BIOLOGY

Paper 9700/01
Multiple Choice

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

General comments

The mean score was 24.6 (61.5%) and there was a very good spread of scores, the standard deviation being 6.39. Seven questions were answered correctly by 80% or more of candidates – **Questions 5**, **8**, **11**, **15**, **23**, **33** and **37**. Nine questions were difficult; 40% or fewer candidates answered **Questions 7**, **9**, **18**, **24**, **26**, **34**, **36**, **38** and **40** correctly.

Comments on specific questions

Question 1

The relative difficulty of this item was due to many candidates failing to appreciate that the most appropriate unit for measuring the diameters of alveoli is micrometres and that the width of cell walls should be measured in nanometres.

Question 2

Most of the less able candidates did not realise that if nucleoli are missing from cells, the cells die because no ribosomes are formed and this stops protein synthesis.

Question 3

Almost a quarter of the less able candidates did not realise that specimens viewed under an electron microscope are dead.

Question 4

Many candidates still do not understand that a plan diagram must not contain any cells, but just show the overall distribution and thickness of tissues.

Question 7

The majority of starch is formed as a simple polymer of α-glucose with 1-4 glycosidic bonds. Glucose has the general formula $C_6H_{12}O_6$; however, each time a glucose molecule forms a 1-4 bond, a molecule of water is lost by condensation. Therefore, the general formula of starch is $C_6H_{10}O_5$.

Question 8

This was answered correctly by most candidates, showing understanding of the structure of amylase and amylopectin.

Question 9

Over half the less able candidates incorrectly thought that triglycerides are formed from three fatty acids and glycogen. Fatty acids can be saturated or unsaturated, but both triglycerides and phospholipids can be saturated to differing degrees,

Question 10

Almost all of the more able and about half of the less able candidates got this correct. The other less able candidates had no real understanding of what a carboxyl or amine group is.

Question 11

It was pleasing to note that the vast majority of candidates know the colours formed during the Benedict's test.

Question 12

Even some of the more able candidates did not appreciate that the benefit of having the disaccharide, lactose, in the milk of mammals would be to provide a gradual release of monosaccharide.

Question 13

Just under half of all candidates did not realise that upon hydrolysis of triglycerides, fatty acids are formed which would decrease the pH and this acidity could denature the lipase.

Question 17

This question was answered correctly by the majority of the more able candidates, but only by 35% of the less able candidates.

Question 18

Over half of all candidates incorrectly thought that a reduction division reduces the chance of mutation. The reduction division is necessary to ensure that the diploid number is retained in future generations.

Question 19

Many less able candidates could not work out that a chemical that stops chromatids separating during mitosis would result in cells stopping dividing at metaphase.

Question 20

Over half of the less able candidates only converted the DNA triplet CAT to a mRNA codon of GUA, instead of a RNA anticodon of CAU.

Question 22

This was correctly answered by the majority of the more able candidates.

Question 24

Whilst 67% of candidates knew that transpiration is the loss of water vapour from leaves, only 22% knew that the advantage of this to the plant is to have stomata open for gas exchange.

Question 25

Most candidates realised that the circumference of a tree varies due to water movement, but only just over 50% linked this to reduced tension in the xylem vessels during the night.

Question 26

Most candidates did not realise that mass flow can occur in different directions in different phloem sieve tubes at the same time. Mass flow can occur only in one direction in one sieve tube due to active loading at the source.

Question 27

A significant number of candidates forgot that ions cannot cross a phospholipid bilayer.

Question 29

Candidates must ensure that they fully read the question. Statement A is incorrect since although human haemoglobin has a greater affinity for oxygen than vertebrate X, there is no information about the affinity at other temperatures. Therefore, we do not know if the affinity increases more in humans than in vertebrate X because there is not enough data.

Question 30

Many of the less able candidates did not understand the effects of the different components of cigarette smoke.

Question 31

Many candidates appeared to forget that endocytosis involves taking material into the cell. Mucus produced by goblet cells would be released by exocytosis.

Question 32

Whilst most candidates knew that more mucus would be produced, resulting in more active goblet cells, many did not realise that minute particles would be ‘foreign’ to the body and would produce an immune response.

Question 33

It was pleasing to note that most candidates knew the four types of immunity.

Question 34

The roles of the various types of T-lymphocytes should be understood. A major role of T cells is to detect and destroy any normal cell that has been changed by a virus or mutation into an abnormal cell. Any graft of tissue from a different person will have what the recipient T cells detect as abnormal cells. Therefore, T killer cells will gather at the graft site and destroy the graft. This is called rejection.

Question 35

Many less able candidates still struggle to understand the roles of B- and T-lymphocytes.

Question 36

Most candidates still do not appreciate that a course of antibiotics needs to be taken at regular intervals in order to keep the antibiotic concentration at a high enough level to continue to kill the bacteria.

Question 37

The method of transmission of the diseases cholera, malaria and HIV/AIDS was very well known by almost all candidates.

Question 38

Whilst most candidates realised that the leguminous crop would add nitrates to the soil by nitrogen fixation, many did not realise that by ploughing in the crop, the remains would supply mineral ions to the soil both by decomposed and nitrification.

Question 39

Although most of the more able candidates knew that energy transfer from the sun to plants is least efficient, less than 20% of less able candidates could answer this correctly.

Question 40

Candidates should know that denitrifying bacteria are most common in soil with little oxygen. Soil which is compressed will have far fewer air spaces as will poorly drained or water-logged soil.

Location Entry Codes

UNIVERSITY of CAMBRIDGE
International Examinations

As part of CIE's continual commitment to maintaining best practice in assessment, CIE has begun to use different variants of some question papers for our most popular assessments with extremely large and widespread candidature, The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions are unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiner's Reports.

Question Paper	Mark Scheme	Principal Examiner's Report
Introduction	Introduction	Introduction
First variant Question Paper	First variant Mark Scheme	First variant Principal Examiner's Report
Second variant Question Paper	Second variant Mark Scheme	Second variant Principal Examiner's Report

Who can I contact for further information on these changes?
Please direct any questions about this to CIE's Customer Services team at: international@cie.org.uk

BIOLOGY

Paper 9700/21
AS Structured Questions

General Comments

There were many encouraging responses from the well prepared candidates with good use of previous question papers and mark schemes. Several candidates and sometimes whole Centres did however produce disappointingly low scores. Some Centres who have tended to score generally low in previous sessions did show improvements in the proportion of candidates who performed better.

Question 4 was generally well done and **Question 2**, the ecology question, also scored highly, more so than in previous sessions. **Questions 1(a)(i)(ii)**, **(d)(ii)**, **2(b)(ii)**, **3(a)(b)(ii)**, **4(a)(ii)(iii)**, **5(a)** and in particular **5(b)** and **6(c)** did cause difficulty, even sometimes for the more able candidates.

Several of the part questions above did require the use of extended prose in response, where some candidates had difficulty in organising their thoughts, often repeating themselves or giving generalised accounts in answering the question.

Some candidates continue to lose marks by not using their knowledge and understanding to answer the specific question. For example, in **Question 6(b)** many candidates described in detail the various ways in which cigarette smoke damages lung tissue rather than specifically addressing lung cancer.

Again, in **Question 1(d)(ii)**, candidates often gave imprecise suggestions referring to densely populated countries and lack of medicines rather than overcrowded housing and lack of vaccinations and antibiotics in suggesting reasons for the higher fatality ratios for tuberculosis in some countries.

Interpreting tables and graphs and then applying knowledge, as in **Question 1(d)(i)(ii)** and **Question 6(c)** was not easy for many candidates.

As mentioned on previous occasions, candidates should be encouraged to take note of mark allocations given in brackets and words in bold type face as well as using appropriate scientific terminology in composing their answers.

Differentiation between candidates was evident. There were many marking points available on the mark scheme to allow candidates to demonstrate their knowledge and understanding. Some candidates gave no answers to some part questions but this was due to lack of knowledge and understanding rather than lack of time.

The continued use of previous papers and mark schemes as part of in depth revision will improve the scores of many candidates.

Comments on Individual Questions

Question 1

Some candidates gained only a few marks but many others produced a high scoring response with full and accurate answers. Several found **(d)(ii)** difficult.

(a) (i) Many candidates were able to draw and label the nuclear envelope and a mitochondrion, as seen under the electron microscope, in the ciliated cell in **Fig. 1.1**. Others, however, drew organelles of inappropriate size, often with one membrane (rather than a nuclear / mitochondrial envelope), no nuclear pore(s) and cristae attached to the inner mitochondrial membrane rather than infoldings of the inner membrane or cristae indicated separately in the matrix. Several candidates had their drawing of the mitochondrion inside a large nucleus, produced light microscope drawings and sometimes failed to label their structures.

(ii) There have been recent improvements in calculations. However, in calculating the magnification of the ciliated cell in **Fig. 1.1.** several candidates still did not appreciate that magnification = size of image / actual size (100 × 1000 / 35 = × 2857). Errors included not measuring the scale bar in mm, problems with unit conversions to micrometres, failing to give an answer to the nearest whole number and occasionally not showing any working. Several candidates apparently did not possess a ruler and were guessing the length of the scale bar, for example 6 cm, whilst others in expressing their answer to the nearest whole number rounded up 2857.14 to 2860 or even 3000. Weaker candidates sometimes gave × 3500, having divided the actual size by the measured length.

(b) Many candidates were able to state three structural features that are found in **both** *M. tuberculosis* and animal cells, making suitable reference to the cell membrane, cytoplasm, ribosomes and chromosomes / DNA material. Several candidates simply gave membranes or inappropriately referred to 80S / larger ribosomes rather than stating ribosomes / 70S ribosomes. Vacuole was not uncommon.

(c) In explaining how *M. tuberculosis* is transmitted from an infected person to an uninfected person, many candidates, whilst referring to coughing / sneezing, even breathing out by the infected person, failed to mention the aerosol / droplets when referring to inhalation by the uninfected person. Several candidates referred inaccurately to the breathing in of air or bacteria. Few candidates on this occasion failed to read the question carefully and made erroneous references to cows and unpasteurised milk. Some candidates confused TB with, for example, HIV / AIDS and described sexual transmission / via the placenta.

