repeated the experiment to find a mean in part **(i)** but then failed to include this information in the table. This resulted in one of the four marks not being awarded.

(b)(i) Very few candidates failed to realise that the table in **(i)** needed to be completed. Most candidates gave the correct answer of 0.81 and correctly used this data in **(ii)**.

(ii) Generally graphs were well drawn and clearly plotted. Candidates who gave an incorrect answer in part **(i)** were not penalised in **(ii)** as long as they correctly plotted their incorrect data. Credit was given for axes that were correctly labelled, scaled and oriented, all the points plotted correctly and a line of best fit drawn. Most candidates scored full marks on this part.

(iii) This part produced a variety of responses. Good answers included reference to more enzyme molecules, giving more active sites, thus allowing more collisions. Better candidates went on to explain about limiting factors and why the graph was linear. Those candidates who simply referred to more enzyme substrate complexes were limited to two of the three marks.

(c) This should have been an easy end to the question, and simply required candidates to say that a constant temperature was required and then explain how they would achieve it e.g. use a water bath. However, all too often candidates referred to keeping the temperature within a range and this was not credited. More obscure methods of controlling temperature such as using thermostatic air conditioning were credited as long as they were feasible and would work.

Question 2

(a)(i) This part proved to be quite difficult for some candidates who reverted to known theoretical knowledge rather than what they could see through the microscope. Most candidates scored the first marking point, writing that the islets were paler pink than the surrounding tissue but then failed to consolidate their score by giving two other distinguishing features. Credit was given for noticing that the islets had slightly larger nuclei, that the islets were larger than other structures, or that the islets had an irregular shape or were less densely packed than other tissues.

(ii) Most candidates managed to score a mark by saying that different islets had different sizes. Credit was also given for correct reference to the shape of different islets or the number of cells that they contained.

(iii) This part was not well answered. Credit was given for candidates referring to the variation in size or shape but what was required was that candidates realise that the section may well have been taken at different orientations or different levels through the islets. Only the most able candidates scored these two marks. In order to facilitate candidates answering this question, credit was also given if candidates referred to the different ages or stages of maturity of the various islets.

(b) This part produced a wide range of different drawings. Many candidates failed to read the question and drew significantly more than five cells. All too often masses of cells were drawn that included much of the surrounding tissue. Good drawings included five cells, showing nuclei that were labelled, and with at least three of the cells touching one another. Good drawings of this standard should have been commonplace at this level. Yet again, evidence of drawing textbook diagrams from memory were all too common. Centres would be well advised to severely discourage this practice.

Paper 9700/06
Options

General comments

Once again ***Option 3*** *Growth, Development and Reproduction*, proved to be the most popular choice with candidates. A few Centres favoured ***Option 4*** *Applications of Genetics* or ***Option 1*** *Mammalian Physiology*, while Examiners marked very few of ***Option 2*** *Microbiology and Biotechnology*.

Examiners were pleased to see a number of high scoring scripts with good answers to the questions on most options. The paper contained questions able to discriminate well between candidates. As a result, candidates' marks were spread across most of the available range.

Candidates were, in many cases, well prepared and equipped with factual material that they could use when recall of information was required. There is a need, however, to stress the detail that is essential at this level and to read the question carefully to allow the selection of an appropriate response. Once again interpretation of data proved difficult for many. At times the obvious was not stated and lack of figures limited some otherwise good answers. Candidates should also be advised to check the information supplied by the stem of the question. This frequently is the key to the questions posed in the sub-sections of a question.

Comments on specific questions

Option 1

Mammalian Physiology

Question 1

(a)(i) While a few candidates confused the bipolar and ganglion cells, many correctly identified **A** to **D**.

(ii) Some candidates noted that this layer was pigmented and would prevent reflection in the eye by absorbing light that had passed through the retina. Very few noted that it supplied glucose or oxygen to the retina.

(iii) This part scored well for many candidates who understood that single cone cells were connected to single ganglion cells, keeping impulses separate, thus giving greater resolution. The pooling of the information from several rod cells similarly gained credit.

(b)(i) This proved very discriminating. Candidates had difficulty explaining that red and blue light stimulate different cone cells, so the brain interprets impulses from each one differently. Too often the different types of light were described in terms of different wavelengths, but without any reference to neurone or brain activity, insufficient to score any marks.

