BIOLOGY

GCE Advanced Level and GCE Advanced Subsidiary Level

Paper 9700/01
Multiple Choice

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

General comments

Scores showed a satisfactory spread around the mean of 25.5 (63.75%), the standard deviation being 5.9. There was a good range of question facility. The easiest items, where 80% of candidates or more answered correctly were **Questions 1**, **2**, **9**, **22**, **28**, **29** and **35**. The most difficult ones, answered correctly by 40% or fewer were **Questions 10**, **13**, **24**, **33** and **34**.

Comments on specific questions

Question 4

While this presented no difficulty for the more able, option **B** was popular among weaker candidates.

Question 6

Options **C** and **D** were the most popular but the choice of the correct one, **C**, depended on knowing whether endocytosis is an active or a passive process. Candidates were expected to approach this as a problem to be solved by considering, for instance, whether endocytosis is likely to be carried out by metabolically inactive cells. Many of the more able guessed that endocytosis is passive, so reducing the discrimination of the question.

Question 10

Candidates found this to be a very difficult question. Weaker candidates, in particular, confused glycogen with glycerol and chose option **A**, while many of the more able chose option **B**. This indicates poor comprehension of the term 'saturated'.

Question 13

Candidates answered this question less well than expected. It was not anticipated that this question would be so difficult. The word 'why' may have led many candidates to look for a purpose rather than a cause.

Question 14

Surprisingly many of the more able candidates chose option **C**. At *X*, product is being formed at a rapid rate, so it is unlikely that the number of enzyme-substrate complexes is low.

Question 15

Weaker candidates were able to identify the correct answer almost as frequently as those who achieved a higher overall score, leading to low discrimination. Options **C** and **D** attracted too many of the better candidates.

Question 22

The role of lignin in strengthening xylem vessels was very well known.

Question 24

This was a test of the ability to interpret dissociation curves. Only candidates with the highest overall scores were able to do so. Most of the remainder guessed at the answer.

Question 28

The function of goblet cells was very well known.

Question 33

This question tested section J(e) of the syllabus. It proved difficult, requiring either specific knowledge, or the ability to evaluate the likelihood of the truth of each option.

Question 34

This was another question which again, could be answered either by having specific knowledge, or by application of related knowledge. The popularity of option **C** shows that more candidates adopted the second approach and perhaps supposed that the treatment described was a form of gene therapy.

Paper 9700/02

Theory 1

General comments

There were many excellent answers to all 6 questions especially **Question 5** from the well prepared candidates though disappointingly there were some very low scores and even the more able candidates occasionally had some difficulty with **Questions 1**, **3 (a)(iii)**, **3 (b)**, **4 (b)**, **4 (c)** and **6 (a)(ii)**.

Candidates often lost marks by not using their knowledge to answer the question set. For example, in **Question 3 (b)**, where candidates were asked to explain, in terms of protein structure, how it is possible for each type of T cell receptor to bind specifically to one type of antigen, more than a few simply described the general structure of proteins or enzymes or did not refer at all to protein structure in their answers. Again, in answer to **Question 2 (d)**, many candidates described the results they would expect rather than how they would use the apparatus to investigate the effect of changing substrate concentration. Other candidates were far too imprecise in their answers. For example, in **Question 1 (c)**, statements such as "DNA replicates by using half of the original strand" were far too common.

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

Comments on specific questions

Question 1

Overall a disappointing standard of response.

(a) Most candidates correctly indicated with the letter M one stage where mitosis occurred in the life cycle of the brown seaweed, inserting M on equal occasions between the zygote and the young seaweed or between the young seaweed and adult stages. A significant number of candidates incorrectly placed M on the arrows from gametes to zygote.

(b) Many candidates could not however explain clearly why it is important that DNA replication occurs in cells during interphase prior to division by mitosis. Examiners expected answers in terms of enabling each chromosome to contain two identical chromatids so that the daughter cells can receive a copy of each chromosome. A considerable number of candidates simply referred to ensuring that daughter cells received the same number of chromosomes rather than an exact copy of the parental cell's DNA.

(c) The best candidates were able to explain semi-conservative replication of DNA by reference to each strand acting as a template for the formation of a complementary strand of nucleotides, though some candidates thought that only one of the two strands of DNA acts as a template. Many more simply, though correctly, stated that the new DNA had an old and a new strand. Several candidates were unable to express themselves clearly, for example, "half of the old DNA is carried over to the new cell", and lost the mark. Some confused DNA replication with transcription.

(d) A significant number of candidates had difficulty in explaining why meiosis occurs in the life cycle of the seaweed. Though many used the terms gametes and zygote in their answers, they failed to link these terms correctly with haploid and diploid. Only the more able candidates understood the need to keep the chromosome number the same from generation to generation. Few referred to reduction division in their answers.

Question 2

The standard of response was generally good though answers to **(d)** were frequently disappointing.

(a) Many candidates correctly explained why the total volume of gas collected after 210 seconds remained constant in terms of the hydrogen peroxide having all been used up. A considerable number however referred incorrectly to the saturation of the active sites of the enzyme catalase.

(b) It was not uncommon to find candidates who were unable to correctly sketch, on fig. 2.2, a curve below that given for 20°C, reaching the same plateau at around 150 seconds or heading for it, to indicate the expected result of the experiment if repeated at 10°C. Graphs often showed lines plateauing out below the 20°C curve, straight line graphs or lines reaching the 20°C plateau far too early. These were not given credit.

(c) The vast majority of candidates, and in great detail, were able to describe and explain the results expected if a pre-treated sample of catalase solution, kept at 70°C in a water bath, was added to the hydrogen peroxide. The best answers referred to no reaction/no O_2 evolved due to the denaturation of the enzyme with appropriate reference to loss of tertiary structure, hydrogen/ionic bonds breaking, the substrate no longer fitting the active site. Most understood that disulphide bonds would not break at this temperature. Surprisingly many candidates thought that 70°C would not denature the enzyme but would speed up the reaction. It is clear that many candidates had not taken note of the fact stated that the catalase solution was pre-treated in a water bath at 70°C and thought the reaction occurred at 70°C.

(d) This part of the question caused some difficulty with only the most able candidates fully explaining how they would use the same apparatus to investigate the effect of changing substrate concentration on catalase activity. Many candidates did make suitable reference to repeating the procedure using different concentrations of hydrogen peroxide, often giving extra detail of the range and relative concentration of the solutions to be used. They also appreciated the need for keeping the temperature/pH and enzyme concentration constant. Disappointingly few made appropriate reference to using fresh solutions of catalase each time, the need for repeat readings at each concentration or any understanding of the need to calculate *initial* rate and the method employed (e.g. vol. in 15 secs./gradient). Weaker responses interchanged "amount" and "concentration" and often included a theoretical description of the result of changing the substrate concentration rather than details of how they would actually carry out the investigation.

