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

General comments

The mean score, at 27.9 (68.7%) was similar to last year, and there was a very good spread of scores, the standard deviation being 6.3. Eleven items were answered correctly by 80% or more of candidates, **Questions 1**, **2**, **3**, **10**, **12**, **17**, **22**, **25**, **27**, **31** and **33**. Only two questions were difficult; fewer than 40% of candidates answered **Questions 11** or **32** correctly.

Comments on specific questions

Question 11

The relative strength of a disulphide bond was not well known even by the more able candidates.

Question 16

Almost as many chose option **C** as chose the correct option, **B**, suggesting that the significance of facilitated diffusion is not well understood.

Question 19

The popularity of option **D**, particularly amongst the weaker candidates, reflects the common misconception that reduction division produces gametes rather than haploid cells, which may or may not become gametes.

Question 21

A large proportion of weaker candidates pushed back the events of prophase into interphase and chose option **A**.

Question 23

While better candidates appreciated that the question was about transfer RNA anticodons, a majority of the weakest chose the list of mRNA codons.

Question 25

Predictably, this was a very easy question.

Question 26

The context of this question perhaps made it more difficult than a straightforward one asking for the name of the tissue that conducts excitation through the ventricles. Among weaker candidates, both option **A** and option **C** were more popular than the correct option, **B**.

Question 29

The meaning of systolic blood pressure was not widely known.

Question 31

Candidates had no difficulty matching the names of the blood vessels to their structures.

Question 32

This proved to be a very difficult question with poor discrimination, revealing poor understanding of the mechanics of gas exchange in the lungs. Evidently a majority of candidates either did not know that oxygen diffuses through the squamous epithelial cells of the alveolar wall and then through the endothelial cells of the capillary wall or they failed to understand that the oxygen crosses two cell surface membranes as it diffuses into and then out of each cell. The fifth membrane is, of course, the surface of the red blood cell.

Paper 9700/02

Paper 2

General comments

There were many extremely encouraging answers to all six questions especially **Questions 1**, **2**, **4** and **6** from the well prepared candidates, though disappointingly there were some low scores, and even the more able candidates had some difficulty with **Questions 2 (b)**, **3 (c)**, **4 (d)**, **5 (b)**, **6 (d)** and **(e)(ii)**.

As in previous sessions, candidates often lost marks by not using their biological knowledge to answer the question set. For example, in **Question 1 (b)**, where candidates were asked to explain why the wall of chamber S, the left ventricle, is much thicker than the wall of chamber R, the left atrium, many inappropriately explained why chamber S had more muscle than the right ventricle in terms of how far blood needs to be pumped and made incorrect reference to blood only needing to be pumped to the lungs.

Again, in answer to **Question 3 (b)**, many candidates spent far too much time using the data in **Table 3.1**, obtained from a potometer investigation, to describe the effect of temperature and wind speed on the rate of water uptake, when the question also required some explanation of the effects as well. These candidates could not therefore fully access the marks available.

Other candidates were far too imprecise in their answers. For example, in **Question 1 (d)**, candidates were asked to outline the effects of atherosclerosis in coronary arteries and in doing so made general statements relating to the constriction of the artery and less oxygen supplied to the heart, with no reference to the narrowing of the *lumen* and *less* oxygen being delivered to the heart *muscle*.

There were sufficient marking points to allow candidates to demonstrate their knowledge and understanding and most candidates appeared to have had sufficient time. Candidates should be aware of the significance of the use of bold type face in questions and to follow the instruction **Turn over** where it appears at the bottom of a **BLANK PAGE** which resulted in a few candidates failing to attempt **Question 6** after Page 11.

Comments on specific questions

Question 1

There were some high scoring answers to this question.

(a) The vast majority of candidates named chamber **P** and blood vessel **Q** in Fig. 1.1 as the right atrium/auricle and aorta respectively. Weaker candidates occasionally named **P** as the left atrium and **Q** as the pulmonary artery.

(b) Candidates were required to explain why the wall of chamber **S** (left ventricle) is much thicker than the wall of chamber **R** (left atrium). The best candidates indicated that there was more muscle in the wall of **S** which was needed to pump blood around the whole body, certainly further than the left atrium which pumps blood over a short distance into the ventricle. The most able occasionally mentioned that the wall has to resist high pressure in **S** and is needed to overcome greater resistance to flow. Weaker candidates as mentioned earlier often explained the difference in thickness of the two ventricles and often referred to force rather than pressure.

(c) Here candidates were asked to describe how the sinoatrial node (SAN), atrioventricular node (AVN) and Purkyne tissue initiate and co-ordinate the contraction of the heart. The most able candidates made reference to the SAN, the pacemaker initiating the heart beat, the AVN delaying the impulse to allow the ventricles to fill before relaying the impulse to the Purkyne tissue which conducted the impulse to the base of the heart, causing the ventricle muscle to contract from the base upwards and forcing blood into the arteries.

Weaker candidates often inappropriately explained the involvement of the brain in changing heart rate or simply named the structures already given without any clear description of their respective roles in the contraction of the heart. A significant number of candidates referred to the SAN sending out impulses directly to the Purkyne tissue or thought that the SAN contracts. Very few of the most able candidates made reference to the contraction of the papillary muscles prior to the rest of the ventricle muscle contracting and far too many candidates at this level referred to electrical waves, signals and messages rather than impulses or waves of depolarisation.

(d) The key word here was atherosclerosis in asking candidates to outline its effect on blood flow through coronary arteries and the heart itself. Many candidates did not fully understand the term and even where they did only referred to reduced blood flow due to the deposition of fat/cholesterol inside the arteries rather than in the walls of the coronary arteries. The best responses made reference to the narrowing of the lumen, rather than constriction of the artery and qualified the reduced blood flow in terms of less oxygen/glucose being supplied and less wastes removed to and from the heart muscle respectively. Candidates were required to make reference to the effect of atherosclerosis on the heart. Those that did only occasionally referred to fibrillation, angina/CHD, or myocardial infarction (MI), the commonest effect being a heart attack or heart failure. Weaker candidates were not precise enough in describing the 'effects' on blood flow, with incorrect statements linking blockages and clots with sticky platelets and occasionally tar.

Question 2

There were many excellent answers to this question.