(d) (i) In completing **Table 1.1** several candidates ignored the quoted fatality ratios in the table, given to two decimal places (significant figures) and stated 0.246 rather than 0.25 and a significant number inappropriately entered .25, again not following the established convention in **Table 1.1**.

(ii) As mentioned under 'General Comments', some candidates still link 'overcrowding' and 'poor' with countries / populations rather than specifically with some accommodation, housing and people in those countries, in suggesting why tuberculosis fatality ratios are higher in certain countries than in others. Weaker responses were often characterised by general references to the level of education, the availability of medicines, lack of money, even erroneously to poor sanitation and hygiene. Able candidates referred to the lack of effective antibiotics and availability of medical services in rural areas, to TB being an opportunistic disease of HIV / AIDS individuals and occasionally to MDR-TB / not completing the course of antibiotic treatment resulting in antibiotic resistance. Few mentioned the lack of DOTS (Direct Observation Treatment Scheme) to encourage individuals to finish their drug treatments. There was the occasional mention of the lack of testing / treatment of cattle / milk which was appropriate on this occasion.

Question 2

This was often a high scoring question, reflecting good understanding and revision, though **2(b)(ii)** caused difficulty for some candidates, as mentioned under 'General Comments'.

(a) Only the weaker candidates had difficulty with habitat, niche and population. The use of the word habitat in defining community was accepted, although since within a community many species may well have their own habitats, it may have been more appropriate to refer to an ecosystem / place / area. Other candidates did not always emphasise that the term community refers to, for example, all the organisms in an ecosystem. Only the very weakest candidates left blanks.

(b) (i) Most candidates gave primary consumer / herbivore in stating the trophic level occupied by the sloth in the food chain described in **Fig. 2.1**. Several simply referred to the second (trophic level) or even more inappropriately to secondary level.

(ii) In suggesting **one** advantage to the sloth of having bacteria / microbes in its stomach, many candidates simply referred to these micro-organisms digesting cellulose, which was information given in the stem of the question, without clearly emphasising that the sloth is unable to digest cell wall material itself. There were many inappropriate and unclear references to microbes helping or allowing the sloth to digest cellulose and to microbes providing energy for the sloth rather than products / sugars which can be utilised by the sloth. A few candidates were aware that such microbes can provide protection for the sloth from gut pathogens and parasites.

(iii) In suggesting why there are few predators in the forest ecosystem despite the presence of many producers such as trees, good candidates understood that inefficient energy transfer between trophic levels limits the numbers of prey. Only the most able understood that this in turn limits the population of predators, which are often top carnivores competing for prey. Other appropriate responses referred to hunting of predators by man and occasionally the areas where predators live being destroyed. Weaker responses mentioned energy loss but with no reference to between trophic levels and several erroneously stated that 10% was lost. Very poor responses referred to sloths hiding in trees making it difficult for predators to hunt their prey.

Question 3

There were many encouraging answers to this question, with stronger candidates able to apply their knowledge and understanding to an unfamiliar situation. Others were less confident and their responses in particular to **3(a)** and **3(b)(ii)** were sometimes disappointing.

(a) In explaining, with reference to the information in **Fig. 3.1**, how flatworms survive without a transport system, a pleasing number of candidates referred to a flat / thin body providing a large surface area to volume ratio (sometimes substantiated with a calculated ratio from the data provided) through which gas exchange by diffusion could occur and no cell being far from the body surface. Only a few candidates mentioned the low activity / metabolism of the flatworm as being significant. Weaker responses only made reference to the large surface area, referred incorrectly to a small surface area to volume ratio, failed to take into account both long surfaces in any calculation, frequently referred to pores and occasionally mentioned lungs.

(b) (i) Able candidates appreciated that active transport / uptake using ATP would enable the flatworm to move sodium ions against their concentration gradient and therefore help to retain sodium ions in their body fluids. Few indicated that sodium ion channels might not be present in the cell membranes, rendering them impermeable to sodium ions. Weaker candidates often confused ion channels and sodium pumps, whilst many responses involved reference to all the physical processes of diffusion, facilitated diffusion and osmosis.

(ii) Able candidates fully appreciated the role of sodium ions in organisms, usually referring to the generation / conduction of the nerve impulse. Fewer candidates stated the roles of concentrating urine or maintaining the water potential of body fluids or maintaining the electrolyte balance. Reference to the co-transport of glucose was rare. Less able candidates inappropriately mentioned electric impulses and impulses moving across a synapse, confusing the roles of sodium ions with calcium ions in synapses. Several mentioned water potential but with no suitable qualification, or the sodium-potassium pump, with no reference to impulse transmission. Many candidates could not give a suitable answer.

Question 4

There were some excellent responses to all parts of this question, showing a sound knowledge of biological molecules and biochemical tests, though **4(a)(ii)** and **(iii)** did cause difficulty for some candidates.

(a) (i) The vast majority of candidates were able to name **A, B, C** and **D** in **Fig. 4.1**, a diagram showing how catalase is produced in cells, as transcription, tRNA, ribosome and anticodon respectively. However a significant number gave **A** as translation and **D** as codon, and many in naming the sequence of bases (bracketed) at **D** gave the names / letters of individual bases rather than anticodon.

(ii) Candidates were asked to refer to **Fig. 4.1** in stating ways in which the structure of catalase is similar to and different from that of haemoglobin. Able candidates having studied **Fig. 4.1** referred to, for example, a quaternary structure, a polymer of amino acids, to four subunits or to the presence of haem in stating two structural similarities. Weaker candidates referred to four identical subunits or that both were globular. In stating one structural difference, most referred to the four identical subunits (as compared with the alpha and beta polypeptides of haemoglobin). Weaker responses made inappropriate reference to differences in secondary and tertiary structure, or stated that haemoglobin was not an enzyme.

(iii) In stating why it is possible for a catalase molecule to bind to four substrate molecules at the same time, able candidates mentioned each of the four subunits / polypeptides having an active site or the presence of four haems.

(b) No great difficulties here for able candidates. Many candidates understood that iodine in potassium iodide solution and Benedicts solution would allow the progress of the reaction to be followed. Candidates appreciated that these solutions would indicate the disappearance of the substrate (starch) and the appearance of the product (maltose) respectively. Weaker candidates incorrectly referred to iodine rather than iodine solution. The preferred response is iodine in potassium iodide solution. Others confused Biuret solution with Benedicts reagent. The question did not require candidates to qualify their answers with descriptions of the actual biochemical tests, but many did, including giving 'before' and 'after' colours. Although this was not penalised, candidates should be reminded to answer the command term for each question. Examiners did note that, where candidates had qualified their answers, many did not realise that maltose was a reducing sugar and mentioned acid, alkali and Benedicts in their response.

Question 5

There were relatively few very good responses to this question particularly in **5(b)**.

(a) Not all candidates explained, in terms of **water potential**, how water moves from **Q** (xylem vessel) to **R** (the atmosphere) as shown on the transverse section of a leaf in **Fig. 5.1**. Only the best candidates made sequential reference to water moving down a water potential gradient from the xylem vessel through the cell walls / apoplast pathway and symplast pathway into the spongy mesophyll cell walls. Not all candidates appreciated that evaporation involves the loss of water vapour from these cell walls into the air spaces prior to diffusion through the stomata. Weaker responses still mention water moving down a concentration gradient and to the loss of water from the stomata by evaporation. Detail of the pathway of water through the leaf was not well known.

(b) Many candidates still find it very difficult to correctly link structural features of xylem vessels with appropriate explanations when describing adaptations for the transport of water. For example, candidates might correctly state no cytoplasm or the lack of end walls but inappropriately link such features with transport of large volumes of water rather than their being less resistance to flow. Having a large / wide lumen would be a structural feature linked with the large volume of water that can be transported. The narrowness of the vessels was often given as a structural feature, even though capillarity is not thought to be a main factor in (mass) transport. A significant number still refer to lignin preventing bursting of the xylem vessel rather than stops collapse (under tension). There appears to be some confusion between cellulose and lignin – cellulose has a hydrophilic nature so allows adhesion of water molecules. Candidates should understand that the fact that the xylem vessel is dead is not a structural feature. For many an explanation consisted of a general comment regarding helps / allows the transport / mass flow of water, as suggested in the stem of the question. It is disappointing that many candidates are not even aware of the structural features of xylem vessels.

Question 6

A very sound overall level of response from many candidates in **(a)** and **(b),** but **(c)** was not well answered even by able candidates.

(a) Candidates were asked to state which features of the cell shown in **Fig. 6.1** indicated that it is at metaphase and not anaphase during mitosis. Many candidates correctly indicated the presence of chromosomes at the equator / middle of cell rather than chromosomes separating and moving towards opposite poles. Few noticed the nuclear membrane(s) / envelope still (partially) visible at this metaphase stage. Weaker responses incorrectly mentioned the lack of a nuclear membrane and to chromosomes not being at the poles (this would be a comparison with telophase, not anaphase). Several made reference to centromeres holding chromosomes / chromatids together and to spindle fibres, apparently both being visible in **Fig. 6.1**. A significant number referred inappropriately to chromosomes not splitting. Others used the term genetic material or chromatin or demonstrated no knowledge of mitosis and made reference to dark areas in a line across the cell in their response.

(b) In describing how cigarette smoke is responsible for the development of lung cancer, the majority of candidates knew that smoke / tar contained carcinogens, occasionally giving an example such as benzpyrene. Many additionally and sequentially referred to mutation / change to DNA, to uncontrolled mitosis / cell division and the formation of a tumour in their responses. Only occasionally was the effect on gene expression mentioned, with suitable reference to oncogenes, or that tar actually settles on the bronchial epithelium (not the lining of the alveoli / lungs). Several candidates unnecessarily gave detail of metastasis to other parts of the body when the question referred to lung cancer. Weaker responses were often characterised by the giving of irrelevant detail concerning the effect of smoke / nicotine / carbon monoxide on cilia / goblet cells / mucus production and lung diseases in general, whilst others incorrectly mentioned nicotine and carbon monoxide as examples of carcinogens.