Question 3

There were some good quality answers to the question though parts **(a)(iii)** and **(b)** proved difficult for many.

(a)(i) By far the majority of candidates correctly named the molecule labelled **A** as a Phospholipid. Some common errors included additional reference to layer or bilayer.

(ii) Most of the above candidates went on to clearly describe the phospholipid structure in terms of glycerol, 2 fatty acid/hydrocarbon tails/chains and phosphate. A significant number omitted glycerol, insisted on using the word molecule after each of the above components and disappointingly many incorrectly described the properties of phospholipids using words such as hydrophilic and hydrophobic, polar and non polar with appropriate reference to orientation.

(iii) In explaining why membranes are described as *fluid mosaic* in structure, few convincingly referred to phospholipids being fluid/moving about/diffusing in their own monolayer or made suitable reference to the pattern and arrangement of protein as they floated/moved about in this fluid. Many weaker responses made reference to cholesterol being responsible for the fluidity of the membrane or gave a long list of component molecules floating around as a mosaic in a liquid membrane.

(b) This part of the question proved difficult for many with only the most able explaining in terms of protein structure how it is possible for each type of T cell receptor to bind specifically to one type of antigen. Examiners looked for some reference to a variable region (seldom mentioned) due to differences in sequences of amino acids and tertiary structure, being complementary in shape to a specific antigen. It was pleasing to see some candidates making appropriate reference to R groups in their explanation. Many weaker responses however included a general description of protein structure from primary to quaternary and/or description of enzymes with active sites and frequent mention of "lock and key".

Question 4

There were some good quality answers to this question though part (c) was challenging to many.

(a) Those candidates who recognised the phase of the cardiac cycle shown in Fig. 4.1 were able to give a full description of the events involved in terms of ventricular systole, blood forced into the aorta through the open semi-lunar valve with the atrioventricular valve being closed. Some candidates surprisingly started their response with blood being oxygenated in the lungs and others disappointingly made inappropriate reference to right atrium, tricuspid valve and even the venae cavae in their answers.

(b) Good candidates were able to explain in terms of unidirectional valves how backflow of blood was prevented to ensure that blood flows from the pulmonary vein to the aorta and not in the reverse direction. Many, but not all, referred appropriately to atrial and ventricular systole, opening and closing of bicuspid and semi-lunar valves and pressure differences in their explanation. Few made any suitable reference to the role of tendons and papillary muscles in preventing reverse flow. Weaker candidates had semi-lunar valve between the left atrium and ventricle, had blood flowing between the left ventricle and the right hand side of the heart and referred to the tricuspid valve. For many "valves prevent backflow" was their only contribution.

(c) Only the most able explained that the pressure falls to zero in the left ventricle because all the blood is expelled on contraction and even fewer gave a suitably qualified explanation of the role of *smooth* muscles and *elastic* fibres (e.g. elastic recoil) in explaining why the lowest pressure recorded in the arteries is about 10kPa. Very few references were made to the contribution of the narrow diameter of the capillaries/arterioles/small arteries, beyond the main arteries, in terms of resistance to flow. Weaker responses simply referred to muscles and stretching of arterial walls and even the need for pressure to be maintained in the system to deliver blood to the tissues.

(d) The more knowledgeable candidates could precisely and clearly describe how nicotine, through constricting blood vessels and raising blood pressure/heart rate, causing blood platelets to become 'sticky' and forming a blockage/clot and with carbon monoxide, another ingredient of 'smoke', damaging the endothelium of arteries, greatly increased the risk of atherosclerosis. They were able to briefly describe atherosclerosis in terms of atheroma/fatty plaques and further explain the reduced oxygen transport due to carbon monoxide levels in the blood, all in terms of coronary heart disease and stroke. Weaker responses were characterised by unspecific reference to the effect of smoke, simply stating the term atherosclerosis, interchanging words such as thrombus, atheroma and clot, giving details of carbon monoxide combining with haemoglobin without stating this reduced oxygen transport and even giving an explanation of the effect of tar in the lungs.

Question 5

There were many excellent clear, explicit and precise answers to both parts **(a)** and **(b)** but especially to **(a)**. Weaker responses were often vague and general in character.

(a) A large number of candidates were able to clearly distinguish between drug tolerance and physical dependence, describing the former in terms of decreased response, more having to be taken to achieve the same effect and occasionally mentioning increased rate of metabolism and decreased sensitivity of receptors in their answers. Physical dependence was explained in terms of the body not being able to function without the drug, the drug becoming part of metabolism and suitable reference to withdrawal symptoms. Weaker responses included vague statements regarding persons not being able to live/work without a drug.

(b) In describing the long term changes in the liver due to regular alcohol consumption, weaker candidates generally described change to the liver in terms of carrying out its functions. Many able candidates referred specifically and clearly to fatty liver, liver cells dying and being replaced with fibrous tissue/collagen leading to hard nodules and cirrhosis. Liver cancer was occasionally mentioned. Those candidates who referred to hepatitis did not always link it with inflammation of the liver or stated it was caused by Hepatitis B.

Question 6

There were few maximum scores to this question, largely due to inappropriate responses in part **(ii)**.

(a)(i) Most candidates had no difficulty in naming the processes **A**, **B** and **C** as nitrogen fixation, nitrification and denitrification respectively. Where there were errors this often involved incorrect linkage between the letters and the above processes.

(ii) In explaining how a farmer maintains the fertility of the soil without using nitrogen fertiliser, only the very best candidates made suitable reference to the ploughing in of green manure/compost and similar organic material and occasionally went on to describe decay leading to the release of ammonium (ions)/nitrates. The use of crop rotation and the growing of legumes for nitrogen fixation were frequently mentioned and more occasionally improved aeration/draining of waterlogged soils (in the context of favouring nitrification/nitrogen fixation and reducing denitrification). Weaker candidates did not plough in the organic matter, simply referred to the growing of legumes and had nitrifying bacteria rather than nitrogen-fixing bacteria in the root nodules.

Paper 9700/03

Practical 1

General comments

- The quality of answers was very high from many Centres with several candidates scoring well in excess of 20 marks out of a possible 25.
- The paper appeared to discriminate well between candidates but allowed all candidates to demonstrate their knowledge and practical skills.
- As a general principle, some candidates are failing to realise that a 4 mark question usually requires a four point answer. The number in square brackets is a very useful piece of information. Candidates would be well advised to take this information into account when writing their answer.
- There was no evidence of a lack of time.