(a) The vast majority of candidates were able to demonstrate their understanding of the terms (primary) producers, population, community, ecosystems and primary consumers in relation to the definitions given. Occasionally weaker candidates transposed **(ii)** and **(iii)**, population and community respectively, gave niche in **(iv)** rather than ecosystem, and omitted the word primary, in primary consumers, in describing herbivorous animals which are prey for carnivores in **(v)**. Several candidates also gave secondary consumers or predators in answer to **(v)**.

(b) Most candidates in explaining the term habitat made reference to a place where an organism lives and gave desert as an example of such a habitat. Few made reference to physical and biotic features in their explanation. Weaker candidates did not make use of the information from the passage to explain the term habitat, naming for example ponds for toads rather than deserts for foxes.

(c) In explaining how the *leaves* of desert plants may be adapted for survival in areas with little rainfall, the commonest answers involved reference to the reduction of leaf area, sunken stomata, hairs that trap moisture and a waxy cuticle. Common errors included inappropriate reference to spines, thorns, folded leaves, fewer stomata and even reference to parts of the plant other than leaves, for example the stem being involved in water storage. Most candidates correctly linked the leaf adaptations correctly described to a reduced rate of transpiration/water loss to enable survival in areas with little rainfall. Several candidates however incorrectly believe that the xeromorphic leaf adaptations they described are designed to totally prevent transpiration.

Question 3

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

(a) Candidates were required to complete a table to show which one of the four statements regarding the properties of water was responsible for each of the five statements given about the roles of water in living organisms or as an environment for living organisms. The most knowledgeable candidates had no difficulty in correctly completing the table. Several candidates ignored the instruction to link *one* property of water with each role and used two or more ticks for each role on a number of occasions.

(b) Using the data in Table 3.1 obtained from the use of a potometer to investigate the rate of water uptake by leafy shoots, candidates were asked to describe and explain the effect of two conditions, namely temperature and wind speed, which had been changed during the investigation, on the rate of water uptake.

Virtually all candidates indicated that a higher temperature and higher wind speed gives a higher rate of uptake, but only the most able made use of figures with units from the data table to make a valid comparison. Weaker candidates as mentioned earlier did not explain these effects in terms of, for example, kinetic energy and the rate of evaporation, for temperature or to the air outside the stomata not becoming saturated/less humid due to the wind moving water molecules away from the leaf surface. Very few candidates gained maximum marks in this part question. A few candidates even referred to the counting of bubbles rather than the rate of bubble movement. These candidates often referred to temperature affecting enzyme reactions in photosynthesis as being responsible for any changes in rate, and hence referred to more bubbles being given off. A significant number quoted figures from experiments which gave an invalid comparison because one factor was not kept constant.

(c) In suggesting why the rate of water movement in an intact shoot is less than that measured in a potometer, few appreciated the idea of resistance to water flow inside the plant, that the water was under tension in the xylem of the stem, that the supply of water from the soil could be limited as indeed might be the actual rate of water absorption by the roots of the plant. Most candidates answered simply in terms of the distance water has to travel in the intact shoot without any appropriate reference to xylem vessels.

Question 4

Overall a sound level of response.

(a) A significant number of candidates were able to calculate the magnification of Fig. 4.1, an electron micrograph of a mesophyll cell from a leaf, as x 16,000. Many candidates still insist on taking measurements on the electron micrograph rather than using the scale bar given which measured 4 cm. i.e. 40,000 micrometres representing an actual distance of 2.5 μm, in order to perform their calculation. As a result a part question that should have been answered very quickly must have taken some candidates a considerable period of time.

(b) By far the majority of candidates were able to identify by using the letters **A** to **F**, a part of the mesophyll cell shown in Fig. 4.1 where the substances chlorophyll, cellulose, DNA and phospholipid are located, indicating **C**, **B**, **D** and **C/F** respectively. The main error amongst weaker candidates was in not identifying the nucleus shown at **D** as a source of DNA and the cell wall at **B** as the location of the substance cellulose.

(c) No real difficulty here. Most candidates could state three ways in which the *structure* of a red blood cell differs from the structure of the mesophyll cell. The commonest response made reference to the lack of a nucleus, cell wall, vacuole or named organelles such as chloroplasts or mitochondria. Some candidates inappropriately gave functional differences, incorrectly referred to shape or referred to chlorophyll, cellulose and haemoglobin when *structures* were required.

(d) In explaining why the red blood cell count is much higher in a person who lived at high altitude, only the very good candidates made reference to the low partial pressure of oxygen requiring more haemoglobin to compensate for the smaller volume of oxygen absorbed. Weaker candidates may well have referred to a low concentration of oxygen at altitude, but merely restated that the red cell count would be higher with no reference to the significance of increased haemoglobin levels to make up for the lower saturation levels. Furthermore several candidates believed that the answer to the question was connected with an understanding of haemoglobin dissociation curves.

Question 5

There were some good, clear and factually accurate answers to this question.

(a)(i)(ii) It was encouraging to note that the majority of able candidates could name **U**, **W** and **X** as phosphate, deoxyribose and cytosine and **Z** as hydrogen (bonds) in the part of the DNA molecule shown in Fig. 5.1. A significant number of candidates did however name **W** and **X** as a pentose sugar and a nitrogenous base respectively.

(b) Candidates were asked to describe *three* features of a polypeptide molecule that are different from those found in a DNA molecule. The most favoured correct responses included reference to amino acids (rather than nucleotides), 20 monomers (compared with 4 sub units), the presence of peptide bonds (not phosphodiester) and a single strand (not double helix). It was not uncommon for weaker candidates to invalidate the correct description of the polypeptide molecule by giving biologically incorrect information in comparison with the DNA molecule, even though a comparison was not required. For example, many stated correctly that peptide bonds link the sub-units in polypeptides, but inappropriately named hydrogen bonds as linking the sub-units (i.e. nucleotides not bases) in DNA indicating a lack of knowledge of the phosphodiester bond. Many candidates confused polypeptides with RNA or proteins.

Question 6

Overall a disappointing level of response from many candidates.

(a) Fig. 6.1 showed three different T lymphocytes and the events that occur during an immune response to an antigen. The majority of candidates were able to correctly name the type of nuclear division that occurs at **X** on Fig. 6.1 as mitosis, though weaker responses included reference to meiosis, cell division and cytokinesis.

(b) Almost all candidates used the term clone to describe the group of identical cells shown at **M** on Fig. 6.1. Weaker candidates occasionally referred to daughter cells, tissue and plasma cells.