(c) Very few candidates clearly explained why the mortality rate from lung cancer among men increased and then decreased over the period of time shown in **Fig. 6.3**, even though the percentage of smokers decreased over the same time period as shown in **Fig. 6.2**. Not all able candidates appreciated the idea of a long time gap of some 20 to 30 years before symptoms of cancer appeared. Even fewer could quote correct 'data' to <u>support</u> this idea with trends and / or numerical data (often incorrectly read from the graphs) being anchored in <u>both</u> graphs. Several merely quoted the data but did not relate it to any explanation, whilst others only used data from one graph. Many thought it was passive smoking that caused an increase in the mortality rate despite the drop in the numbers smoking. Some candidates mentioned other direct risk factors for lung cancer, for example, air pollution but did not always link such explanation of increasing mortality with exposure from an earlier time (1930s onwards). A significant number correctly suggested earlier diagnosis / improved treatment extending life, with fewer dying, as explaining the decreasing mortality rate. Weaker candidates did not address the question and wrote generally at length about the smoking habit, passive smoking, diet, working conditions and even the age / gender of the persons referred to in **Fig. 6.3**.

BIOLOGY

Paper 9700/22
AS Structured Questions

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Question 4 was generally well done and **Question 2**, the ecology question, also scored highly, more so than in previous sessions. **Questions 1(a)(ii)**, **(d)**, **(e)**, **2(b)(ii)**, **3(a)(b)(ii)**, **4(a)(ii)(iii)**, **5(b)** and in particular **5(c)** and **6(c)** did cause difficulty, even sometimes for the more able candidates.

Several of the part questions above did require the use of extended prose in response, where some candidates had difficulty in organising their thoughts, often repeating themselves or giving generalised accounts in answering the question.

Some candidates continue to lose marks by not using their knowledge and understanding to answer the specific question. For example, in **Question 6(b)** many candidates described in detail the various ways in which cigarette smoke damages lung tissue rather than specifically addressing lung cancer.

Again, in **Question 1(d)**, candidates often gave inappropriate and imprecise information in explaining how it is possible to reduce the number of deaths during a cholera epidemic. Candidates often attempted to give detail of how a cholera epidemic could be prevented, with vague reference to proper sanitation and clean water rather than, for example, rapidly providing bottled water, antibiotics and ORT for individuals suffering from cholera.

Interpreting graphs and then applying knowledge as in **Question 6(c)** was not easy for many candidates.

As mentioned on previous occasions, candidates should take note of mark allocations given in brackets and words in bold type face as well as using appropriate scientific terminology in composing their answers.

Differentiation between candidates was evident. There were many marking points available on the mark scheme to allow candidates to demonstrate their knowledge and understanding. Some candidates gave no answers to some part questions but this was due to lack of knowledge and understanding rather than lack of time.

The continued use of previous papers and mark schemes alongside revision programmes will improve the scores of many candidates.

Comments on Individual Questions

Question 1

Generally candidates scored well in **(a)** to **(c)**, but many found **(d)** and **(e)** difficult, demonstrating a lack of understanding of the treatment and prevention of cholera respectively, in different socio-economic countries of the world.

(a) (i) Many candidates were able to fully and clearly draw a Golgi body forming secretory vesicles and a secretory vesicle releasing its contents by exocytosis in **Fig. 1.1**. Others, however, whilst drawing a Golgi body, failed to show secretory vesicles forming at the sides / ends of the Golgi or show sufficient – at least three – cisternae. Again, some candidates did not draw a secretory vesicle already fused with the cell surface membrane during exocytosis in the region of the cell labelled **X**. Some drawings showed whole vesicles leaving the cell surface membrane with or without fragments of the cell membrane or a gap was left in the cell surface membrane so that no connection to the membrane was obvious. Some candidates attempted to draw exocytosis occurring along the actual line indicating region **X**. Occasionally candidates gave drawings of linked / connected cisternae or used arrows indicating endocytosis rather than exocytosis.

(ii) There have been recent improvements in calculations. However, in calculating the actual diameter of the nucleus of the pancreas cell in **Fig. 1.1**, several candidates still did not appreciate that actual size = size of image / magnification (40 × 1000 / 8000 = 5 μm). Errors included not measuring the length of bar in mm, problems with unit conversions to micrometres, failing to give an answer to the nearest whole micrometre and occasionally not showing any working.

(b) Many candidates were able to state three structural features of *Vibrio cholerae* that are **not** found in animal cells. Such candidates made suitable reference to DNA being free in the cytoplasm, to one type / size of ribosome and the presence of a cell wall. Able candidates occasionally referred to the presence of a capsule and a (simple) flagellum. Weaker responses made inaccurate reference to ribosomes, mentioning smaller / 70S ribosomes rather than prefixing their answer with '**only**'. Others indicated the lack of a nucleus or no mitochondria which was an inappropriate strategy for answering the question.

(c) In completing **Table 1.1** several candidates ignored the quoted mortality rates in the table given to two decimal places (significant figures) and stated 0.471 rather than 0.47 and a significant number inappropriately entered .47, again not following the established convention in **Table 1.1**.

(d) Many candidates were not able to explain specifically how it is possible to reduce the number of deaths during a cholera epidemic. They did not appreciate that deaths are often caused by rapid dehydration, so providing ORT (oral rehydration therapy) with glucose and salts to help with the absorption of water by osmosis would help, as would the provision of boiled water / bottled water. Weaker responses concentrated solely, though not always with detail, on the provision of treatment / medical services or the provision of medicines / antibiotics without any qualification, for example, the need for rapid provision of ORT / medical personnel. Many candidates simply and generally referred to safe disposal of sewage and clean water, again without suitable qualification, for example, providing bottled water / boiled water (to kill bacteria). There were many inappropriate references to washing hands, proper sanitation and vaccination. Many candidates did not address the question and their answers were concerned with preventing an outbreak of cholera rather than reducing deaths during an actual cholera epidemic following, for example, a natural disaster.

(e) In explaining why cholera is unlikely to be transmitted in developed countries, many candidates simply affirmed the general points they had made in **(d)** and restated such countries have safe disposal of sewage and clean water. Examiners were looking for some indication of sewage treatment / mains drainage and chlorination of water to kill bacteria in water treatment plants. It was obvious that many candidates were not familiar with the transmission cycle of cholera and made general points which could apply to many infectious diseases, with vague comments on better education, more money for treatment, improved housing. Many thought the best way to prevent cholera was to vaccinate.

Question 2

This was often a high scoring question, reflecting good understanding and revision, though **2(b)(ii)** caused difficulty for some candidates, as mentioned under 'General Comments'.

(a) Only the weaker candidates had difficulty with habitat, niche and population. The use of the word habitat in defining community was accepted, although since within a community many species may well have their own habitats, it may have been more appropriate to refer to an ecosystem / place / area. Other candidates did not always emphasise that the term community refers to, for example, all the organisms in an ecosystem. Only the very weakest candidates left blanks.

(b) (i) Most candidates gave primary consumer / herbivore in stating the trophic level occupied by the sloth in the food chain described in **Fig. 2.1**. Several simply referred to the second (trophic level) or even more inappropriately to secondary level.

(ii) In suggesting **one** advantage to the sloth of having bacteria / microbes in its stomach, many candidates simply referred to these micro-organisms digesting cellulose, which was information given in the stem of the question, without clearly emphasising that the sloth is unable to digest cell wall material itself. There were many inappropriate and unclear references to microbes helping or allowing the sloth to digest cellulose and to microbes providing energy for the sloth rather than products / sugars which can be utilised by the sloth. A few candidates were aware that such microbes can provide protection for the sloth from gut pathogens and parasites.

(iii) In suggesting why there are few predators in the forest ecosystem despite the presence of many producers such as trees, good candidates understood that inefficient energy transfer between trophic levels limits the numbers of prey. Only the most able understood that this in turn limits the population of predators, which are often top carnivores competing for prey. Other appropriate responses referred to hunting of predators by man and occasionally the areas where predators live being destroyed. Weaker responses mentioned energy loss but with no reference to between trophic levels and several erroneously stated that 10% was lost. Very poor responses referred to sloths hiding in trees making it difficult for predators to hunt their prey.

Question 3

There were many encouraging answers to this question, with stronger candidates able to apply their knowledge and understanding to an unfamiliar situation. Others were less confident and their responses, in particular to **3(a)** and **3(b)(ii)**, were sometimes disappointing.

(a) In explaining, with reference to the information in **Fig. 3.1**, how flatworms survive without a transport system, a pleasing number of candidates referred to a flat / thin body providing a large surface area to volume ratio (sometimes substantiated with a calculated ratio from the data provided) through which gas exchange by diffusion could occur and no cell being far from the body surface. Only a few candidates mentioned the low activity / metabolism of the flatworm as being significant. Weaker responses only made reference to the large surface area, referred incorrectly to a small surface area to volume ratio, failed to take into account both long surfaces in any calculation, frequently referred to pores and occasionally mentioned lungs.

(b) (i) Able candidates appreciated that active transport / uptake using ATP would enable the flatworm to move sodium ions against their concentration gradient and therefore help to retain sodium ions in their body fluids. Few indicated that sodium ion channels might not be present in the cell membranes, rendering them impermeable to sodium ions. Weaker candidates often confused ion channels and sodium pumps, whilst many responses involved reference to all the physical processes of diffusion, facilitated diffusion and osmosis.

(ii) Able candidates fully appreciated the role of sodium ions in organisms, usually referring to the generation / conduction of the nerve impulse. Fewer candidates stated the roles of concentrating urine or maintaining the water potential of body fluids or maintaining the electrolyte balance. Reference to the co-transport of glucose was rare. Less able candidates inappropriately mentioned electric impulses and impulses moving across a synapse, confusing the roles of sodium ions with calcium ions in synapses. Several mentioned water potential but with no suitable qualification, or the sodium-potassium pump, with no reference to impulse transmission. Many candidates could not give a suitable answer.