Comments on specific questions

Question 1

This was answered well by many candidates. However several lost marks by failing to indicate the units used, in the left hand column. Candidates should be advised not to enter units in each cell of the table, but rather in the cells that carry the labels. Most calculations in the table were performed correctly but some candidates lost marks for poor mathematical skills.

Many candidates successfully completed the correct order for the solutions in Table 1.2. This was used as a check to determine the accuracy of the candidate's practical skills when carrying out the experiment. It was pleasing to see how many candidates performed the practical element correctly.

Most candidates scored full marks on the graph by correctly labelling and orienting the axis. Points were well plotted, but all too often candidates failed to use a 'line of best fit'. Those candidates who performed the practical correctly had little problem with part **(iv)** but far too many lost the mark by failing to use the units. Part **(v)** proved a much harder question. Most candidates thought that there would be no movement of water. Only more able candidates realised that there would be no 'net movement' and that a state of equilibrium existed.

Part **(b)** was well answered with a variety of correct responses allowed. Only those candidates who repeated what they should have done in the experiment, rather than improve it, failed to score.

Question 2

The quality of drawings varied considerably. Many failed to realise that a plan drawing had been asked for and details of individual cells, was not required. Clear lines and correct labelling was required to score marks. Too many candidates drew and labelled from memory rather than what they could see on the slide. Credit was not given to candidates who labelled structures that they could not possibly see but who had remembered the structure from a theory lesson. Candidates should be told that this is a practical exam, not a theory one. However many candidates scored full marks and produced some excellent drawings.

In part **(b)** many scored full marks for measuring the drawing and dividing their answer by the size of the specimen on the slide. Those candidates who used the magnification on the microscope lenses failed to score. Candidates would be well advised to estimate the magnification before calculating it. This would prevent them from writing down totally impossible answers because of mistakes in their calculation.

Part **(c)** was well answered by many, but all too often candidates used theoretical knowledge, rather than what they could see under the microscope. Good observational skills were required with the correct interpretation. More able candidates scored well on this question.

Paper 9700/04

Theory 2

General comments

This paper allowed good discrimination between the candidates, they were spread across the whole range of the paper. There were sufficient marking points to allow candidates to demonstrate their ability and the candidates appeared to have sufficient time to complete the paper. The overall performance of the candidates was highly variable. Some candidates produced responses of a high quality whilst others had very little markable knowledge, some omitted large parts of questions.

Comments on specific questions

Question 1

There were some very good responses to this question. The majority of candidates having a good understanding of photosynthesis.

(a) Thylakoid was commonly given but only a small proportion managed to refer to grana. Some candidates made vague reference to the membranes of the chloroplast.

(b) Most candidates scored full marks. Source of energy and the excitation of the electrons were the most common answers. Some confused NAD with NADP, and water splitting was used rather than photolysis.

(c) There were some excellent answers to this section, candidates having a very good understanding of cyclic photophosphorylation and non-cyclic photophosphorylation. Better candidates were able to distinguish between the electron pathways for both, and described photolysis and NADP production. However many candidates gave muddled and confused answers. Many appeared to forget which process they were talking about.

(d) Very few candidates scored well on what was a straightforward question, no reference being given to the fact that paraquat can be used to kill weeds around growing crops. A lot of candidates referred to gene therapy and selective breeding.

Question 2

Many candidates had difficulty in answering this question. There were several unattempted sections. It was apparent that a number of candidates were not familiar with a respirometer and its use in measuring O_2 uptake and RQ values.

(a) In defining the term respiratory quotient there was often a lack of precision, there being no mention of the ratio of volume/moles/amount of carbon dioxide evolved to volume of oxygen absorbed in respiration. A small number of candidates got the relationship reversed.

(b) In explaining the significance of the different values of RQ that may be obtained, many candidates scored full marks. Reference being made to different substrates and the RQ values being given for carbohydrates, lipids and proteins. However there were some vague and incorrect answers, with reference being made to comparison between different respiration rates in different organisms. Very few candidates managed to relate RQ to aerobic and anaerobic respiration.

(c) Many candidates were not able to outline how the apparatus is used to measure the rate of oxygen uptake by a known mass of seeds. Those candidates familiar with the apparatus were able to score full marks. Many candidates made no reference to a change in level in the manometer in a set period of time, nor to the fact that the boiled seeds acted as a control. Very few stated how the rate would be calculated. A number of candidates merely referred to the fact that the soda lime absorbs the carbon dioxide.

(d) Very few candidates scored full marks in explaining how the apparatus could be modified to measure the RQ of the germinating seeds. A large number mentioned the removal of soda lime but gave no further details.

(e) The candidates were asked to explain why an increase in temperature from 15° C to 25 ° C will increase the rate of oxygen uptake in germinating seeds. This was poorly answered with many not being able to relate respiration to the activity of enzymes. They also did not give any relevant detail about the effect of temperature increase on enzyme activity. No mention was made of more kinetic energy, increased collisions nor to more substrate molecules with activation energy.

Question 3

There were some disappointing answers to this question but on the other hand there were some good responses.

(a) Candidates were asked to explain how charged ions are able to pass across membranes of nerve cells. Channels, gates and pumps were commonly given along with a lot of physiological knowledge.

(b) In describing the role of Na^+ along a nerve cell the good candidates made reference to the influx of the ions resulting in the depolarisation of the membrane. Few referred to the setting up of the action potential. Some incorrect answers stated that the ions were actively pumped into the cell or that they moved out of the cell. In describing the role of K^+ reference was made to the ions passing outwards resulting in depolarisation.

Many weaker candidates confused the direction of movement of the ions and incorrectly referred to depolarisation and polarisation.

(c) The candidates were asked to describe the function of the myelin sheath. Insulation, saltatory conduction and increased speed of transmission were all favourite answers. Few candidates referred to the fact that an action potential can only be fired at a node of Ranvier. Some thought that the sheath was used for protection.

(d) In suggesting how the intensity of a stimulus can be passed along a single nerve cell very few candidates mentioned frequency and many simply referred to the all or nothing law and threshold levels.

Question 4

There were some very good answers to this question but there were a number of candidates who were confused and did not appear to understand the functioning of the kidney tubule and its associated blood system.

(a)(i) In describing the function of the glomerulus most candidates scored with reference to ultrafiltration but failed to state what was passing into the glomerular filtrate. Very few candidates mentioned the fact that plasma proteins and blood cells were too large to pass into the filtrate.

(ii) The majority of candidates made reference to the reabsorption of substances from the proximal convoluted tubule into the blood stream. However no reference was made to the types of substances being absorbed.