(c) In explaining why T lymphocyte **K** has responded to the antigen during the immune response, but not T lymphocytes **J** and **L**, able candidates appreciated that the T lymphocyte **K** receptor was a correct/exact match for the antigen or that the T cell receptor was complementary (in shape) to the antigen. Able candidates made additional reference to the wrong shapes of receptors on **J** and/or **L** and to specificity. Vague reference to fit and incorrect mention of receptors and antigens having similar or identical or even the same shape characterised many responses, whilst several candidates used enzyme terminology and referred to ‘active sites’ and ‘lock and key’.

(d) Candidates were asked to describe *one* role of T lymphocytes in fighting an infectious disease. Many able candidates made suitable reference to 'helper' cells secreting cytokines/lympokines to stimulate B cells to produce antibodies. Exceptionally good candidates made appropriate reference to plasma cells and macrophages. Others referred to 'killer T cells' destroying host cells and their intracellular parasites by 'punching' holes into these cells and releasing toxic substances such as hydrogen peroxide into such cells.

This part did prove difficult for some weaker candidates who merely answered again in terms of T lymphocytes detecting antigens as in **(c)** and producing antibodies. A considerable number of candidates gained no additional marks by describing the roles of both helper and killer T cells and were often confused as to their respective roles. Many thought that 'killer T cells' killed antigens.

(e)(i) Most candidates were able to state the name given to agents that increase the chances of a cancerous growth as carcinogens/mutagens. Occasionally candidates incorrectly gave carcinogenes, cancergenes as well as oncogenes, ultra violet light and tar as answers.

(ii) In suggesting the likely effects on the body of T cells that do not function normally, many weaker candidates appreciated that the body would be more susceptible to infection. More able candidates additionally explained that T cells would not recognise antigens, so reducing the immune response with no/few antibodies being produced. A significant number of candidates answered in terms of autoimmunity or the development and spread of cancer.

Paper 9700/03

Practical 1

General comments

The paper proved to be very accessible to the vast majority of candidates, who demonstrated good knowledge, understanding and practical skills, while at the same time, discriminating between weaker and more able candidates. There was less evidence of candidates drawing 'text book diagrams' instead of what they actually saw under the microscope, but unfortunately there are still too many candidates who are still drawing stylised diagrams from memory. As in previous years, candidates who did this were unable to score full marks on a question. There was no evidence that candidates ran out of time and almost every candidate attempted every question.

Comments on specific questions

Question 1

Most candidates clearly understood food tests and how to use them. Candidates who performed poorly on this question usually did so because of poor examination technique rather than due to a lack of knowledge or understanding. Candidates would be well advised to read questions carefully before starting to answer them.

(a)(i) This part was very well done by almost all candidates, indeed, candidates often gave too much information over and above what was asked for. Simply entering the name of the reagent, the colour obtained and the conclusion e.g. "protein present" was sufficient to score. Candidates often gave the results of several food tests for each solution. Although candidates were not penalised for this, it was often difficult to untangle the detail of the answer to award marks. One mark was awarded for each correct line and an additional mark for line S2 if hydrochloric acid was used.

Where candidates had confused solutions, the first answer was marked incorrect, but then the error was carried forward so that marks could still be awarded for the second incorrect solution providing the answer was correct. This ensured that candidates were not penalised twice for mixing up two solutions.

(ii) This section proved to be a good discriminator between weaker and more able candidates. Poor answers simply repeated what had been written in the table, whereas good answers included reference to heating with HC*l*, cooling and neutralising with sodium hydrogen carbonate. Credit was also given for boiling or heating above 80^{o}C with an excess of Benedict's solution.

(iii) This part was not well done by the majority of candidates. Even more able candidates often gave wrong answers by explaining the chemistry of what happened during the Benedict's test. Good answers were rare and included making a series of glucose solutions with known concentrations and testing them with Benedicts to get a series of colour references to which the unknown solutions can be compared when they are tested with Benedict's solution. Credit was also given for an explanation of the colour range and the fact that the mass of precipitate could also be used as a semi-quantitative measure. Clearly, most candidates did not understand what was meant by a semi-quantitative test.

Question 2

Most candidates scored well on this question and produced some clear well drawn diagrams, showing a good understanding of mitosis.

(a) Most candidates drew a clear diagram of either anaphase or metaphase. Those candidates who failed to read the question and drew some other phase were limited to a maximum of two marks. Credit was given for drawing what was seen under the microscope, rather than drawing 'text book' diagrams. Good answers had a clear single or close double line for the cell wall, and chromatids covering at least half the area of the cell. Credit was also given for two correct labels, but all too often, labels indicated things that could not possibly be seen through a light microscope, such as spindle formation and cell organelles.

(b)(i) This question was also done well. However the most common error was not to label the two diagrams as interphase and telophase, and this resulted in one mark not being awarded. Again, credit was given to those candidates who clearly drew what they saw under the microscope. Candidates who drew and labelled chromosomes during interphase were clearly drawing from memory or did not understand the implications of interphase. This question also tested scale and awarded a mark for the cell at telophase being at least twice as long as it was broad. These are small details that candidates often miss when drawing diagrams and indicate a lack of drawing skills.

(ii) In this part, candidates were asked to draw a cell to the same scale as the one drawn in **(b)(i)**. This instruction was often ignored and resulted in the loss of two 'comparative' marks by having a different size of nucleus to the one drawn in interphase and a shorter cell, to the one drawn in telophase. Candidates would be well advised to practice this skill for future examinations.

Paper 9700/04

Paper 4

General comments

The paper showed a large range of marks and there were a large number of high scoring candidates. However there were a number of low scoring candidates whom did not appear to be prepared for this examination. **Question 1** was found quite hard but most candidates found the free response questions **6** and **7**, quite easy to answer. The majority candidates answered **Question 6** and got a very high scoring mark.

Comments on specific questions

Question 1

(a) Candidates were well aware of the bonds involved and scored two marks but few were able to link the bonds to the various stages of globular protein structure. Very few had any idea of alpha helix and beta pleated sheets.

Few candidates mentioned the fact that the amino acid sequence determines the folding sites of the protein. Some candidates referred to a quaternary structure rather than the tertiary structure.

(b) This question was often misunderstood and most candidates thought the vector was a plasmid and the product was insulin. It was encouraging to note that many seemed to know all the enzymes involved in this technique. Very few made reference to the DNA being inserted into hamster kidney or ovary cells.

(c) Surprisingly few candidates mentioned no contamination or reference to HIV. A few candidates mentioned a greater production rate.