Question 4

There were some excellent responses to all parts of this question, showing a sound knowledge of biological molecules and biochemical tests, though **4(a)(ii)** and **(iii)** did cause difficulty for some candidates.

(a) (i) The vast majority of candidates were able to name **A, B, C** and **D** in **Fig. 4.1**, a diagram showing how catalase is produced in cells, as transcription, tRNA, ribosome and anticodon respectively. However, a significant number gave **A** as translation and **D** as codon, and many in naming the sequence of bases (bracketed) at **D** gave the names / letters of individual bases rather than anticodon.

(ii) Candidates were asked to refer to **Fig. 4.1** in stating ways in which the structure of catalase is similar to and different from that of haemoglobin. Able candidates having studied **Fig. 4.1** referred to, for example, a quaternary structure, a polymer of amino acids, to four subunits or to the presence of haem in stating two structural similarities. Weaker candidates referred to four identical subunits or that both were globular. In stating one structural difference, most referred to the four identical subunits (as compared with the alpha and beta polypeptides of haemoglobin). Weaker responses made inappropriate reference to differences in secondary and tertiary structure, or stated that haemoglobin was not an enzyme.

(iii) In stating why it is possible for a catalase molecule to bind to four substrate molecules at the same time, able candidates mentioned each of the four subunits / polypeptides having an active site or the presence of four haems.

(b) No great difficulties here for able candidates. Many candidates understood that iodine in potassium iodide solution and Benedicts solution would allow the progress of the reaction to be followed. Candidates appreciated that these solutions would indicate the disappearance of the substrate (starch) and the appearance of the product (maltose) respectively. Weaker candidates incorrectly referred to iodine rather than iodine solution. The preferred response is iodine in potassium iodide solution. Others confused Biuret solution with Benedicts reagent. The question did not require candidates to qualify their answers with descriptions of the actual biochemical tests, but many did, including giving 'before' and 'after' colours. Although this was not penalised, candidates should be reminded to answer the command term for each question. Examiners did note that, where candidates had qualified their answers, many did not realise that maltose was a reducing sugar and mentioned acid, alkali and Benedicts in their response.

Question 5

There were relatively few very good responses to this question, particularly in **(c)**.

(a) No real problems here for the able candidates who were able to use label lines and the letters **P, Q** and **R** to identify (in the vascular bundle shown in **Fig. 5.1**) an endodermal cell with a Casparian strip, a cell wall strengthened with lignin and a tissue that transports assimilates respectively. Weaker candidates occasionally labelled a xylem vessel as **P**, labelled the lumen of the xylem vessel rather than the wall as **Q** and labelled **R** below the xylem tissue or one of the cells in contact with the endodermis rather than the phloem tissue immediately above the xylem.

(b) Good candidates clearly described the function of the endodermis in roots, being aware that the Casparian strip was impermeable to water so blocking the apoplast pathway (other than passage cells if present). Not all however were aware of the significance of this in terms of water and solutes having to pass through the cytoplasm of the cell / symplast pathway, with the cell selecting the solutes required for entry into the base of the xylem (and the possible link with root pressure). Weaker candidates were not aware of or did not understand the function of the endodermis and often described the role of the 'epidermis' in terms of water and mineral salt uptake. Several candidates thought the endodermis provided strength and support to the root.

(c) Many candidates still find it very difficult to correctly link structural features of the phloem sieve tube with appropriate explanations when describing adaptations for the transport of assimilates. For example, candidates might correctly mention sieve plates but inappropriately link this with allowing easy flow of sap rather than preventing the sieve tubes from bursting (not collapse as several candidates stated). It is the presence of sieve pores (in sieve plates) which allow easy flow of assimilates, though several inappropriately referred to flow of water. Other candidates incorrectly referred to no cell contents (rather than little / peripheral, cytoplasm) allowing little / less resistance

to flow. For many, an explanation consisted of a general comment regarding helps / allows the transport or mass flow of assimilates, as suggested in the stem of the question. Several candidates described phloem tissue, referring to companion cells, with no mention of connecting plasmodesmata to the adjacent sieve tube(s), stating many mitochondria as a structural feature. Several candidates confused xylem vessels with phloem sieve tubes and stated that lignin prevents collapse / provides support. It is disappointing that many candidates were not aware of the structural features of phloem sieve tubes.

Question 6

A very sound overall level of response from many candidates in **(a)** and **(b)**, but **(c)** was not well answered even by able candidates.

(a) Candidates were asked to state which features of the cell shown in **Fig. 6.1** indicated that it is at metaphase and not anaphase during mitosis. Many candidates correctly indicated the presence of chromosomes at the equator / middle of cell rather than chromosomes separating and moving towards opposite poles. Few noticed the nuclear membrane(s) / envelope still (partially) visible at this metaphase stage. Weaker responses incorrectly mentioned the lack of a nuclear membrane and to chromosomes not being at the poles (this would be a comparison with telophase, not anaphase). Several made reference to centromeres holding chromosomes / chromatids together and to spindle fibres, apparently both being visible in **Fig. 6.1**. A significant number referred inappropriately to chromosomes not splitting. Others used the term genetic material or chromatin or demonstrated no knowledge of mitosis and made reference to dark areas in a line across the cell in their response.

(b) In describing how cigarette smoke is responsible for the development of lung cancer, the majority of candidates knew that smoke / tar contained carcinogens, occasionally giving an example such as benzpyrene. Many additionally and sequentially referred to mutation / change to DNA, to uncontrolled mitosis / cell division and the formation of a tumour in their responses. Only occasionally was the effect on gene expression mentioned, with suitable reference to oncogenes, or that tar actually settles on the bronchial epithelium (not the lining of the alveoli / lungs). Several candidates unnecessarily gave detail of metastasis to other parts of the body when the question referred to lung cancer. Weaker responses were often characterised by the giving of irrelevant detail concerning the effect of smoke / nicotine / carbon monoxide on cilia / goblet cells / mucus production and lung diseases in general, whilst others incorrectly mentioned nicotine and carbon monoxide as examples of carcinogens.

(c) Very few candidates clearly explained why the mortality rate from lung cancer among men increased and then decreased over the period of time shown in **Fig. 6.3**, even though the percentage of smokers decreased over the same time period as shown in **Fig. 6.2**. Not all able candidates appreciated the idea of a long time gap of some 20 to 30 years before symptoms of cancer appeared. Even fewer could quote correct 'data' to <u>support</u> this idea with trends and / or numerical data (often incorrectly read from the graphs) being anchored in <u>both</u> graphs. Several merely quoted the data but did not relate it to any explanation, whilst others only used data from one graph. Many thought it was passive smoking that caused an increase in the mortality rate despite the drop in the numbers smoking. Some candidates mentioned other direct risk factors for lung cancer, for example, air pollution but did not always link such explanation of increasing mortality with exposure from an earlier time (1930s onwards). A significant number correctly suggested earlier diagnosis / improved treatment extending life, with fewer dying, as explaining the decreasing mortality rate. Weaker candidates did not address the question and wrote generally at length about the smoking habit, passive smoking, diet, working conditions and even the age / gender of the persons referred to in **Fig. 6.3**.

BIOLOGY

Paper 9700/31
Advanced Practical Skills 1

General comments

The majority of Centres returned the completed Supervisor's Report, but in a very few cases the report was not enclosed with the scripts. Centres are reminded how important it is that the Examiner receives the report with each packet of scripts, so that candidates are not penalised for any problems encountered with the practical.

In a few cases it appeared that the Confidential Instructions had not been seen before the day of the examination. The correct materials and apparatus are vital to the success of the examination and thus it is important that entries are made early, so that the Confidential Instructions are received in good time.

Although it is essential that these instructions remain confidential and are not left where candidates may see them, they should be available for use prior to the examination. It is possible that for biology practicals the Centre may be required to germinate seeds or try out reagents.

The question papers must not be opened before the start of the examination. Any checks which are required prior to the examination will be included in the Confidential Instructions. It is important that the Centre does not make changes, either to the quantities or apparatus, without prior consultation with CIE as this may make it impossible for the candidates to fulfil the requirements of the skills being assessed.

It was very pleasing that many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates.

For **Question 1** it was expected that candidates should carry out the instruction to record the colour of the pH paper supplied, even if it did not change. For example, as with ethanol, the paper would be expected to remain yellow. The colour for the glucose might vary depending on the distilled water being used to make up the solution. Thus, the pH recorded could be stated as < 5.2.

Candidates which were familiar with following instructions recognised that if the colour remains the same this is a result to record and thus gave a pH of < 5.2. This type of result gives a significant error in the experiment which was correctly noted by some candidates. Candidates should always follow the instructions and record their observations. Centres should not try to 'make the experiment work' as this will make it more difficult for their candidates to select a significant error and suggest modifications if required.

In any activity the candidates should make a response and record the result gained even if it is unexpected. As this examination is skills based, a candidate may be awarded marks for drawing a correct table regardless of the results. Data analysis, or graph questions, using the candidates' own results are not set so no candidate is disadvantaged by their own lack of results.

The syllabus shows that this component has a microscope activity and it gives the required specification for the microscope lenses. The examination questions are based on the use of an eyepiece lens of magnification ×10 with the appropriate objective lenses of magnification ×10 or ×40. If higher power lenses are provided this may make it more difficult for the candidate to view the required section or cells without having to move the slide. If additional lenses are present they should be removed for the examination.

It is expected that all candidates will have access to a clean, working microscope in order to complete the activity. As the syllabus requirement is for one microscope between two and candidates need the slide for approximately half the examination time, CIE supplies slides on the basis of half the number of slides for the total candidate entry. It is important that Centres make their entries early so that slides can be sent early for Centres to check they have the required number of correctly labelled slides and that they have arrived intact. Centres are reminded that no-one should view the slides prior to the examination. Any specific problems

with slides should be recorded on the Supervisor's Report with the relevant candidate numbers. Candidates should not be penalised if they break a slide.