(iii) Many candidates were confused as to the role of the vasa recta. Many vague answers made reference to the reabsorption of mineral salts. Very few candidates made reference to the removal of water which had been removed from the collecting duct nor to the maintenance of a water potential in the medulla.

(b) The candidates were asked to explain the role of the collecting duct in controlling the water contents of body fluids. Many knew that ADH was involved but did not relate this in any sensible content. The variability of the permeability of the collecting duct was frequently given but most candidates did not relate this to the different water potential of the blood and the need to reabsorb different amounts of water.

(c) Candidates appeared to be well acquainted with the disadvantages of the use of dialysis machines in treating kidney failure. Favourite answers were time, cost and infection.

Question 5

(a) This was a standard dihybrid cross but a number of candidates failed to score. Even the good candidates often failed to relate genotype to phenotype to score full marks. Even though appropriate symbols were given a number of candidates used different symbols and therefore were penalised.

(b) Whilst many answers quoted wrinkled green as being homozygous recessive and yellow round being heterozygous very few stated that homozygous dominant breed true.

(c) Many candidates could use the table to achieve a correct score for probability but could not go on to explain it. A large number of candidates appeared to be unfamiliar with the chi-squared test.

Paper 9700/05

Practical 2

General comments

- The quality of answers was very high from many Centres with several candidates scoring well in excess of 25 marks out of a possible 30.
- The paper appeared to discriminate well between candidates but allowed all candidates to demonstrate their knowledge and practical skills.
- As a general principle, some candidates are failing to realise that a 4 mark question usually requires a four point answer. The number in square brackets is a very useful piece of information. Candidates would be well advised to take this information into account when writing their answer.
- There was no evidence of a lack of time.

Comments on specific questions

Question 1

The quality of drawings varied considerably. Many failed to realise that a plan drawing had been asked for and that details of individual cells, was not required. Clear lines and correct labelling was required to score marks, with main areas of the leaf indicated. Marks were awarded for correct use of scale when comparing the size of different parts of the leaf. Too many candidates failed to read the question and drew a full leaf showing the midrib.

In part **(ii)**, several candidates again failed to read the question and drew many more than three cells. Many candidates labelled the cells from memory and not from what they could see under the microscope. Credit was only allowed for observable features. However there were some excellent drawings from several candidates and because there were several marking points, many candidates scored full marks.

Part **(b)** was well answered by many. The features that scored marks had to be observable ones and many candidates correctly identified both feature and function. However those candidates who simply stated that the feature reduced water loss, failed to score. Some further detail was required to explain how the water loss was prevented. Part **(ii)** was well answered with most candidates realising that a reduction in surface area would mean less light being absorbed by the plant for photosynthesis.

Question 2

Part **(a)** discriminated well between more able and weaker candidates. Many gave too simple an explanation of how they would carry out the experiment and even though there were many marking points, failed to score more than a couple of marks. Clear and logical answers, that referred to how to set up the apparatus, what measurements to take, and how often, scored full marks. It was clear that some candidates were more familiar with practical procedures than others. Some candidates required more room for writing. This should not have been the case if the candidate had written short bullet points. However if candidates do require extra space, they would be well advised to write clearly. All too often the writing was scattered across every available space and made accurate marking very difficult. Although every attempt is made to credit correct answers, candidates are not helping themselves when this happens.

Part **(b)** usually scored at least one mark. More able candidates realised that two marks were available and gave two examples of variables to control.

Part **(c)** indicated yet again that too many candidates fail to read the question fully. The answer required reference to light intensity and gas production. However several candidates used this to explain everything they knew about photosynthesis and failed to score many marks. More able candidates gave a correct relationship and then scored full marks by giving a clear explanation. Correct reference to the inverse square law and limiting factors, all scored marks.

Paper 9700/06
Options

General comments

Of the four options, by far the most popular was ***Option 3***, Growth, Development and Reproduction, followed by ***Option 4***, Applications of Genetics. Fewer candidates answered ***Options 1*** or ***2***, with rather more attempting the Biodiversity than the Biotechnology.

The general standard suggested that many candidates did not find this paper to be easy. Certainly, some questions were found to be quite difficult and, in some cases, it was evident from the answers given that candidates had not entirely understood what was being asked.

Comments on specific questions

Option 1 - Biodiversity

Question 1

(a) The majority of candidates were able to make a correct identification of the three phyla illustrated, though they were not always able to provide a correct diagnostic feature. That said, it was not uncommon for 3 marks to be gained in this section.

(b)(i) This was generally answered quite well. However, it was difficult to credit some answers because an appropriate *comparison* had not been made. The most frequently encountered correct answers were coelom v no coelom, triploblastic v diploblastic and bilaterally v radially symmetrical.

(ii) Marks were often picked up here for correct descriptions of the roles of the chaetae and the coelom (acting as a hydrostatic skeleton). Good answers also included descriptions of the roles of the longitudinal and circular muscles, working antagonistically. Answers often fell short when it came to describing how *segments* of the worm will alternately shorten and thicken, propelling the worm forward – many answers suggested incorrectly that this happens to the whole worm.

(c)(i) Candidates were often credited for suggesting that earthworms mostly eat organic material/humus/dead leaves. Very occasionally, better answers made reference to the role of the prostomium and/or the muscular pharynx in the ingestion of food.

(ii) Few, if any, good answers were seen in this section. It was rarely pointed out that earthworms will feed selectively i.e. they will not eat all of the soil. This means that the calcium, magnesium and carbon will mostly come from the leaves that have been consumed. Further credit could also have been gained by pointing out that the calcium will be derived from calcium pectate, the magnesium from chlorophyll and the carbon from a variety of organic compounds. Rarely did candidates suggest that the worms might bring up leached material from layers of the soil below 15 cm.

Question 2

(a) Generally well answered, with 2 or 3 marks being common. Many candidates knew that deforestation occurs to provide land for housing, road building and agriculture. Also, to provide wood for building purposes or export.

(b)(i) It was often realised that mortality rates were always greater at the edge of the forest fragments, compared with the interior. Also that it was the trees with a diameter greater than 60 cm that were most affected. A further mark could also have been gained for pointing out that, up to a diameter of 60 cm, the percentage increase in mortality was fairly uniform. Rarely were figures quoted from the bar chart in support of the conclusions given.

(ii) Generally, this was not well answered. The majority of candidates thought that the only plausible explanations were related to selective logging activities. Whilst credit could have been gained for suggesting that logging activities might have been responsible for some damage, it was rarely appreciated that the main reasons would be the exposed conditions at the edge of the forest fragments i.e. increased likelihood of wind damage (especially the larger trees) together with more chance of soil erosion and nutrient loss.