(d) There were few correct answers to this question. Few candidates referred to introns and extrons. No reference was made to the fact that only mammalian cells have Golgi or enzymes for post translational modification.

Question 2

(a) The arrow to the site of oxidative phosphorylation often ended up in the inter membrane space and not on the membrane of the cristae. Most candidates indicated that Kreb's cycle took place in the matrix.

(b) The majority of candidates scored marks making reference to the cristae providing a large surface area and the stalked particles being involved in ATP synthesis. Few mentioned the intermembrane space allowing the accumulation of H^+, the impermeability of the inner membrane to H^+ thus maintaining a H^+ gradient, and to the fact that the linear arrangement of the ETC on the inner membrane allowed for greater efficiency.

(c) This part was well answered, candidates realised that oxygen is the final proton acceptor and that no ATP would be synthesised and that Kreb's cycle would not take place.

Question 3

(a) Most candidates identified the structure A as the microvilli or the brush border. Very few identified B as the basal channels or invagination of the membrane. The common incorrect answer referred to podocytes.

(b) In explaining three ways in which the cells of the proximal tubule are adapted for selective reabsorption most candidates gained 2 marks. Reference was made to the microvilli providing a large surface area and to the many mitochondria providing ATP for active transport. However many candidates made reference to mitochondria but failed to mention that there were a large number of them. Few candidates referred to carrier proteins, and tight junctions.

(c) Not many candidates had a good knowledge of how glucose is reabsorbed into the blood from the lumen of the proximal convoluted tubule. Very few made reference to the cotransport with Na^+ into the cells and the diffusion of glucose out of the cells into the blood vessels. Many made reference to the glucose being actively taken up into the cells.

(d) This question highlighted a frequent problem - that is that candidates do not actually read the question. So many tried to describe how the blood absorbed the water from the proximal convoluted tubule rather than how water got into the cells. Weaker candidates referred to water moving from a low water potential to a high water potential. Very few candidates referred to the cells having a low water potential due to a high concentration of salts.

Question 4

(a) What should have been a good easy question frequently ended up as a ramble about all types of mutation and the types of mutagens involved. Nevertheless many candidates did score 3 marks. Sickle cell anaemia and Downs syndrome were the two main examples given. When referring to gene mutations a change in an amino acid was often mentioned but a change in the base was often omitted.

(b) The possession of sickle cell allele was often stated as giving individuals an advantage without emphasising that this was in the heterozygote. Candidates were often confused between resistance and immunity. Only better answers referred to homozygotes and the fact that they were likely to die from either malaria or sickle cell anaemia.

Question 5

This was a high scoring question. Many candidates had a good knowledge of basic genetic crosses.

(a) Most of the candidates scored full marks. However a few candidates insisted in putting symbols on the Y chromosome.

(b) Candidates were asked to give the genotypes and phenotypes of the offspring that may result from mating a tortoiseshell female with a black male. A number of candidates only gave either the genotype or the phenotype. Often the genotype and phenotype were not linked.

(c) Candidates were asked to suggest an explanation for the tortoiseshell coat in terms of the activity of the X chromosome. The most common answer was “co-dominance”. No reference was made to the X chromosome being inactivated randomly early in development.

Question 6

This was a very high scoring question.

(a) Most candidates were able to explain in detail how a synapse works. Details were given of the action potential arriving at the presynaptic membrane and the events leading up to the release of the neurotransmitter into the cleft. Further information was given as to the effect the transmitter had on the post synaptic membrane

(b) Some weaker answers confused insulin with glucagon. A large number of candidates knew that glucagon was released from alpha cells when there were low levels of glucose in the blood. Glycogen was sometimes confused with glucagon. Better candidates mentioned the use of fatty acids in respiration.

Question 7

Not many candidates answered this question.

(a) Many answers were illustrated with good diagrams. Some candidates failed to mention that RuBP was a 5C compound. Others made no mention of the unstable 6C compound. Regeneration of RuBP was well known. The need for ATP and reduced NADP was usually given for the production of TP. Few candidates mentioned that ATP was required to provide phosphate for the regeneration of RuBP

(b) The fact that NADP was a coenzyme was often not stated. The candidates realised that they became reduced and were carriers of protons and electrons. Reactions on the thylakoid membrane and the transfer to the Calvin cycle were only occasionally mentioned.

Paper 9700/05

Practical 2

General comments

The paper proved to be very accessible to the vast majority of candidates, who demonstrated good knowledge, understanding and practical skills, while at the same time, discriminating between weaker and more able candidates. There was no evidence that candidates ran out of time and almost every candidate attempted every question.

Comments on specific questions

Question 1

This question tested knowledge and understanding as well as practical skills. Candidates generally showed good technique and produced clear and reliable data. Most were then able to explain and use this data for the rest of the question.

(a)(i) Almost all candidates scored full marks on this easy start to the question. A clear description of observations was required and marks were awarded for noticing the formation of bubbles on the bead, the fact that it sank initially and then floated to the surface. A further mark was awarded for description of the bead placed in water.

(ii) This part required an explanation of the observations and yet again, most candidates performed well. Most understood that enzymes within the yeast catalysed the breakdown of hydrogen peroxide into oxygen and water. Credit was also given for writing down the equation as an alternative to a written explanation. Fewer candidates went on to write about the reduction in density causing the bead to float and simply reported that "it floated". Further credit was given for an explanation that the enzymes had nothing to react with in the water and thus no reaction occurred. Simply writing "nothing happened" failed to score. On occasions, some candidates mixed up the idea of enzyme and reactant and referred to the hydrogen peroxide as the enzyme. This misconception resulted in a loss of marks.

(b)(i)(ii) In this part candidates had to devise their own table to record their results. Good answers included tables with clear headings and units at the top of the column and had six boxes to record the results. Means shown in the table were also credited and a further mark awarded for correct calculation of the means. The final mark was awarded if the more concentrated solution had a faster reaction time. Generally tables were well constructed but often means were missed out and calculated in open space below the table. Although this was not penalised, candidates would be well advised to practice the skill of constructing clear and well thought out tables of results.

(iii) Answers to this part were worrying. Most candidates failed to understand that this referred to safety and wrote about how they controlled their variables. Reference was made to the danger of hydrogen peroxide in the instructions to Centres and candidates should be able to carry out practical examinations in a safe and secure way. This will be tested again in future papers and candidates would be well advised to know and understand how to carry out practical experiments in a safe manner.