It was pleasing to find that some candidates had used their eyepiece graticule to draw their plan diagrams. However, the actual units for each layer should not be left on the drawing as this obscures the plan.

Candidates should be taught to use the eyepiece graticule to enable them to proportion their drawings correctly, for example sizes of vascular bundles or depths of layers.

CIE provides eyepiece graticules but it is understood that some Centres have eyepiece graticules already fitted in their eyepiece lenses and it is therefore acceptable for these to be used.

It is important that there is no opportunity for the candidates to see another candidate's work. It is not acceptable for candidates to be given help to use the microscope as the use of the microscope is one of the skills being assessed. However, if a microscope is found to be faulty it should be replaced or extra time allocated for the candidate to complete the activity on another microscope.

It is hoped that the trend to draw what the candidate can actually see down the microscope will continue. Marks are not awarded for additional details which cannot be observed. Some candidates do not seem to be aware that marks are awarded for sharp, unbroken lines and no shading so it is important to have a sharp pencil and to have practised this skill frequently. Centres are reminded that unfamiliar material can be set so candidates need to be able to follow the instructions carefully and only draw what is required.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. The questions, for example, which ask for the errors in an experiment will expect the candidate to select the most significant errors for that specific experiment.

Comments on specific questions

Question 1

(a) (i) The majority of candidates gained both marks for clearly recording the colour of the pH paper for the glucose and ethanol and then interpreting the correct pH values.

(ii) Most candidates were able to decide on an even range of percentage ethanol concentrations using 40% and taking the 0% as the control, so for example 30, 20 and 10% or as a serial dilution 40, 20, 10 and 5%.

In many experiments scientists use a serial dilution to give the range and then repeat the investigation within a narrower range. Candidates should be familiar with serial dilutions by halving or dividing by a factor of 10 between each concentration.

The examples provided indicated that 10 cm^3 should be made up for each dilution and therefore the correct volumes had to be recorded to make the percentage concentration selected.

It was also important that the tubes were organised either in ascending or descending concentration so that when the results were recorded any pattern would be easier to find.

(iii) It was pleasing that most candidates organised the space into a single table. The table should have shown both sets of data for each time and ideally the heading for the concentration of the ethanol with the unit, percentage. The other headings for separate columns should have been the colour of the pH paper and the pH. The different readings for the two times should have been clearly organised. No marks were awarded if the units, colour or pH were recorded with the data. Every candidate who completed the experiment and recorded different colours for at least two of their tubes gained a mark. Where a Centre recorded any difficulty this mark was reviewed so that candidates were not penalised.

This was a complex table and many candidates presented their results very clearly.

(b) (i) Candidates are expected to recognise the most significant errors for the particular experiment and in this case these would have been the fact that the determination of the colour against the chart was difficult or there were readings outside the narrow range pH paper used or the idea that the timing was not the same for each one or that there could have been a loss of carbon dioxide.

(ii) The degree of uncertainty for a syringe is ± half the value of the smallest division on the syringe, with the units cm^3. This is because the whole volume should be released and thus there is only one error for the volume measured.

The percentage uncertainty cannot be calculated unless an actual measured volume is used and as this was not given in the question it was inappropriate to try and calculate the percentage uncertainty.

Many candidates forgot to include the ± or the units or simply confused the units.

(c) (i) It was pleasing that many candidates were able to gain full marks. This meant that the candidate drew the graph with the x (the independent variable) and y (the dependent variable) axes orientated correctly, labelled them clearly, included units, used an appropriate scale, plotted the points accurately as crosses or dots in circles and then drew the line of best fit or joined each point with a ruled line.

The axes labels are best written exactly as they are presented in the table so that candidates do not fail to gain this mark.

Awkward scales were penalised. It should be clear that the grid size on the question paper will enable candidates to select an appropriate scale which will just fit the grid.

Candidates should realise the importance of making sure that they clearly label the intersection of the axes in order to show the values represented by this point. Whilst it is normal to assume that this point is 0,0 many candidates lost this mark as they failed to label the origin.

The plotting of points is also described in the syllabus. In future, candidates using large 'blobs' of more than 1 mm instead of a dot in a circle or a cross will not be able to gain the plotting mark. Some candidates used 'blobs' in circles and did not gain marks. If candidates are not sure what a dot in a circle is, then using a small cross, which clearly shows where the point is being plotted, will always get the plotting mark. As only a limited number of points are plotted it is expected that candidates will take great care to plot them correctly.

Despite the limited number of points some candidates failed to plot one point and this meant that they could not gain this mark. Some candidate appeared to have plotted an additional point where they were asked to estimate at 25°C, this mark was lost for plotting an additional point.

Lines should not be more than 1 mm wide so it is important that candidates have a sharp pencil. Candidates who used a pen were at a disadvantage if they made a mistake as it was very difficult to correct their error. Candidates should be reminded not to extrapolate the line beyond the points given.

(ii) Many candidates correctly read their graph at 25°C but then did not round to a whole number of bubbles or include the complete units. When the question requires the use of the graph then it is inappropriate to try and calculate a reading using the table of data.

(iii) Accuracy is defined as 'the obtaining of results as close to the true value as possible' – so for this answer candidates needed to consider the method of measuring and suggest a method which would improve the results, such as collecting the gas in a gas syringe.

Reliable is defined as 'having results, which are as repeatable as possible'. This would include repeating each measurement to give at least three readings so that a mean could be calculated.

Controlling the variables could improve accuracy or reliability so that any one standardisation of a relevant variable was given credit under either heading. Relevant variables included using a water-bath to keep the temperature constant, using the same volume or concentration of the substrate, staggering the start of each concentration so the timing was kept constant or using a buffer to keep the pH constant.

Candidates often gained the mark for standardising a variable but too many still do not indicate how this would be achieved.

(d) In answering this type of question candidates need to make a clear statement as to whether the hypothesis is correct or partly correct. Candidates should not just restate the hypothesis. However, in this instance it was not valid to state that the hypothesis was incorrect as it is correct for the range of 15 to 40^{o}C. They should then use the information to support their statement. Centres are advised to use a wide range of different hypotheses with different types of data, some of which will support the hypothesis and some of which will not, so that candidates are familiar with how to answer this type of question. Candidates need to quote the data to support their answer and remember to include the units.

Question 2

(a) (i) Candidates need to be aware that it is important to draw only what is asked for in the question and to look carefully at what they can see. Most candidates correctly used the diagram given to draw the part of the stalk which was required.

This question requires the use of a sharp pencil and those candidates who used a pen found it difficult to gain the quality mark or to correct their drawing when they made a mistake. The majority of drawings were large enough.

There are still a number of candidates who draw lots of cells when cells should not be drawn in a plan diagram. Most candidates correctly observed and recorded that the outline was very irregularly folded.

To gain the marks, candidates were expected to draw what they saw, observe that there was a complete but irregular ring of stained tissues below the cortex and use their eyepiece graticule to proportion the layers correctly so that the layer under the epidermis was wider than the narrowest region.

Candidates drawing the whole section failed to gain the mark for observing and drawing at least three very different sized vascular bundles. Candidates should be trained to use the high-power of their microscope to observe the distribution of the tissues which are then drawn onto their low-power plan. For example, vascular bundles can be observed so that their shapes, sizes and distribution of xylem and phloem are recorded carefully, whilst not drawing the actual cells. This would also help the candidates to correctly label the xylem and phloem which would be much clearer on the high-power.

In order to gain marks for plan diagrams candidates need to have seen as much unfamiliar material as possible and practised drawing them.

(b) (i) Candidates are reminded to show all their working.

This question required the candidates to know that a large sample was required to find the mean. At least 5 cells, and preferably more, should be measured as this would give the most accurate mean.

Some candidates failed to mark on the diagram which cells were measured so were unable to gain the first mark. It is important that any method used to identify the cells is very clear to the Examiner.

A few candidates did not include the units so could only gain the two marks for measuring at least 5 cells and showing how to calculate the mean.

For the working it was expected that the measurements should be shown being added up and this total divided by the number of cells measured.

To find the actual size in m it was then necessary to show the multiplication of the answer, for example in mm by 1000 to change it to m, and to show the division by 400 to take into account that the photomicrograph had been magnified by 400.

The best answers presented by candidates clearly showed their calculation step by step as follows:

cell 1 ------- 20 mm
cell 2 ------- 21 mm
cell 3 ------- 17 mm
cell 4 --------16 mm
cell 5 -------- 21 mm

Mean = $\frac{20 + 21 + 17 + 16 + 21}{5}$
= 19 mm
19 mm = 19 **x 1000** m
= 19 000 m
Mag. = × 400
Actual = $\frac{19000}{400}$ = 47.5 m

The best candidates were able to gain full marks on this question and most were able to gain 2 or 3 marks. The syllabus clearly identifies various mathematical tasks and formulae which candidates are expected to know and understand.

(ii) Candidates who realised that the section showed a cell undergoing mitosis were able to correctly identify the region of the root where mitosis takes place.

(c) Following the instructions was very important to enable the candidate to gain the marks. The candidates needed to identify three complete cells and mark these on the photomicrograph. A number of candidates failed to mark the cells on the figure or selected cells which were not complete.

All candidates should be able to draw using sharp, unbroken lines with no shading and large enough so that the cells would not fit into a 6 cm by 6 cm grid. Candidates should make full use the space provided on the question paper.

The cells drawn should have been touching and the best drawings showed that the candidate had carefully observed the shape and relative sizes of the cells.

As there was only one cell without a nucleus which could be selected candidates should have drawn two cells with nuclei and these should have been of the correct proportion for the cell and in the correct position.

It was also clear which candidates had taken care to observe as the cell membranes were being pulled away from the cell walls and did not touch in places around the edge.

As the candidates were asked to label the drawings, a mark for correctly labelling the cell wall and nucleus was given. A few candidates failed to realise that these were plant cells and labelled the outer boundary as the cell membrane.