(c)(i) Some candidates were able to point out that, clearly, there were fewer seedlings in the smaller areas and that, in both the 100 ha and 10 ha areas there were greater numbers of seedlings at the interior than at either the edges or corners of the fragments. Few answers included any attempt to compare the 100 ha and 10 ha fragments in terms of the mean numbers of seedlings at the interior, edges and corners.

(ii) Marks were rarely secured in this section. Most candidates failed to realise that there would be more edge in the smaller fragments of forest. Hence, more trees would be lost from these, especially the larger trees, which would be responsible for producing the most seeds. Equally, few pointed out that the conditions at the edges would be less suitable for the survival of seedlings i.e. drier soil, greater rate of transpiration, more likely to be eaten as seeds or seedlings.

(d) Again, few scripts gained much credit here. The results would suggest that, as smaller fragments have fewer seedlings, it would be best if fragments of rainforest were as large as possible to conserve biodiversity.

Question 3

Of the candidates who answered this option, it was not evident that either **3(a)** or **3(b)** was more popular than the other.

(a)(i) There were some good answers to this section – clearly many candidates were well able to make a comparison between a prokaryote and a eukaryote, with specific reference to E.coli and Paramecium. Several scripts included good diagrams of each cell, though, unless a valid comparison had been made, these were often difficult to credit.

The most frequently made comparisons were with reference to their nuclei and DNA, the size of ribosomes and the presence or absence of membrane-bound organelles, a cell wall, cilia, plasmids and contractile vacuoles. Credit could also have been gained for discussing the presence of an oral groove and food vacuoles in Paramecium, but not in E.coli.

(ii) In this section, marks were awarded for discussing a suitable biotechnological use of bacteria, the correct name of the bacterium used and some further relevant detail. Good answers included the use of *Streptococcus* and *Lactobacillus* in cheese and yoghurt production, *Agrobaterium tumefaciens* as a vector to insert genes into plant cells and *Acetobacter* in vinegar production. Others included the role of genetically engineered bacteria in producing, for example, insulin and human growth hormone, of thermophilic bacteria as a source of enzymes for washing powders and the use of *Bacillus thuringiensis* as an insecticide.

(iii) This section was marked in a similar way the section **(ii)**. The answers which most commonly picked up credit were the use of *Saccharomyces* in alcoholic fermentation to produce alcoholic beverages and gasohol, together with its role in the baking industry. Other named fungi that were included in answers were *Penicillium* and *Streptomyces* in antibiotic production and *Fusarium* in the production of non-meat protein.

Some candidates were somewhat confused between bacteria and fungi, which made it difficult for them to gain many marks in sections **(ii)** and **(iii)**.

(b)(i) Generally, those candidates who attempted this question knew about bryophytes and filicinophytes. Structural differences were well known and marks were picked up for distinguishing between their vascular tissues and their types of roots (the rhizoids of bryophytes were sometimes, incorrectly, referred to as 'rhizomes'), stems and leaves.

Marking points that were rarely included were the absence of stomata in bryophytes and details of the sporangia of filicinophytes or the capsules of bryophytes.

(ii) Many candidates appreciated that bryophytes are not well adapted to life on land, though they found it more difficult to discuss many features to substantiate this. Those most commonly stated were the absence of a cuticle (and the associated problems with water retention) and the fact that they need water for sperm to be able to swim in the fertilisation process.

Further points that could have been made were a poorly developed water transport system and the absence of lignin (so they rely entirely on turgor pressure for support).

(iii) One or two candidates appeared to mis-read this question and went on to describe the adaptations of filicinophytes, rather than coniferophytes. However, those who answered it correctly did realise that coniferophytes are well adapted to life on land and were able to provide a reasonable amount of evidence to back this up. This often included the presence of well-developed vascular tissue for efficient water transport and the presence of lignified tracheids to provide support. Some answers made reference to the possession of true roots, adapted to provide anchorage and the uptake of water, together with leaves having a cuticle and shape to reduce water loss. Aspects of reproduction were often included – wind pollination and a method of fertilisation in which the gametes do not have to swim and do not, therefore, rely on wet conditions. Also, the wind dispersal of seeds and the dormancy of seeds through cold or dry conditions. Clearly, there were many ways of picking up the marks in this section and better candidates made an ample number of relevant points.

Option 2 – Biotechnology

Given that this was the least popular option, by far, the following remarks are based only on a small number of scripts.

Question 1

(a) Most answers included a correctly named organism involved in fermentation (usually *Saccharomyces cerevisiae*) and described the process as anaerobic fermentation. Few, however, pointed out that the starch would need to be hydrolysed into a suitable sugar (e.g. maltose) and that to produce alcohol with a reasonable degree of efficiency, conditions (such as pH and temperature) would need to be carefully controlled.

(b) This section was, generally, well answered. It was commonly suggested that the development of gasohol would reduce the use/reliance on fossil fuels, which are only finite in supply. Also, that the burning of gasohol will produce fewer harmful emissions. In addition, the production of gasohol will cause much less environmental damage than the extraction and transport of fossil fuels.

(c) The tendency here was simply to quote from Table 1.1 – the question asked candidates to evaluate the advantages and disadvantages. In order to gain credit, answers needed to suggest exactly why the various features would be advantageous or disadvantageous. For example, exhaust emissions have a score of +2 and cold weather starts have a score of –3 – it was not enough to state that the exhaust emissions are an advantage and the cold weather starting is a disadvantage. The former needed to be related to some aspect of environmental pollution e.g. the greenhouse effect or acid rain and the latter needed to be related to different climates.

(d) Candidates often suggested that countries with a source of oil do not yet need to produce and use gasohol. Also that the production of gasohol requires a ready source of fermentable carbohydrate, which is not always available. Equally, many countries do not have the resources to be able to develop the appropriate technology.

(e) The two most frequently stated advantages of using biogas fermenters were that it is less expensive than having to import other alternative fuels and that it is one way of making good use of waste materials. Few suggested that one advantage is the fact that the methane can be produced locally (thereby eliminating the need for transport) or that, if methane is used instead of wood, it will reduce the need for tree felling/deforestation.

Question 2

(a) Few candidates appreciated that this question related to methods that biosensors might use to measure glucose concentration. Those who did know how biosensors work did suggest that oxygen consumption would be one method or measuring the change in pH. Few suggested that the sensor might measure the rate of hydrogen peroxide production.

(b)(i) Generally well answered. Many scripts picked up marks for high blood glucose levels/glucose present in urine, excessive thirst and the tendency to faint or even pass into coma. Occasional answers included reference to possible eye damage.