(iv) This part was not always well answered. Good answers referred to the concentration of hydrogen peroxide and the number of molecules and active sites and how this affected the rate of reaction. Credit was also given for the idea that time taken was the inverse of the rate of reaction.

(c) This part was often done very well indeed, but this is clearly an area on which some need to concentrate their efforts, as the question was worth six marks out of a total of thirty. Credit was given for using a temperature range that included at least five different temperatures and an explanation as to how these temperatures would be controlled. Good answers also included a description of how the gas evolved would be measured and that a constant concentration of yeast and substrate was used. Controlling another variable and repeating to determine the mean was also credited. It is clear that candidate's skill in answering this type of question has constantly improved over the last few years and this is to be applauded.

Question 2

This question was mainly answered well with most candidates scoring at least six of the eight marks.

(a) Good answers included a diagram with clean, clear lines and accurate labels. The question clearly asked for a plan diagram and a mark was awarded for showing no cellular detail at all on the diagram. Other marks were awarded for a line delineating the storage from non-storage tissue, two or three concentric circles for the endodermis and pericycle, and showing a stellate conductive tissue. A scale mark was also awarded for the stele being less than one third of the root diameter. This point was often missed by candidates, who often drew a stele much larger than could actually be seen through the microscope.

(b) Most candidates clearly identified the section as being taken from a root.

(c) This was generally well done with candidates scoring two or three marks. Credit was given for the wall of the conductive cell being relatively thicker than the storage cell, the conductive cell being empty and the storage cell having at least some storage contents.

Paper 9700/06

Options

General comments

Of the four available options, far more candidates attempted ***Option 3*** (*Growth, Development and Reproduction*) than any of the others. A significant number did ***Option 1*** (*Mammalian Physiology*), and ***Option 4*** (*Applications of Genetics*) though only a small number attempted ***Option 2*** (*Microbiology and Biotechnology*).

The standard of answers was variable, though there were candidates who scored highly on ***Options 1***, ***3*** and ***4***. Those who attempted ***Option 2*** tended to score less well.

Comments on specific questions

Option 1

Mammalian physiology

Question 1

(a) The Gastric Pit/Gland (A) was, generally, correctly labelled. However, there was frequently some confusion over the labelling of B, C and D. The main confusion was between circular and longitudinal muscle and between 'mucosa' and 'submucosa'. The answers required to gain the marks were B - muscularis mucosa, C - circular muscle or muscularis externa and D - mucosa. If B and C were simply labelled 'muscle', a half mark was awarded for the two answers.

(b)(i) This was well answered - a majority of candidates knew that pepsin is secreted in the form of pepsinogen, which is then activated by the hydrochloric acid (or by the pepsin itself). This was, in fact, enough to gain the two marks, though good answers also pointed out that the pepsinogen is secreted by chief cells (also known as peptic or zymogen cells) and that the activation is brought about by the removal of a short chain of amino acids.

(ii) Although this was also well answered on the whole, it was not common for all of the three available marks to be awarded. The markscheme required reference to the *hydrolysis* of proteins, with further marks for describing the breaking of *peptide* bonds and the production of shorter peptides (many actually described the production of individual amino acids, for which there was no credit). Good answers described the pepsin as an endopeptidase, though few appreciated that it is, in fact, preparing for further hydrolysis by exopeptidases.

(c)(i) Most answers to this part pointed out that gastrin clearly increases or stimulates the secretion of the hydrochloric acid. Further credit was then given if the candidate quoted figures from Fig. 1.2, describing the maximum level of secretion reached after 120 mins, followed by a levelling off after 160 mins (an alternative to this last point would be to point out that the effect is still evident after 180 mins). Few, if any candidates attempted to make a comparison with the level of secretion in the absence of gastrin.

(ii) Here, candidates were told that somatostatin is released in the presence of acid. Hence, there was no credit for repeating this. However, if they pointed out that as more acid is produced, the secretion of somatostatin is increased, one mark was awarded. Many thought that the somatostatin then reduces the acidity by neutralising the acid present - no marks for this. Better answers explained that the somatostatin actually inhibits the secretion of the acid - and a further mark could be gained for citing this as an example of 'negative feedback'.

(iii) Although a majority of candidates seemed to understand why it is important that the tissue has not been exposed to food during the previous 24 hours, answers were seldom well expressed and it was more common for one mark to be gained than two. Many thought that it has something to do with food stimulating the release of hydrochloric acid - though, of course, food stimulates the release of hormones and it is these that would interfere with the investigation. Few explained that hormone release stimulated by food already present would introduce an additional variable and it would not, therefore, be a fair test.

Question 2

(a) A - many thought that the function of the transverse process is to articulate with other vertebrae or even the ribs. However, a majority did state, correctly, that its function is for the attachment of muscle.

B - most candidates did appreciate that the function of the centrum is to provide some rigidity for support or load-bearing. Some thought that it was a cartilage disc.

(b)(i) Here, many candidates performed the correct calculation and gained both marks for an answer of 320%.

A common error was to correctly calculate the increase as 16, then work this out as a percentage of 21 (rather than 5).

(ii) Answers here had a tendency to be somewhat vague. Good answers made a comparison between men and women below and above the age of 49. Unless trends at specific ages were included in the answer, it was difficult to gain both of the available marks.

In this type of question, candidates need to appreciate the need to quote accurately from the data in the table.

(iii) Here, answers were somewhat mixed. Good candidates were able to point out that women have a normal bone density that is less than men and that the higher rates of fractures in men below the age of 49 can probably be explained by the fact that men are more active than women. Although the menopause was often mentioned, it was not always appreciated that the relevance of this is that the protective effect of oestrogen is lost. Some very good answers included reference to the increased activity of osteoclasts and the decreased activity of osteoblasts at later ages.

Question 3

(a)(i) Most (though by no means all) who answered this option knew that substance X is carbon dioxide.

(ii) Here, also, most knew that the blood vessel is the hepatic vein. That said, a significant number thought it is the hepatic portal vein and some, the hepatic artery.

In terms of how the urea is excreted, most knew about ultrafiltration in the glomerulus/Bowman's capsule and the fact that it is excreted in solution, in the form of urine.

Some went into some detail regarding the route from the kidney being via the ureter, bladder and urethra. Credit was available for this, though some did confuse the ureter and urethra.

(iii) Few seemed to appreciate that, excreting ammonia directly into the water means that there is no need to convert it into a less toxic compound (i.e. urea) and therefore no need for the ornithene cycle at all. Most picked up one mark for suggesting that the main advantage is that it will conserve the ATP that has to be used in the ornithene cycle.