(d) It was pleasing to see that most candidates organised their space into a table or Venn diagram with clear underlined headings. Most candidates scored high marks for clear comparisons. However, if the question asks for differences then candidates should not include similarities.

Again those candidates who had seen and compared different structures were able to apply this skill to the more unfamiliar material.

BIOLOGY

Paper 9700/32

Advanced Practical Skills 2

General comments

The majority of Centres returned the completed Supervisor's Report, but in a very few cases the report was not enclosed with the scripts. Centres are reminded how important it is that the Examiner receives the report with each packet of scripts, so that candidates are not penalised for any problems encountered with the practical.

In a few cases it appeared that the Confidential Instructions had not been seen before the day of the examination. The correct materials and apparatus are vital to the success of the examination and thus it is important that entries are made early, so that the Confidential Instructions are received in good time.

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The question papers must not be opened before the start of the examination. Any checks which are required prior to the examination will be included in the Confidential Instructions. It is important that the Centre does not make changes, either to the quantities or apparatus, without prior consultation with CIE as this may make it impossible for the candidates to fulfil the requirements of the skills being assessed.

It was very pleasing that many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates.

It was very pleasing that many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates.

For **Question 1** it was expected that candidates should carry out the instructions without any additional assistance.

Some candidates were familiar with following instructions and recognising that even when the drops formed are erratic and do not form evenly, some pattern or trend can still be seen. This type of result gives a significant error in the experiment which can be observed by the candidates. The delay between carrying out the counting of drops from each concentration also meant that candidates were able to use this as a significant error. Candidates should always follow the instructions and record their observations. Centres should not try to 'make the experiment work' as this will make it more difficult for their candidates to select a significant error and suggest modifications if required.

It was not expected that all candidates would see the same changes in number of drops. However, if candidates accurately recorded a different number of drops for at least two concentrations they gained the skill marks.

In any activity the candidates should make a response and record the result gained even if it is unexpected. As this examination is skills based, a candidate may be awarded marks for drawing a correct table regardless of the results. Data analysis, or graph questions, using the candidates' own results are not set so no candidate is disadvantaged by their own lack of results.

The syllabus shows that this component has a microscope activity and it gives the required specification for the microscope lenses. The examination questions are based on the use of an eyepiece lens of magnification ×10 with the appropriate objective lenses of magnification ×10 or ×40. If higher power lenses are provided this may make it more difficult for the candidate to view the required section or cells without having to move the slide. If additional lenses are present they should be removed for the examination.

It is expected that all candidates will have access to a clean, working microscope in order to complete the activity. As the syllabus requirement is for one microscope between two and candidates need the slide for approximately half the examination time, CIE supplies slides on the basis of half the number of slides for the total candidate entry. It is important that Centres make their entries early so that slides can be sent early for Centres to check they have the required number of correctly labelled slides and that they have arrived intact. Centres are reminded that no-one should view the slides prior to the examination. Any specific problems with slides should be recorded on the Supervisor's Report with the relevant candidate numbers. Candidates should not be penalised if they break a slide.

It was pleasing to find that some candidates had used their eyepiece graticule to draw their plan diagrams. However, the actual units for each layer should not be left on the drawing as this obscures the plan.

Candidates should be taught to use the eyepiece graticule to enable them to proportion their drawings correctly, for example sizes of vascular bundles or depths of layers.

CIE provides eyepiece graticules but it is understood that some Centres have eyepiece graticules already fitted in their eyepiece lenses and it is therefore acceptable for these to be used.

It is important that there is no opportunity for the candidates to see another candidate's work. It is not acceptable for candidates to be given help to use the microscope as the use of the microscope is one of the skills being assessed. However, if a microscope is found to be faulty it should be replaced or extra time allocated for the candidate to complete the activity on another microscope.

It is hoped that the trend to draw what the candidate can actually see down the microscope will continue. Marks are not awarded for additional details which cannot be observed. Some candidates do not seem to be aware that marks are awarded for sharp, unbroken lines and no shading so it is important to have a sharp pencil and to have practised this skill frequently. Centres are reminded that unfamiliar material can be set so candidates need to be able to follow the instructions carefully and only draw what is required.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. The questions, for example, which ask for the errors in an experiment will expect the candidate to select the most significant errors for that specific experiment.

Comments on specific questions

Question 1

(a) (i) Many of the more able candidates were able to decide an even range of percentage salt concentrations using 10% stock solution and taking the 0% as the control so for example 10, 7.5, 5 and 2.5% or 5, 4, 3, 2% or as a serial dilution 5, 2.5, 1.25 and 0.625%.

In many experiments scientists use a serial dilution to give the range and then repeat the investigation with a narrower range. Candidates should be familiar with serial dilutions by halving or dividing by a factor of 10 between each concentration.

The examples provided indicated that 10 cm^3 should be made up for each dilution and therefore the correct volumes had to be recorded to make the percentage concentration selected. However, many candidates were unable to calculate the percentage concentration of salt when mixed with yeast.

It was also important that the tubes were organised either in ascending or descending concentration so that when the results were recorded any pattern would be easier to find.

A significant number of candidates were unable to make use of the examples given and gave volumes which would not give the candidates nominated percentage concentration of salt.

(ii) The method required the candidate to decide an appropriate time over which to record the number of drops produced. Obviously this would vary depending upon the conditions in the laboratory. However, all samples should be counted over the same time interval. In most cases the candidates should have decided to take multiple readings for each sample. This was rarely done even when candidates used a suitable time interval of 30 to 60 seconds.

It was pleasing that most candidates organised the space into a single table. The table should have shown the heading for the percentage concentration of the salt when mixed with yeast percentage as the unit. The other heading for a separate column should have been the number of drops along with an indication of the time taken. No marks were awarded if the units were recorded with the data. Every candidate who completed the experiment recorded different numbers of drops for at least two of their tubes. Where a Centre recorded any difficulty this mark was reviewed so that candidates were not penalised.

This was a straightforward table and many candidates presented their results very clearly.

(iii) Candidates are expected to recognise the most significant errors for each particular experiment and in this case these would have been that the samples were left for different times before counting the number of drops, the drops were of different sizes or that there was some form of blockage in the nozzle.

(iv) The degree of uncertainty for a ruler depends upon the type of ruler used. For most plastic rulers there will be an error at each end of the measurement of ± half the value of the smallest division on the ruler with the unit, mm. Therefore, the overall error is ± 2 times half the value of the smallest division.

On some metal rulers, 0 is right at the end of the ruler, therefore the error will only be ± half the value of the smallest division of the ruler.

The percentage uncertainty cannot be calculated unless the candidate includes the actual measured length of the pipette and shows how this was calculated. However, many candidates who did this calculation forgot to include ±.

It was clear a significant number of candidates had been taught how to work out the degree of uncertainty, however, many of these candidates forgot to include either the ± or the units in their answer.

(v) Accuracy is defined ‘as the obtaining of results as close to the true value as possible’ – so for this answer candidates needed to consider the method of measuring and suggest a method which would improve the results such as to collect the volume of solution produced in the drops.

Reliable is defined as ‘having results, which are as repeatable as possible’. This would include repeating each measurement to give at least three readings so that a mean could be calculated.

Controlling the variables could improve accuracy or reliability so that any one standardisation of a relevant variable was given credit under either heading. Relevant variables included staggering the start of each concentration so the timing was kept constant or using a buffer to keep the pH constant. Candidates need to realise that in certain experiments it is not possible to use a water-bath to keep the temperature constant.

Candidates often gained the mark for standardising a variable but too many still do not give how this would be achieved. Other marks gained were those for reliability but it was unfortunate that some candidates reversed their answers.

(b) (i) It was pleasing that many candidates were able to gain full marks. This meant that the candidate drew the graph with the x (the independent variable) and y (the dependent variable) axes orientated correctly, labelled them clearly, included units, used an appropriate scale, plotted the points accurately as crosses or dots in circles and then drew the line of best fit or joined each point with a ruled line.

The axes labels are best written exactly as they are presented in the table so that candidates do not fail to gain this mark.

Awkward scales were penalised. It should be clear that the grid size on the question paper will enable candidates to select an appropriate scale which will just fit the grid.

Candidates should realise the importance of making sure that they clearly label the intersection of the axes in order to show the values represented by this point. Whilst it is normal to assume that this point is 0,0 many candidates lost this mark as they failed to label the origin.

The plotting of points is also described in the syllabus. In future, candidates using large 'blobs' of more than 1 mm instead of a dot in a circle or a cross will not be able to gain the plotting mark. Some candidates used 'blobs' in circles and did not gain marks. If candidates are not sure what a dot in a circle is, then using a small cross, which clearly shows where the point is being plotted, will always get the plotting mark. As only a limited number of points are plotted it is expected that candidates will take great care to plot them correctly.

Despite the limited number of points some candidates incorrectly plotted one point (2.25/53) and this meant that they could not gain this mark. In other cases, candidates appeared to have plotted additional points where they were expected to estimate at 60% and 25%, this resulted in a mark being lost for plotting additional points.

Lines should not be more than 1 mm wide so it is important that candidates have a sharp pencil. Candidates who used a pen were at a disadvantage if they made a mistake as it was very difficult to correct their error. Candidates should be reminded not to extrapolate the line beyond the points given.

(ii) Many candidates correctly read their graph at 60% and 25% but then did not round to the correct number of decimal places. Table 1.4 already had one set of data showing the correct format for the missing results.

(iii) Most candidates clearly showed on the graph how the mass of dried yeast was obtained for 1 and 3 days.

(c) In answering this type of question candidates need to make a clear statement as to whether the hypothesis is correct, incorrect or partly correct. They should not just restate the hypothesis. They should then use the information provided to support their statement. Centres are advised to use a wide range of different hypotheses with varieties of data, some of which will support the hypothesis and some of which will not, so that candidates are familiar with how to answer this type of question. Candidates need to use quotes from the data to support their answer and remember to include the units.