(ii) Candidates were usually able to draw suitable conclusions from Fig 2.1 without too much difficulty. Basically, these were that the consumption of refined sugar increased over the period, as well as the number of cases of diabetes. Many were also credited for suggesting that the two might be related. A further mark would have been available for the correct use of figures to support the conclusions.

(iii) If it was suggested that there is no evidence in Fig 2.1 to substantiate the conclusion that sugar consumption and cases of diabetes are related, one mark would have been awarded. To gain a second mark, it was then necessary to suggest some other factor (i.e. other than sugar consumption) might be responsible for the increase in diabetes e.g. some other dietary factor, level of exercise etc. Several candidates suggested that the increased number of cases was a result of more people being diagnosed as being diabetic, resulting from better methods of detection. This was also given credit.

(c) This question required two benefits to the *person* i.e. injections of insulin will no longer be needed, it leads to a better lifestyle/less need to be careful over diet and the reduction of the long term chances of infection (from the needles used for the injections).

(d) Again, this was generally well understood. Many suggested that the production of insulin by bacteria allows large amounts to be produced at a low cost (two marks). Also that it actually produces human insulin, as opposed to having to use cow or pig insulin. However, few pointed out the advantages of this – less chance of any allergic reaction and faster acting when injected. It was commonly pointed out that some diabetics do not want to inject themselves with animal insulin for religious or other personal reasons.

Question 3

(a)(i) Of the very few candidates who answered this question, most knew that the organism involved is the fungus, *Fusarium graminearum* and that it would need to be cultivated in a looped air flow fermenter. Further credit was available for explaining that the culture would need to be maintained at a temperature of 25 – 35 ^{o}C, the maintenance of which is aided by a cooling jacket or heat exchanger. Also that suitable nutrients would need to be added (e.g. glucose, amino acids, mineral salts) together with growth promoters, such as choline. The mycoprotein would be continuously harvested and the RNA content reduced by heating to a temperature of 60 – 70 ^{o}C. Further marks were awarded if the candidate explained that the product would need to be extracted and purified, as well as being flavoured to produce the final product.

(ii) Generally, this section was well answered, though it did tend to be the same points that were made. Some candidates did not always read the question correctly and often began by stating that one of the main uses of genetic engineering is to improve the yield of crop plants – which was actually in the wording of the question.

Better candidates made reference to the controlling of fruit ripening, to reduce spoilage from softening – also to improve the taste of fruits (and, indeed, vegetables). Credit was also given for discussing the genetic modification of crop plants to increase their resistance to pests and diseases, as well as improving their tolerance to harsh weather conditions – especially low temperatures.

Rarely were other points made, such as modifying the content of the plants, in terms of oils, starch, protein or fibre content, or producing potatoes with starches that absorb less fat on frying.

(iii) Here, also, the main points to be included in answers were enhanced disease resistance (e.g. chickens that resist infection by *Salmonella*) and the introduction of genes to improve the nutritional value of milk, as well as the production of leaner meat. Credit was also given for discussing the fact that genetic engineering can accelerate animal improvement programmes by taking advantage of genes that would not be readily accessible through normal selective breeding.

(b) Of the few answers written to this question, the standard was, generally, very good indeed.

(i) The first point that was normally made is that biotechnology can increase the yield of individual plants, thereby reducing the amount of space needed. Also, it can reduce the need for fertilisers, which has accompanying environmental benefits. In addition, disease resistance can be increased, as well as hardiness and the reduction of fruit-spoiling.

(ii) There were some very thorough answers to this section. Good candidates knew that a starter culture of bacteria would have to be added to milk and incubated at somewhere between 38 – 46 ^{o}C. Also that the names of the bacteria involved are *Lactobacillus bulgaricus* (or *acidophilus*) and *Streptococcus thermophillus* (or *Bifido bifidum*). They then went on to gain most of the available marks by describing the precise roles of the bacteria (*Lactobacillus* breaks down proteins to peptides, which encourages the growth of *Streptococcus.* The *Streptococcus* then produces formic acid and carbon dioxide, which stimulates the *Lactobacillus* to produce lactic acid, reducing the pH to 4.4 – 4.6).

(iii) Again, there were good answers here, though, perhaps, fewer candidates were able to gain the maximum marks. Credit was given for knowing that this involves the injection of papain (a protease enzyme) into cattle, immediately before, or after, slaughter. Also that the papain, as it circulates through the tissues of the cattle, causes the break down of *fibrous* proteins, such as collagen or elastin. This then releases the muscle fibre, which reduces the time that the meat needs to be stored in order to tenderise.

Option 3 – Growth, Development and Reproduction

As already stated above, this was by far the most commonly answered option.

Question 1

(a) Generally, this was correctly answered as *allometric growth*.

(b)(i) Again, there were many candidates who picked up both marks in this section, pointing out that, in the eight week fetus, the head makes up 50% of the body, whilst in the baby at birth it is only 25% and in the adult of 25 years it is around 12%. Others gained credit by making valid comparisons on the basis of the 'at birth' head being, relatively, half as big as the eight week fetus, while the 25 year old adult's is relatively a quarter of the size.

If mistakes were made here, it was usually a result of misreading the figures in Fig 1.1 or by making the wrong comparisons.

(ii) Many candidates gained one mark here for suggesting that one of the main reasons is the growth of the brain at an early stage of development. Occasionally, it was pointed out that hormones will play a part in the differential development and further credit could have been gained by specific reference to Growth Hormone, Thyroxine or Testosterone. Rarely was the development of sense organs related to the size of the head at an early stage and few, if any candidates suggested that the development of different parts of the body would be a result of genes being switched on at different times.

(c)(i) Some candidates did not find it easy to interpret the data in Fig 2.1. Those who did appreciated that the highest percentage of babies born were at a mass of around 3 kg and that the lowest percentage mortality (approx 3%) occurred when the mass of the baby was just over 3 kg. All of this would be sufficient to gain 3 marks. Credit could also have been gained by pointing out that the percentage mortality increases with lower and higher birth masses, with a further mark for quoting figures in support of this.

(ii) The best answers to this section included reference to natural selection – indeed, *stabilising* selection. Even when such points were not made, many answers did explain that babies with a birth mass of approx 3 kg were favoured and that babies of lower and higher masses were less likely to survive. Rarely was it suggested that this would mean that alleles favouring a birth mass of around 3 kg would be more likely to be inherited, and passed on, successfully.