(ii) Many responses noted that there was only one type of rod cell and one type of pigment. This proved, however, to be a discriminating question as candidates failed to explain how this resulted in rod cells having only one type of response regardless of light colour.

(c)(i) Examiners expected candidates to state that this trait was sex linked and recessive but these marks were rarely given. Many did appreciate the differences in X Y chromosomes. They were, however, often unable to express clearly that the male lacks a second allele of the gene to mask the effect of the colour blind allele. Too many candidates used the term 'gene' inappropriately, when 'allele' was required.

(ii) Only a small number of candidates applied their knowledge realising that genes code for protein structure and therefore opsin would be the relevant part.

Question 2

(a) Very few candidates gained full marks here. The movement of the Z lines and the actin filaments were usually correctly shown but the diagram should have been drawn approximately the same size as the original to make a valid comparison.

(b) Good responses were provided here, the commonest weakness being the role played by ATP.

(c) The role of the triceps contracting was understood but its effect in extending the arm, thus pulling on the myofibril, was generally lacking.

Question 3

(a) Most calculated this correctly as 1.7 or 1.67 (%). Occasionally the responses were not adequately rounded up; neither 1.667 nor 1.66 being sufficient.

(b) Generally this was correct.

(c) Many scored marks for the role of hepatocytes and cholesterol but rarely were sodium ions mentioned, some candidates merely stating the names of bile salts. A common error was to confuse this with red blood cell breakdown.

(d) The emulsification of lipids often gained credit but further detail was usually muddled or absent. Their role, increasing the rate of digestion, was rarely clearly stated. Able candidates should refer to hydrophilic and hydrophobic groups and the dispersal of fat droplets into water as surface tension decreases.

Question 4

(a) The cerebellum's role in controlling balance was recognised but the co-ordination of precise movements or the learning of complex motor tasks was not. The roles of the medulla oblongata scored well.

(b)(i) This was well known.

(ii) Responses varied from good detail of the physical effects on neurones and acetylcholine secretion to very minimal ideas of the causes being both genetic and environmental.

Option 2

Microbiology and Biotechnology

Question 1

(a) A poor scoring part as candidates tended to answer vaguely in terms of bacteria and bacteriophage. The possibility of temperatures being favourable for pathogenic organisms needed to be discussed to gain credit.

(b)(i) Very limited responses were given. A few realised that at 10^{-6} plaques might overlap but most did not go beyond the idea of the large variation in numbers counted. Other possibilities, such as pipetting/diluting errors or greater statistical errors at higher dilutions, were not appreciated.

(ii) Candidates who understood the fundamentals of dilution plating calculated this as 1.32×10^8.

(c) Despite the simple numbers involved, low or no marks were commonly scored here. Candidates failed to understand that there were no deaths until after day two or to observe that the fastest death rate was between day four and day six. Quoting figures correctly would also have scored.

(d)(i) Many candidates stated that a disease was transmitted from one organism to another but failed to note the involvement of a pathogen. Some responses scored a detail mark for transmission methods or causative agents.

(ii) Poor responses here. References to laminar flow cabinets and smooth working surfaces were made but many answers described aseptic techniques rather than *structural* features.

Question 2

(a) Generally well answered, only the cell wall material causing some difficulty.

(b) Well prepared candidates realised that the bacteriophage needed a host cell for replication or appropriately noted the presence or absence of binary fission. The absence of enzymes or protein synthesis in phages or the presence of a prophage stage was rarely mentioned.

(c) The standard of drawing was generally poor. Some complex copies of text book diagrams were unsuccessfully attempted. Candidates should show the differences clearly on a simple diagram, indicating a thinner peptidoglycan layer and the extra lipopolysaccharide/lipoprotein layer outside.

Question 3

(a) Candidates familiar with the fusion of myeloma cells and lymphocytes scored well. Note that a *specific* antigen stimulates the lymphocyte production. The cloning of the antibody producing cells and their large scale production was rarely mentioned.

(b) Responses were often imprecise. Some stated that the radioactive molecule might kill cells but the attachment of the antibody to the target antigen was rarely stated clearly or that this was a method of finding the target.

(c) This scored well.

Question 4

(a) Most candidates could describe the differences in these methods.

(b) Candidates did not seem to appreciate that the number of resistant bacteria would have increased in response to selective pressures. Marks gained were usually for a valid point re. social changes.