In this case the most accurate answers were either that there will be a higher mass after two days, since the values at 1 and 3 days are both higher than the value at 0 days, or that the hypothesis is not true because there is insufficient data to conclude what happens between day 1 and day 3.

Question 2

(a) (i) Candidates need to be aware that it is important to draw only what is asked for in the question and to look carefully at what they can see. Most candidates correctly used the diagram given to draw the part of the TS of the leaf which was required.

This question requires the use of a sharp pencil and those candidates who used a pen found it difficult to gain the quality mark or to correct their drawing when they made a mistake. The majority of drawings were large enough.

There are still a number of candidates who draw lots of cells when cells should not be drawn in the plan diagram. Most candidates correctly observed and recorded that the outline had a closed, tapered end.

Candidates who drew what they saw, observed that there was a complete region at the tapered end of a densely stained tissue. Additionally, the epidermal layer was clear.

Candidates drawing the whole section failed to gain the mark for observing and drawing only one or two vascular bundles. Candidates should be trained to use the high-power of their microscope to observe the distribution of the tissues which are then drawn onto their plan diagrams.

The candidates which annotated the drawing frequently did so with descriptions of function. This was incorrect since the question asked for annotations describing the visible appearance. Suitable annotations included the epidermal cells being clear or one cell thick, the collenchyma being closely packed or densely stained or having thick cell walls. Xylem could have been labelled as

containing large cells or having red staining, whilst phloem had small cells or blue/green staining. Candidates should be trained to use high-power in order to observe these features.

In order to gain marks for plan diagrams candidates need to have seen as much unfamiliar material as possible and practised drawing them.

(ii) All candidates should be able to draw using sharp, unbroken lines with no shading and large enough so that the cells would not fit into a 6 cm by 6 cm grid. Candidates should make full use of the space provided on the question paper.

The cells drawn should have included two cells from either the upper or lower epidermal layer plus those cells immediately touching them.

A few candidates drew a line of cells including a single upper epidermal cell and a single lower epidermal cell and this was allowed.

Candidates who drew what they saw clearly included an epidermal cell with an outer projection or presence of a large oil drop.

As the candidates were asked to label the drawings a mark for correctly labelling the epidermal cell was given in the majority of cases. The other labelling mark was also often given for any correct observable structure, such as cell wall, nucleus, cytoplasm, chloroplast or vacuole.

(b) This question required the candidates to know which was the stage micrometer and which was the eyepiece graticule.

Those candidates who had experience of measuring using the microscope were better prepared to carry out the question.

The stage micrometer had three divisions visible across the field of view. Therefore the diameter of the field of view was 0.3 mm.
The radius is half the diameter which equals 0.15 mm.
Then all the candidate needed to do was to substitute the value for r in the given formula.
$\pi r^2 = \pi(0.15)^2$

Candidates are also reminded that some assessments are for their reasoning of how to make a calculation, so that where they are asked to show their working this should show the complete, step by step calculation required, as shown above.

Following the instructions was very important to enable the candidate to gain the mark for counting and recording the number of stomata in the field of view. First the candidates needed to identify the stomata and then clearly mark them in some way. A number of candidates failed to mark the stomata on the figure.

For the rest of the working it was expected that the number of stomata would be divided by the value obtained for the area of the field of view. The expected answer should have been about 400 stomata per mm^2.

Too many candidates failed to read the question carefully enough and did not realise that the field of view in **Fig. 2.3** was the same as that in **Fig. 2.4**, Therefore, there was no requirement to take magnification into account.

Candidates should study a range of slides and carry out various measurements and calculations so that they have an appreciation of the actual size of objects and the numbers of cells or stomata in such a small area.

The best candidates were able to gain full marks on this question and most were able to gain 2 or 3 marks. The syllabus clearly identifies various mathematical tasks and formulae which candidates are expected to know and understand. Indeed, candidates should not need to be told the formula for the area of a circle.

(c) It was pleasing to see that most candidates organised their space into a table or Venn diagram with clear underlined headings. Most candidates scored high marks for clear comparisons. However, if the question asks for differences then candidates should not include similarities.

Again, those candidates who had seen and compared different structures were able to apply this skill to the more unfamiliar material using different shapes, sizes, number and arrangement of cells.

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Paper 9700/04
A2 Structured Questions

General comments

This paper was thought to be challenging in parts but provided a very good range of marks with good candidates being able to score very highly. The spread of marks was as large as has been seen and the paper as a whole has discriminated well.

There was generally a good performance by many candidates and overall the marks were higher than last year.

Candidates lost marks for leaving out units in **Question 4(d)(i)**, made errors in reading the appropriate axis and extracting correct figures from **Question 5(b)** and not linking phenotypes to genotypes in **Question 7(a)**. The genetics question was better handled this year although some still attempted sex linkage in **Question 7(a)**.

All questions equally had a variable quality of answers with some very good performances. Neatness of presentation is improving but some candidates wrote into margins for several of the questions.

There were very few problems with the short calculation in **Question 1** which is an improvement on last year. The analysis of the graph in **Question 5** proved to be quite difficult for a number of candidates and consequently this question, along with **Question 8**, was a good discriminator.

Comments on specific questions

Section A

Question 1

(a) Almost all candidates gained full marks on the calculations, working out **(i)** as 18 and **(ii)** as 0.72. A few unnecessarily rounded the answer down in **part (ii)** but still gained a mark as 0.72 was usually shown in the working.

(b) Many candidates attained full marks here. The most common error was in failing to distinguish between the steep decrease and the more gradual decrease in RQ while describing the results.

Most realised that carbohydrates were being respired or metabolised at the start, followed by fats as the RQ dropped due to the carbohydrates running out. Vague responses only described substrates being *used*, while others incorrectly thought that respiration changed from aerobic to anaerobic.

(c) Most responses explained that the rate would increase, with many able to amplify their response, referring to an increase in kinetic energy or enzyme action. Only a minority referred to the idea of $Q_{10} = 2$.

Question 2

(a) Most candidates were able to identify the sites of secretion of oestrogen and progesterone.

(b) The majority of candidates had little trouble in gaining full marks usually mentioning that the secretion of LH and FSH would be inhibited and that follicles would not develop and ovulation would not occur. Only a few referred to the role of the hypothalamus / pituitary gland or negative feedback in their answers.

(c) Many candidates did not appreciate the idea of SOCIAL implications, describing the effect on individuals or families rather than society in general. Many incorrectly cited moral or religious reasons against contraception. A reduction in poverty, starvation and disease, together with the idea of children receiving greater care, were some of the positive ideas expected. Of the negative implications some candidates realised there might be more promiscuity, STD's or cancers. It was also possible here to discuss the negative impact of a reduced population in terms of fewer workers.

Question 3

(a) The activities of humans leading up to the elephant becoming endangered were well known with most candidates gaining full marks.

(b) Few candidates fully used the information supplied about the meerkat to answer this question with some just giving a reverse argument to the problems experienced by the elephants. Unlike the elephants, meerkats feed on a variety of foods, need small amounts of food due to their small size and produce large numbers of offspring. Their burrows also provided protection. Other possible suggestions which a few candidates correctly offered were the idea that they are of no value to humans so are not hunted or that they are camouflaged against their background.

Question 4

(a) (i) Very few candidates could label any of the parts of the maize fruit. It seems apparent that this part of the syllabus needs to be emphasised more in teaching.

(ii) The function of the endosperm as a food or starch store was reasonably well known and some candidates recognised that this food would be needed for use by the germinating maize. Some realised that starch would be hydrolysed to glucose, but few considered its use in respiration – some simply said that the glucose would provide energy. No candidates mentioned the production of cellulose or protein, let alone their functions.

(b) (i) Many candidates were able to describe inhibition although the fact that the inhibition would be permanent was rarely mentioned.

(ii) Most candidates knew that the acetylcholine would not be broken down, but thought that it would remain 'in the synapse' and that no more action potentials would be generated which is in fact the opposite of what happens. Very few considered the depolarisation of the membrane.

(c) Although point mutations were described well, few went on to explain the resulting consequence of the different sequence of amino acids. It should be pointed out that a changed triplet code does not cause a different amino acid to be synthesised. Very few candidates stated that the acetylcholine might still bind with the enzyme after a point mutation, but a significant number realised that pyrethrum would no longer be able to bind with acetylcholinesterase.

(d) (i) Units were not always stated and their omission was only penalised once. The effect of the insecticide on the resistant group compared to the hybrid group for each concentration was rarely considered. For example, candidates were more likely to give the lowest concentration of insecticide when no resistant insects died and compared it to the lowest concentration of insecticide when no hybrid insects died.

(ii) A very small number of candidates thought about basic genetics here and genes or alleles were rarely considered.

Question 5

(a) Candidates were asked to explain why batch culture was used for the production of penicillin. Unfortunately penicillin was mostly ignored and many candidates listed the overall benefits of batch culture over continuous culture. A few did state that penicillin is a secondary metabolite and a very few that a batch culture would cause the nutrient level to drop so that penicillin would be produced.

(b) This question was designed to test the ability of candidates to describe and explain information given in a complicated graph. Colour was used to help the candidate choose the relevant data in answering the question. However, very little data was used in describing the differences in concentrations of penicillin, time was rarely stated and the units for penicillin concentration were often omitted. Most recognised the continual increase in penicillin production when the pH was controlled, but almost no descriptions included a reference to the time period. The fact that penicillin concentration increased and then decreased when the pH was not controlled was described, but the clues were not often picked up to enable the candidates to explain this rise and fall. Some thought that the penicillin itself was broken down by the high pH rather than realising the penicillin production was stopping. Others stated that the fungus was killed, but this still did not cause them to consider enzymes. The optimum pH was sometimes recognised, but only the better candidates remembered the effect of pH on enzyme activity.

(c) This question was well answered with most candidates realising that as viruses have no cell wall they could not be affected by penicillin as the antibiotic acts on the cell walls of bacteria.

Question 6

(a) It was pleasing to note that most candidates have a very good grasp of this topic with many attaining full marks.

(b) There were also some very good answers describing the benefits of using insulin produced by gene technology as opposed to that produced from animals.