(d) Many candidates were able to gain credit here by describing the effect of smoking in terms of producing babies of a lower average mass. Better answers then substantiated this by making reference to figures from the graph. It was not uncommon for both marks to be given here.

(e) The most common effects explained here were of carbon monoxide, reducing the availability of oxygen to the fetus (because of the formation of carboxyhaemoglobin in the mother's blood) and the effects of nicotine on the fetal nervous system (reference to the brain was acceptable) and circulation (both within the fetus and the placenta).

Occasionally, reference was made to intrauterine growth retardation and problems caused with regard to lung development of the fetus. Other points that would have been credited were the reduced uptake of Vitamin C by the mother, reduced resistance to infection and the increased chance of a premature birth.

Question 2

(a) Here, many candidates simply *described* the changes in the mass of carbohydrates and oil, rather than attempting to explain them. Equally, it was clear from some answers that some candidates thought that these related to changes during germination and not during the ripening of the seeds, as pointed out in the question.

Marks were gained for explaining that the reduction in levels of glucose would be a result of respiration (seldom was it suggested that the glucose might be used in various syntheses) and that the increase in levels of oils would be a result of starch (and possibly the other carbohydrates) being converted into oil.

It was rarely suggested that sucrose would initially be transported from the parent plant (and that this would eventually cease) and that starch was clearly the main initial reserve of the seeds, before completion of the ripening process.

(b) Many candidates picked up a mark here for explaining that, for a given mass, oils can store a greater amount of energy than starch. On occasions, it was simply stated that 'oils contain more energy than starch'. Without the reference to mass, this was not given any credit. Few appreciated that this would allow seeds to be lighter, which would then facilitate dispersal.

(c) Many candidates did not really attempt to describe *how* the oils would be utilised. Many, however, did appreciate that they would need to be hydrolysed, making use of appropriate enzymes and that the resulting fatty acids could either be used for various syntheses or respired. Further credit was also available for including a relevant detail regarding the respiratory pathway involved.

(d) This section was well answered and it was not unusual for all 4 marks to be gained. Points commonly made were that the dry mass would fall, initially, as a result of reserves being used up. References to respiration and the loss of carbon dioxide were credited. Many also explained that the dry mass would eventually begin to increase, once the plumule/leaves had emerged. Few, however, made the point that this could only occur when the rate of photosynthesis exceeds the rate of respiration.

(e) Although some candidates clearly knew the role of gibberellins, many failed to gain more than one mark here. The markscheme gave credit if it was stated that an increase in gibberellin levels is responsible for the breaking of dormancy. Also that this acts on the aleurone layer, increasing the activity of hydrolytic enzymes, which are then used to mobilise food reserves. Better answers included a reference to gene switching and an increase in protein synthesis.

Question 3

(a)(i) In this section, credit was given for correctly naming the method and providing an example of a suitable plant for which it could be used. Also for giving the part of the plant that would be used, together with some appropriate detail of the method.

The methods most commonly suggested were cuttings, grafting, layering and tissue culture or micropropagation. Candidates were not always able to name a plant for which the method would be used and were often somewhat vague about the part of the plant required. They were usually able to gain some credit for providing some relevant detail i.e. the use of rooting hormone to promote the growth of roots on cuttings, the provision of a suitable growth medium in tissue culture, a description of how the scion and stock are bound together in grafting etc.

(ii) This section produced many competent answers. Most candidates divided up their answers into advantages and disadvantages, usually suggesting rather more advantages to the crop growers.

Answers commonly included the fact that only a single parent is needed, from which large numbers of offspring can be produced very rapidly. Also, that these offspring are genetically identical, so that the growers know that they should all have the same characteristics, should all grow well in the same conditions and should all reach maturity at the same time. Micropropagation can be used at any time of the year and it can ensure that plant diseases are not transferred to the next generation. Finally, asexual propagation is very useful with species which are very difficult to produce from seed.

(iii) Many candidates clearly knew how the sexual reproduction in flowering plants can lead to new genetic combinations. Many explained the role of meiosis, together with crossing over, independent assortment and non-disjunction. Further credit was given if appropriate details of crossing over and independent assortment (commonly referred to, incorrectly, as *random* assortment) were included. Other valid points commonly made were the fact that two parents are involved, leading to cross-pollination and the random fusion of gametes.

(b) There were many excellent, thorough answers to this question.

(i) Most candidates who answered this question knew that thyroglobulin is stored in the thyroid gland, before being hydrolysed to T_4 and T_3 (thyroxine and tri-iodothyronine), which are secreted directly into blood capillaries.

As far as the functions of thyroxine are concerned, there were many marking points available, the majority of which were picked up by many candidates. These included the control of BMR, with consequences for the utilisation of food and oxygen and the level of cellular respiration. Many also knew that it has its effect by acting on DNA in the nucleus, switching on RNA synthesis and initiating protein synthesis. Further marks were also given if candidates made suitable reference to the control of bone/skeletal and mental development. Also its influence on heart rate.

(ii) Again, there were many thorough answers to this section. Good candidates gained credit for the role of the hypothalamus in producing TRH (or TRF), which stimulates the *anterior* pituitary gland to produce TSH. Also for explaining that this is entirely controlled (via the hypothalamus) by the levels of thyroxine in the blood i.e. low levels bring about the secretion of TSH, whilst high levels have an inhibitory effect. Pointing out that this is an example of control by negative feedback would gain a further mark. Rarely, if ever, was this linked to season or temperature, nor was it explained in the overall context of a homeostatic mechanism.

(iii) Most candidates who answered this question appreciated that the most usual context of HRT is to alleviate some of the symptoms of the menopause, especially as a result of the ovaries becoming less sensitive to FSH. Credit was given for explaining that this normally involves taking oestrogen, either in the form of pills, or as implants. One of the main benefits of such therapy was usually stated as the fact that oestrogen is antagonistic to parathormone, thereby reducing the possibility of osteoporosis, as calcium is removed from bones. The fact that it also reduces the risk of CHD was rarely mentioned, nor were some of the possible side effects, such as the increased possibility of blood clotting.

Option 4 – Applications of Genetics

Question 1

(a)(i) Whilst many candidates knew that that this type of interaction is known as epistasis, few picked up the second mark for naming it as *dominant* epistasis.

(ii) One mark was often gained in this section for the idea that the allele, B, inhibits the expression of the banding locus of the gene M/m. However, the questions asked HOW the allele B affects the gene M/m and few candidates were able to provide a satisfactory explanation. Credit would have been given either for suggesting that the allele B might code for a protein or polypeptide which blocks the expression of the banding locus, or that it codes for an abnormal enzyme, which is unable to make the appropriate banding pigment.