(b) Some candidates confused transamination with deamination. However, many did know that transamination is the conversion of one amino acid to another. Many also knew some correct detail i.e. that it involves the transfer of an amine group (though a significant number thought it was the transfer of the R group) from an amino acid to an organic or keto acid. Credit was also given if it was pointed out that this occurs so that an amino acid that is in excess can be converted to one in short supply i.e. amino acids acquired in the diet may not always match the body's requirement.

Question 4

(a)(i) Rarely were all four marks gained here. Generally, it was appreciated that the decrease in the size of the pupil is brought about by contraction of the *circular* muscles (though some confusion with ciliary muscles) of the iris. However, few explained that the stimulus is, initially, detected by rods or cones in the retina, which causes an impulse or action potential to be sent to the brain via a sensory neurone. Equally, that an impulse is than transmitted from the brain to the iris via a motor neurone i.e. a reflex arc.

(ii) Here, also, it was generally understood that this involves the contraction of the ciliary muscle which then removes tension from the suspensory ligament (many described this as the ligament 'relaxing'). Few made reference to the elasticity of the lens, though many did describe it as becoming more convex (some thought it became more concave). Again the fact that the loss of focus is initially detected by the brain was rarely, if ever, mentioned.

Of course, both of these responses involve the optic nerve as well as the parasympathetic nervous system. Although few candidates actually pointed this out, credit was given *once* (in either description).

Option 2

Microbiology and biotechnology

There were very few candidates who attempted this option. The following comments, therefore, are based on a relatively small number of scripts.

Question 1

(a)(i) Generally, candidates attempting this option were able to name parts A to D with a reasonable degree of confidence. Acceptable answers were as follows:

A - capsomere

B - nucleic acid, DNA or RNA

C - envelope or lipid bilayer

D - capsid

(ii) Given the scale on the diagram, this was a relatively straightforward calculation. However, it was clear that candidates did not find this to be the case and this section was sometimes left blank.

The correct answer was 1×10^5 or 100 000.

(b) Answers here tended to be very weak and it was clear that there was much confusion here.

Marks were given for correct references to the smaller size of viruses, the lack of any cell structure (absence of organelles or named structures was an acceptable alternative answer) or the fact that viruses cannot reproduce independently outside a host cell.

(c) Answers to this section tended to be reasonable. Credit was gained if the description included the need for the genetic material of the virus to enter the host cell, following which it is replicated. Good answers then pointed out that the components of the host cell are utilised to manufacture viral protein, so that new viruses can be assembled. Once this stage has been reached, cells will burst or lyse and numerous viruses will be released to invade or infect other cells. Good candidates also gained credit for further correct detail, such as the involvement of reverse transcriptase enzymes.

(d)(i) Again, this was a relatively straightforward calculation. The increase between 1989 and 1993 is 700. Given that this is a period of 4 years, this makes it a mean annual increase in HIV/AIDS cases of 175 per year.

(ii) The most frequent correct answers in this section were via blood transfusions, or as a result of shared needles during intravenous drug use. Some candidates were also given credit for the fact that the virus can be transmitted from mother to baby, either via the placenta or during breast feeding.

(iii) Here, again, candidates who answered this option could generally make sensible suggestions for the decline in the number of cases of HIV/AIDS between 1993 and 1997. These included increased publicity, better and better education or level of awareness. A further correct suggestion was an increase in 'safe' or protected sexual practices.

Question 2

(a)(i) The diagram of the air-lift fermenter in Fig. 2.1 did not appear to be well known or understood and answers worthy of credit were few and far between.

Candidates were expected to explain that such a fermenter has no moving parts and works on the basis of a continuous circulation of the culture brought about by the upward movement of aerated culture and the fall of air-depleted culture. Further credit was given if they also pointed out that any heat, produced from the respiration of the fungus, is removed by the heat exchanger at the base of the fermenter.

(ii) The growth requirements of *Fusarium* are very specific and would include the following:

Glucose (as a substrate for respiration)

Ammonia (as a source of nitrogen for synthesis of amino acids)

Ammonium, zinc, copper or iron sulphate (mineral source)

Choline (a growth factor)

(b) Answers here tended to be somewhat vague. However, there are a number of standard treatments of mycoprotein which are required before it is regarded as acceptable for human consumption. These include reducing the level of RNA (a number of candidates did know this), texture improvement by pressing the fibres to form 'pieces' of the protein and the addition of colour and flavour.

Question 3

(a) Answers here were somewhat confused and candidates who answered this option often did not seem to understand the role that barley plays in the production of beer. Equally, many seemed to think that yeast is an enzyme.

As far as the barley is concerned, marks were awarded for describing the production of maltose, by the *hydrolysis* of starch, using the enzyme amylase. Few candidates mentioned the further conversion of maltose to glucose, using the enzyme maltase.

As far as the yeast enzymes are concerned, it was expected that answers would include reference (no particular detail required) to the anaerobic breakdown of sugar to ethanol and carbon dioxide.

(b)(i) The immobilisation of enzymes appears to be a topic that is reasonably well understood. Good answers included mention of the fact that it is easier to remove the enzyme, meaning that there will be no contamination in the end product and the enzyme can then be reused. In addition, immobilised enzymes have a greater stability and are less sensitive to changes in pH or temperature.

Credit was also given for inclusion of other sensible points, such as cost i.e. being able to reuse the enzyme makes the process rather less expensive.

(ii) An appreciable number of candidates did not seem to understand that, in the production of 'light' beers it is necessary to reduce the level of starch - even though this information was clearly stated in the question.

This being the case, it should have been clear that the enzyme to be used would be the α amylase, given that it produces a higher level of maltose in a given period of time. Credit was also given for backing this up with the use of figures from Table 3.1.

Question 4

(a)(i) Although this would appear to be a straightforward question, it was not well explained by many candidates.

Those answering this option would be expected to know that a *genetically engineered microorganism* is one that contains recombinant DNA i.e. the DNA of another organism (could be described as a foreign gene) integrated into its genetic material.

Further credit was given if candidates included any correct detail about how microorganisms might be genetically engineered.

(ii) There were many possible points here and this did appear to be reasonably well known and understood.