(c) Marks were scored for the production being very low when no sugar was present and higher with lower sugar levels. Candidates must be encouraged to quote figures and comment on features of graphs, such as the similarity in production for the first four to five days or a comparison of the gradients for the different sugar levels between days seven and nine.

Option 3

Growth, Development and Reproduction

Question 1

(a) Examiners were disappointed by responses. Some candidates referred to enzyme involvement in the sperm's path through the follicle cells and the zona pellucida, but detail was frequently insufficient for this level. More detail was needed of the acrosome and cortical reactions, with male and female *nuclei* fusing, not simply sperm and ovum fusing.

(b) The key to this part, 'protein ion channel' in the stem, was missed by most, so insufficient detail of how a mutation led to a different non-functional protein was given. Examiners were expecting references to changes in DNA bases, coding for different amino acids, hence different protein tertiary structure and R groups and a non-functional channel.

(c)(i) Responses did not always state the obvious. Just 'fertilisation in a lab' was not sufficient to score and rarely was extra detail such as sterile/nutrient medium given.

(ii) This scored well. Good responses were often seen, accompanied by figures. Poorer answers wasted time comparing the sperm movement rates.

(iii) Better responses noted differences in the rate of movement but comparative figures were rare. Very few candidates linked the lack of ion channel to the sperms' ability to swim fast.

Question 2

(a) Many candidates gained both marks for a clear definition, but the fact that it is an increase in *dry* mass should be noted.

(b)(i) Usually 0.05 was calculated correctly. The commonest error was to use 751 as the starting figure.

(ii) Most gained credit for the decrease over time and the constant rate after 70 y, with appropriate figures. A few responses referred to the decrease slowing with age.

(iii) Weaker candidates chose the wrong parameters, but many correct responses were seen.

Question 3

(a)(i) Some confused **A** with **D** and it should be noted that **C** is a result of two nuclei having fused.

(ii) High scoring for most candidates.

(b) This discriminated well. Few responses clearly stated that the DNA content of **E** and **F** were the always the same or that the DNA of **F** appeared diploid rather than triploid after fertilisation. Rarely was it stated that there was no information about the other two nuclei.

Question 4

(a)(i) Water, oxygen and a suitable temperature were usually stated. Light needed qualifying, as it is not a general requirement. A surprising number of candidates gave different conditions for each stage.

(ii) Most could gain two marks here.

(iii) The action of gibberellin was generally well known. Some confusion with auxin was evident.

Option 4

Applications of Genetics

Question 1

(a) See ***Option 3*** **Question 1 (b)**.

(b)(i) See ***Option 3*** **Question 1 (c)(i)**.

(ii) See ***Option 3*** **Question 1 (c)(ii)**.

(iii) See ***Option 3*** **Question 1 (c)(iii)**.

(c)(i) Few candidates explained this in terms of the principals of electrophoresis, so marks were rarely awarded.

(ii) Some responses gained credit for the bands having come one from **A** and one from **C** but a second mark was rarely given for the heterozygote having both alleles or both lengths of DNA.

Question 2

(a) Selective breeding methods should be well known. Few details of practical methods were given and at times a lack of clarity between non-sticky hybrids and F1 hybrids occurred. Repeating over several generations gained credit but the selection of both sticky rice and resistant characteristics was frequently omitted.

(b)(i)(ii) Often it was unclear whether a response referred to the rice or the fungus. The difference in **(i)** was due to the distance between plants affecting spore filtration, together with the degree of resistance in each type of plant. In **(ii)** candidates failed to appreciate that monoculture selected a few suitable genotypes of fungus, this selection not occurring in mixed planting.

Question 3

(a) Reasons for seed banks were well known. A point frequently omitted was the storage of alleles.

(b) Good responses here.

(c) Candidates were aware of the need to check the seeds viability, by testing every five years and growing when germination fell below 85%.

Question 4

(a) Examiners were pleased to see many candidates able to describe trisomy 21 and its causes.

(b) Some candidates confused this with pedigree analysis. Responses should have concentrated on the detection of either the genetic disease or the genotype that causes it.

(c)(i) Generally correctly calculated as 53%.

(ii) While responses noted that **D** was the most successful, few attempted more detailed comparison of the data using figures. As a result the low success rate of all the tests was rarely noticed.

(iii) It was appreciated that the use of more than one test at a time would increase the %.