(b) This dihybrid cross was very well explained by the majority of candidates who answered this option – it was not uncommon for all 8 marks to be awarded. If marks were missed, it was usually because, in the Punnett square it was not made clear which genotype related to which phenotype. A simple key of some sort was required. Up to 4 marks were available for the Punnett square – 2 for correct genotypes and 2 for correct phenotypes. The other marks were given for Parental genotypes and gametes, F_1 genotypes and phenotypes (1 mark) and F_1 gametes. Also for the correct ratio of the F_2 phenotypes.

(c)(i) The majority knew that linkage refers to genes being situated on the same chromosome.

(ii) From many of the answers to this section, it was not clear whether candidates appreciated what is meant by 'test crossed'. It was not uncommon to find answers such as 9 : 3 : 3 : 1 or 1 : 1, without any reference to the phenotypes. Clearly, neither of these were credited. The only acceptable answer was 1 unbanded pink : 1 banded yellow.

Question 2

(a) Electrophoresis of DNA in genetic screening was well understood and explained by the majority of candidates who answered this option. Points commonly made were that the DNA is cut into small fragments by the use of restriction enzymes. Many also knew that these fragments would then be loaded onto a suitable gel (agarose). Further credit was available for an appropriate reference to the Polymerase Chain Reaction (PCR) or the fact that the DNA fragments would be buffered before being added to the gel.

(b) This was not always well answered. In order to gain both marks, candidates were required to explain that the fragment including the mutant allele would be shorter/lighter than the normal allele and would, therefore, move further or faster during electrophoresis.

(c) Again, this section was well answered by the better candidates. Many knew that the system involves 4 or 6 genes, with many alleles. Also that it codes for tissue type (self v not self) and will lead to rejection if it is not matched. Further marks were available for reference to the terms haplotype or supergene and for explaining that bone marrow cells are much more likely to match if they are transplanted between members of the same family.

(d) Many answers explained correctly that, if the mutant allele is recessive, the addition of a dominant allele should mask the effect of the recessive mutation. However, few appreciated that, if the mutant was dominant, it would have to be removed or inactivated and that this is not really feasible at present.

(e) The majority of candidates did not find this section to be straightforward. In order to gain credit, it needed to be pointed out that the normal mouse possesses two β globin alleles, with their associated promoters. The cells are much more likely to transcribe these alleles than the added human allele. However, when the mouse is heterozygous, one allele is inactive and, therefore, the added human allele is more likely to be switched on.

Question 3

(a)(i) This was often quite well answered, though it was rare for candidates to pick up all the available marks. It was expected that answers would indicate that rare breed collections represent a form of gene bank and, therefore, a source of genetic variation. Put another way, they provide a source of *alleles* of traits, which may be somewhat 'unfashionable' or, even, unrecognised in other populations. As such, therefore, they could be used for selective breeding at some stage in the future. Animal breeders may wish to introduce such alleles into their own flocks or herds to increase yields or resistance to disease etc. They may also be needed to counteract the effects of inbreeding, when numbers of breeding stock are declining.

(ii) This section was not always answered particularly well. Most candidates were usually able to name an appropriate animal (often cattle) and suggest a trait for which they might be selectively bred. Also that suitable parents would need to be selected and that they could be identified as a result of testing progeny. Although better candidates described the process of embryo transplantation to maximise offspring from a suitable female, rarely was artificial insemination mentioned, either in terms of maximising offspring from a suitable male or to allow 'long distance' mating. Equally, few candidates seemed to appreciate that for selective breeding to have any significant effect, it needs to be carried out repeatedly over a number of generations.

(iii) Generally well answered. Many answers included reference to 'inbreeding depression' and the loss of fitness/fertility and genetic variation. Few mentioned the loss of alleles from the breeding population. However, the loss of heterozygosity was frequently mentioned (usually expressed as an increase in homozygosity), especially in the context of the increased expression of deleterious recessive alleles (which, clearly must be in the homozygous condition). Few pointed out that animals are normally outbreeders and, therefore, are affected significantly by any increased level of inbreeding.

(b)(i) It was not uncommon for candidates to gain all the available marks in this section. Many knew that any type of mutation is an unpredictable or spontaneous change in the genetic makeup of an organism. In order to gain marks for explaining what is meant by *gene mutation*, it needed to be made clear that this involves a change in the structure of the DNA – more precisely, a change in *base sequence*. Further credit was then given if it was explained that this could involve additions or deletions, substitutions or inversions. Some further detail outlining the implications of such changes (the possibility of a frame shift, for example) would have gained an additional mark.

As far as chromosome mutations are concerned, most candidates knew that these involve a change in the structure or number of whole chromosomes. Again, a change in structure could involve an inversion, translocation, duplication or deletion. Details of changes in numbers of chromosomes were rarely included in answers (Down's Syndrome was the most common example), though the mark scheme allowed credit for reference to auto or allopolyploidy, together with some further detail or explanation of such a condition.

(ii) Many candidates knew both of these diseases in some detail and were able to score well in this section. Many wasted time by going into considerable detail about the symptoms and the physiological basis of the diseases, which were entirely irrelevant. From the marking point of view, it was helpful when candidates drew up a table to make the comparison.

Good answers included the fact that both diseases result from autosomal mutations (cystic fibrosis on chromosome 7 and Huntington's disease on chromosome 4), which is recessive in the case of cystic fibrosis and dominant in the case of Huntington's. Further details were credited i.e. that the cystic fibrosis mutation is a deletion of a whole triplet, whilst Huntington's is a stutter (or repeat) of the triplet CAG (some candidates knew that it was a stutter, but quoted an incorrect triplet).

As far as the inheritance of the diseases is concerned, it was necessary to point out that, because cystic fibrosis is a recessive mutation, sufferers must be homozygotes and heterozygotes will be carriers. Better candidates knew that the chances of 2 carriers having a child with cystic fibrosis is 1 in 4. Huntington's being a dominant mutation means that heterozygotes will have the condition and have a 1 in 2 chance of passing the allele on to a child. The inheritance of cystic fibrosis was, generally, better known than Huntington's disease.

(iii) Most answers were able to be credited with a reasonable number of marks in this section. All pointed out that it is largely because bacteria reproduce very rapidly. Good candidates were able to go on to discuss the fact that the mutation can be quickly passed on to large numbers of descendants (via *vertical* transmission), usually via plasmids. In addition, it could be passed *horizontally* to other bacteria, which might even be of different species. Although some candidates mentioned the process of conjugation, few were able to go into any detail and transformation or transduction were rarely mentioned.

Further credit was available if answers included an explanation of how selection could operate in favour of those bacteria possessing the mutation.