Correct answers would include the fact that pig insulin is not structurally identical to human insulin and by making use of genetically engineered microorganisms, it is much easier to produce the insulin in large quantities. In addition, it avoids possible allergic responses and prevents the spread of disease. Credit was also given for the fact that some people will object to the use of pigs, either on an ethical or a religious basis.

(b) On the whole, candidates seemed to be rather confused by this question and it was very rare for all three marks to be awarded.

In reality, it was very straightforward, there being four different ways in which the fragments could join.

Firstly, they could rejoin in exactly the same way as the originals - one mark for sketching this.

On the other hand, the left portion of the chromosome from species A could combine with the right portion of species B (one mark) or the right portion of species A could combine with the left portion of species B (one mark).

In order to gain these marks it was important to put the restriction enzyme sites, R1, R2 and R3 in the correct positions on the sketches.

Option 3

Growth, development and reproduction

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

Question 1

(a) This was generally well answered and it was not uncommon for candidates to gain 3 or 4 marks. Many simply said that it results in a clone because all the plantlets are identical, the same or similar. This was not enough. The markscheme required reference to the fact that they are *genetically* identical. Further marks were then gained for explaining that this is a type of asexual reproduction, which involves mitotic division and an exact replication of the parent DNA. Reference to the fact that the plantlets all have the same genotype and that mutation will be very rare were also worthy of credit.

(b)(i) On the whole, this part was not answered particularly well. Far too many candidates simply copied out Table 1.1. Although figures were often quoted, the appropriate units were omitted.

Many did appreciate that *both* hormones need to be present for any growth to occur. Good answers also pointed out that the level and type of growth depends on the relative concentrations of the auxin and cytokinin (up to 2 marks could be gained for appropriate descriptions of this). Few noted that the required concentration of auxin is always much higher than that of cytokinin.

(ii) Here, a majority tried to make use of their own knowledge and understanding, rather than trying to derive their answer from the information in Table 1.1. Many suggested providing a range of other growth substances, such as gibberellins, providing them with minerals and placing them in a source of light.

From the table, it is clear that transferring the shoots from treatment D to treatment B, would stimulate the growth of roots and the development of plantlets.

(c)(i) This calculation was generally correct - though the answer was not always put in the box in the table, as instructed.

(ii) Answers here were all too often somewhat vague and rambling. An appreciable number of candidates had not realised that the figures in the final two columns of Table 1.2 referred to numbers and percentages with NO contamination. Equally, many did not understand that it is the percentage figures which are much more relevant than the actual numbers (given the varying numbers of explants tested in each investigation).

All that said, many did point out that the stem tissue method consistently produced a lower percentage of contaminated explants (irrespective of the time of year) and that, with both methods, the lowest levels of contamination occurred in January. Further, the highest percentages of contamination were in August for the leaf disc method and in April for the stem tissue method.

Credit was given for substantiating the answer with correct quoting of figures from the table.

(d) Here, many candidates simply repeated what they had said in the previous section i.e. they suggested only using the stem tissue method and only taking explants in January.

In order to gain credit, it was expected that they would suggest how contamination could be reduced below those found in the investigation.

Some candidates did realise that there was a clue in the question i.e. these investigations were carried out without the use of fungicides or antibiotics - clearly had these been used, it would be reasonable to expect a much lower percentage of contamination.

Question 2

In this question, many candidates seemed to experience some difficulty in interpreting the data presented in Fig. 2.1.

(a)(i) It was not uncommon for two of the three marks to be scored in this part. A majority did recognise that the probability of pregnancy decreases with age - and they got a second mark for quoting figures from Fig. 2.1 to substantiate this.

Few pointed out that the decrease in probability between the first and the second age groups is approximately the same as between the second and third age groups. Also, that the peak of probability is on the same day of the menstrual cycle for all three of the age groups.

(ii) Many correctly pointed out that, with partners five years older than themselves, there is little change in the 27-34 age group. In addition, good candidates also noted that there is a general reduction (i.e. throughout the period of investigation) amongst women of the 35-39 age group. Few identified the clear decrease of the peak probability in the youngest age group (i.e. 19-26).

(iii) There were many confused answers to this part, suggesting that candidates did not always understand exactly what was being asked. Many answers suggested that they thought they were being asked the probability of becoming pregnant if intercourse occurs on the day of ovulation.

Those who did understand frequently pointed out that the probability is always greater if intercourse takes place before ovulation, as compared to after. If they also pointed out that, for all three age groups, the probability is at its greatest 2 days before ovulation, then a second mark was awarded.

Few made any reference to the fact that the fertile period appears to be the same in all three age groups - and there would have been credit for quoting correct days from the x-axes to substantiate this.

(b) A significant number of candidates failed to gain any credit in this part, because they based their answers on discussion of levels of female hormones at this stage of the menstrual cycle - which, in this case was irrelevant.

Marks were awarded for saying that the 48 hours give the sperm time (1 mark for this idea) both to reach the oviduct and undergo the process of capacitation (two further marks). Credit was also given if some detail of capacitation was included - others also gained a mark for a correct reference to the state of the cervical mucus two days before ovulation.

Question 3

(a) Although half marks were rounded up in the part, it was quite rare for candidates to gain both available marks.

A was frequently labelled as 'filament' - in this part, the markscheme required a label of vascular tissue or bundle.

B is the stomium ('line of dehiscence' was acceptable).

C is the pollen sac - this was quite frequently correct.

D is the tapetum ('nutritive layer' was acceptable - though rarely given as an answer)

(b) This was often very well answered and it was not unusual for candidates to gain all of the available 4 marks. The first three marks were picked up for describing the *meiotic* division of pollen mother cells, to produce a tetrad ('four cells' was acceptable) of haploid cells. Further credit was then gained for describing the formation of cells walls (or correct reference to the intine and exine) and the subsequent *mitotic* division to produce a pollen tube nucleus and generative nucleus (this was, quite often, incorrectly described as the degenerative nucleus). Good answers then went on to describe the mitotic division of the generative nucleus to produce the two male nuclei or gametes.

(c) The completion of this diagram was relatively poor - it was expected that correct diagrams would show that there is a single opening to each pollen sac and that the walls are reflexed once the sacs have burst.

Question 4

(a)(i) It was clear that many candidates did not really understand the data that is presented in Fig. 4.1. This meant that they found it difficult to explain how the data may have been obtained. Credit was given if they explained the need for a large number (i.e. 100 or more) of boys and girls and for the fact that their heights would need to be measured from an early age and, thereafter, on a regular basis (for example, every 6 or 12 months) until their mature height is reached. It would then be necessary to calculate the percentage of that mature height reached in each of the earlier years. A correct reference to the calculation of means would also have gained a mark.

(ii) Here, also, a lack of understanding of the data made it quite difficult for many candidates to answer this correctly. Many suggested that the girls are always taller than the boys and that, at the end of the curves, both sexes reach the same height. Many also tried to relate this data both to absolute and relative growth rates - neither of which have any relevance.

Good answers did point out that, girls reach any given percentage of their mature weight at an earlier age than boys and that they reach their mature height at the age of 16, whilst boys only reach their mature height at the age of 18. Further credit could be gained by correct quoting of figures from Fig. 4.1 and comparing the different ages at which growth spurts occur - for girls this is between the ages of 11 or 12 and 13, for boys it is between the ages of 13 or 14 and 15 or 16.

(iii) Sensible and relevant suggestions for the use of this data were seldom seen. A frequent response was simply to compare the growth of boys and girls.

Much better suggestions would be to monitor growth, so that if there are sign of an abnormality, it can be investigated and treated. Other acceptable suggestions were that the curves could be used to advise levels and types of nutrition at different ages or that they could be used by clothes manufacturers and retailers to determine appropriate sizes that would need to be available for different age groups.

Option 4

Applications of genetics

Question 1

(a) This was generally well answered and it was not uncommon for candidates to gain 3 or 4 marks. Many simply said that it results in a clone because all the plantlets are identical, the same or similar. This was not enough. The markscheme required reference to the fact that they are *genetically* identical. Further marks were then gained for explaining that this is a type of asexual reproduction, which involves mitotic division and an exact replication of the parent DNA. Reference to the fact that the plantlets all have the same genotype and that mutation will be very rare were also worthy of credit.

(b)(i) On the whole, this part was not answered particularly well. Far too many candidates simply copied out Table 1.1. Although figures were often quoted, the appropriate units were omitted.

Many did appreciate that *both* hormones need to be present for any growth to occur. Good answers also pointed out that the level and type of growth depends on the relative concentrations of the auxin and cytokinin (up to 2 marks could be gained for appropriate descriptions of this). Few noted that the required concentration of auxin is always much higher than that of cytokinin.

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From the table, it is clear that transferring the shoots from treatment D to treatment B, would stimulate the growth of roots and the development of plantlets.

(c)(i) This calculation was generally correct - though the answer was not always put in the box in the table, as instructed.

(ii) Answers here were all too often somewhat vague and rambling. An appreciable number of candidates had not realised that the figures in the final two columns of Table 1.2 referred to numbers and percentages with NO contamination. Equally, many did not understand that it is the percentage figures which are much more relevant than the actual numbers (given the varying numbers of explants tested in each investigation).

All that said, many did point out that the stem tissue method consistently produced a lower percentage of contaminated explants (irrespective of the time of year) and that, with both methods, the lowest levels of contamination occurred in January. Further, the highest percentages of contamination were in August for the leaf disc method and in April for the stem tissue method.

Credit was given for substantiating the answer with correct quoting of figures from the table.

(d) Here, many candidates simply repeated what they had said in the previous section i.e. they suggested only using the stem tissue method and only taking explants in January.

In order to gain credit, it was expected that they would suggest how contamination could be reduced below those found in the investigation.

Some candidates did realise that there was a clue in the question i.e. these investigations were carried out without the use of fungicides or antibiotics - clearly had these been used, it would be reasonable to expect a much lower percentage of contamination.

Question 2

(a) Generally, this part was reasonably well answered by the candidates who chose this option. That said, it was rare for all 4 marks to be gained.

Many did explain that it is to maintain genetic diversity (and, therefore, the gene pool) and for use in the future - for example, when certain varieties of rice are wiped out by environmental changes or disease. A further mark was gained if it was pointed out that this could prevent the extinction of certain varieties.

Few appreciated that such a seed bank represents a store of rice ALLELES.

(b) This part was not well answered and few candidates made it clear that they understood that the production of this new variety would involve artificial selection, which is much faster than natural selection, with humans acting as the selection agent.

In many answers it was equally unclear that plants with the desired characteristics would need to be chosen and interbred - followed by selection of the offspring and further interbreeding of those showing the characteristics required in the new variety - as outlined in Table 2.1.

Question 3

(a) Generally, this was well answered - most appreciated that both of these genotypes will produce edible, sugarsnap pods. This was acceptable for credit.

Others went on to describe the two genotypes - Aabb will produce pods with a thin layer of lining cells, though not lignified. aaBB will produce pods without such a lining.

An appreciable number of candidates failed to gain the second mark for by suggesting that aaBB is lignified, even though the lining is absent.

(b) This part was very well answered and it was not uncommon for candidates to gain maximum marks in this part.

Generally, the parental cross to produce the F_1 was entirely correct, with regard to illustrating the gametes and both the F_1 genotypes and phenotypes. A majority of candidates then went on to show a correct Punnett square as regards the interbreeding of the F_1 generation, to produce the F_2. Generally, if mistakes were made, it was that the phenotypes of the F_2 were not either clearly, or correctly, matched with the phenotypes. This often led to the ratio of the F_2 phenotypes being incorrectly quoted.

As in **(a)** there was some confusion between with and without the lining of cells and whether they were lignified or not.

The correct phenotypic ratio was either:

9 tough pods: 7 sugarsnap

or

9 tough: 3 thin layer (non-lignified): 4 no layer

Question 4

Of the candidates who attempted this option, many struggled to gain high marks on this question.

(a) Here, good candidates did appreciate that, if a genetic disease is caused by a recessive allele, it could be masked by a single dominant allele, if it was possible to introduce it via gene therapy.

Further credit was then available if they pointed out that the problem with a disease caused by a dominant allele, is that the dominant allele would have to be removed or inactivated and that, practically, this would be much more difficult to achieve.

(b) A majority of candidates answering this did not understand why the liver should be chosen as the target organ for this type of therapy.

Some realised that it is the site of production of the blood clotting proteins i.e. Factor IX - and this is one very good reason why it would be targeted.

Few suggested that another good reason would be that it is a very large and active organ and therefore more likely to respond to the therapy.

(c) Here, also, a number of candidates appeared to be ‘stabbing in the dark’. Suitable answers were considered to be that the allele might end up being inserted in another gene, thereby disrupting its activity, it may be inserted in a tissue other than the target tissue, with unknown consequences or the virus itself might cause some damage to the tissue.