(c) (i) Despite the prompts and clues in the question stem and diagram, the majority of candidates could not explain why there is a single target site for a particular restriction enzyme. A few did realise that only one antibiotic gene should be cut so that transformed bacteria with the recombinant plasmid could later be identified, but very few explained clearly that there needed to be complementary sticky ends on both the cut ends of the plasmid and the gene to be inserted. Very occasionally, fragmentation of the plasmid was mentioned.

(ii) There was a great range of marks for this question and it appears that in many instances a lot of guesswork was being applied.

(d) (i) A good response indicated that plasmids would be taken up by other bacteria so that a resistant gene can be passed on the other bacteria and spread in this way. Many were able to go on to explain that this would lead to problems with using antibiotics effectively.

(ii) The biggest error in answering this question was that many candidates mentioned a gene that fluoresced rather than a gene that coded for a protein or marker that fluoresced but only under UV light.

Question 7

(a) A number of candidates failed to note that this was a 'simple monohybrid' cross and presented it as an example of sex linkage or used inappropriate superscripts for their symbols. All that was needed was a single letter, as stated in the question, to denote the gene, with upper and lower case to represent the alleles. The genotype of the chestnut foal needed to be identified and a probability (not a ratio) stated.

(b) Many candidates worked through this genetic cross with due care and scored full marks. Credit was given to candidates who had made a small error earlier in the cross to ensure that they did not lose all four marks.

Question 8

(a) Most candidates were able to correctly identify the palisade layer and the vascular bundle.

(b) This question asked the candidates to reverse their knowledge of stomatal closure in describing stomatal opening and this proved to be a good discriminator. Some candidates gave details of the movement of water through a plant or referred to gaseous exchange in the leaf. A number of candidates failed to distinguish between stoma and guard cell but this mistake was only penalised once. However, many candidates were able to explain, in correct sequence, the active removal of

H^+, the inward diffusion of K^+, the lowering of water potential leading to the entry of water by osmosis. This then led to an increase in turgor of guard cells and the opening of the stoma. Credit was also available for the relevant features of the guard cells, e.g. hoops of cellulose microfibrils, cells joined at their ends and thicker inner walls.

(c) (i) The required answer was 'cyclic photophosphorylation' but often 'photo' was missing.

(ii) The term 'photolysis' was familiar to many candidates and most were able to show that oxygen, protons and electrons would result from this.

(iii) ATP was correctly answered by most candidates.

(iv) Many candidates were able to show that reduced NADP was a hydrogen carrier and used to reduce GP to TP, using ATP.

Section B

Question 9

(a) Credit was given for stating that each amino acid is determined by a triplet of bases and that a change to the base sequence is a mutation. Candidates, generally, were familiar with substitution having, in certain cases, no effect or, in other cases, a dramatic effect. They supported this with an example such as sickle cell anaemia or cystic fibrosis. A frame shift which occurs as a result of the addition or deletion of bases was recognised by more able candidates as being significant. The possible production of a stop codon and the consequent effect on transcription / translation of a change in base sequence producing a modified protein all received credit. Some candidates confused bases and amino acids in their answers.

(b) A number of candidates used examples to answer the question although many of the examples had little merit. As has occurred in previous papers, there was the some confusion between 'populations' and 'species'. Credit was available for the fundamental ideas that, despite great reproductive potential, numbers remain roughly constant, meaning that many fail to survive or reproduce. The variation which exists in a population means that those which survive do so because they are best adapted when environmental factors restrict the population size. Candidates found it difficult to express these ideas clearly. There was also the perennial confusion between 'genes' and 'alleles' and in the context of natural selection it is the advantageous alleles which are passed to the offspring. Credit was often gained for a reference to directional selection, which over time there can be the eventual formation of a new species.

Question 10

(a) Many candidates were very familiar with the structure of cells of the proximal convoluted tubule and were able to describe the process of co-transport of glucose, etc. The site of active transport, from the proximal convoluted tubule cells into the tissue fluid, and the site of co-transport from the lumen into the cells, was sometimes unclear. Most candidates were familiar with the term 'selective reabsorption' but did not always make it clear that what is being reabsorbed returns to the blood stream. A number of candidates confused creatine with creatinine - the latter being the one secreted into lumen.

(b) A detailed description of the release of ADH was not required. Many candidates displayed a lack of precision for example using ‘wall’ instead of ‘membrane’. Many good answers included ADH binding to receptors on the membranes of collecting duct cells, a reference to enzyme controlled reactions and phosphorylase in particular. Good candidates also referred to vesicles with water channels fusing with the cell membranes and more water removed from filtrate into the blood down a water potential gradient leading to the production of concentrated urine. Some answers included reference to the role of the loop of Henle, for which credit was available. This quite difficult subject seems well-understood by many candidates.

BIOLOGY

Paper 9700/05

Planning, Analysis and Evaluation

General comments

Candidates continue to show some improvement in their planning skills, although in this examination candidates did not address the question asked. The ability of candidates to identify the different types of variable correctly also showed further improvement, although for some candidates the difference between the dependent and independent variable still present a challenge. However, in **Question 3** it was clear that the abilities of candidates to interpret data and to use of statistics is still very variable. Many candidates achieved very few marks for this question. How to determine the numbers of degrees of freedom for a statistical test remains a problem for a large number candidates, as does their understanding of the difference between accuracy, reliability and significance. For example, common statements in **Question 3(b)** (ii) included 'the standard deviation is narrow so the results are accurate' and 'standard deviation measures the probability of a result deviating from the actual value'.

Candidates tend write too much extra irrelevant information in their answers and should be encouraged to be more selective. This is most evident in planning where candidates often write detailed instructions on how to set up and operate equipment. Plans should only outline the main points of a procedure explaining what should be done, without the extra information about how it should be done.

Comments on specific questions

Question 1

Most candidates failed to score high marks on this question as they did not follow the instructions to use the apparatus illustrated in the Fig. 1.1. The question was intended to assess the ability of candidates to use their planning skills and biological understanding of plant anatomy to design a way of measuring transport through the stem of a plant using unfamiliar equipment. The majority used a potometer which measures water uptake and not the rate of movement in the stem. In questions where an experimental set up is specified, it is essential that candidates use that apparatus,

(a) (i) Most of candidates gave partly correct answer. Better answers referred to cutting a section and using a microscope to find the stained tissue. Weaker answers suggested the tissue could be seen by looking at a cut stem with the naked eye.

(ii) The question expected candidates to use their knowledge of uptake by roots and to realise that dye molecules may be prevented from entering roots by the partially permeable membrane, whereas a cut stem provides direct access to the xylem. Credit was also allowed if candidates realised that the root system of an intact plant would be too extensive to fit in a test-tube or boiling tube. Very few candidates gained marks in this section. The information given stated that it took several hours to reach the leaves, so references to 'speeding up the experiment' were not credited.

(b) (i) Overall this question was answered poorly. **Part (a)(i)** was intended to give candidates a clue that a suitable method might involve cutting sections of stems at timed intervals, or measuring the time taken for dye to reach a known distance along a stem. As already noted, most candidates used a potometer. Those who did use the apparatus specified did not measure movement in the stem. The most popular incorrect idea was to measure the fall in the volume of dye solution, often at minute of five minute intervals. This suggests that candidates had not carried through the information that it took several hours for dye to reach the leaves. In addition it suggests that candidates did not think very clearly about the how long it would take for the volume change in a test tube to be measurable.

Some marks were available for general principles of planning. Many candidates did show an understanding of which variables needed to be standardised. In many cases however a suitable method was not given. Candidates must state in a plan what they intend to use to control or standardise a stated variable. In this particular investigation a water bath is not appropriate for standardising the temperature. As noted in previous reports, air conditioned rooms are not acceptable as means of controlling temperature and for this experiment, air conditioning is not an appropriate way of controlling air current or wind speed.

There were also marks available for comments on how reliable results might be obtained and any safety issues. Candidates will be also credited if they recognise that a procedure is low risk.

(ii) Most candidates answered this correctly. Credit was given to candidates who described an incorrect procedure but showed how to calculate rate from this method.

(iii) Answers were very mixed. Common incorrect answers were that: water movement would stop as stomata would close or water movement would speed up as leaves would transpire too fast. Many candidates gave lengthy explanations of their prediction, which were not required.

Question 2

This question was intended to test the ability of candidates to interpret experimental data. In many cases it was clear that the candidates has not fully understood the data collection process, in particular the purpose of collecting the same number of live snails as the number of broken shells.

(a)(i) Many candidates found it difficult to identify the independent variable. Common incorrect answers were 'the area', 'the birds' or 'the live snails'. Candidates were expected to recognise that predation was the independent variable. The expected answer for the dependent variable was the number of snails of each type eaten, but credit was allowed if candidates recognised that the relative number of each type of snail was important. While most candidates realised that the snails were the dependant variable, the answers were often too vague for credit, for example 'the number of broken shells and the living shells' or 'how many snails were collected'.

(ii) Candidates who understood the basis of the investigation usually gained two marks for commenting on the differential predation in relation to camouflage. Poorer answers misinterpreted the data and referred to the 'increased survival of the banded snails'. Only better answers showed an understanding that predators hunt by sight and that the collection of live snails was as a control to compare the relative numbers of shell types. Poorer answers referred to snail population, about which there was no data or to 'greater number' of banded snails in the area without predatory birds.

Some candidates had obviously studied this type of selective predation as an example of natural selection and evolution and tended to drift into answers about 'survival of the fittest' and changes in gene pools.

(b)(i) Almost all candidates gave a correct answer.

(ii) Candidates were not expected to have carried out this type of population study, but to draw reasoned conclusions about the reliability of two methods of population estimation. Many candidates made a correct link to the time between the first and second collections and the increased chance of predation or movement into or away from the collection area. Only better answers referred to the possible effect of increased time on how well the marks would stay on the snails, or the possible effect of the marks increasing visibility and thus the number of snails predated.

Question 3

This question was intended to test the understanding of data processing, statistical analysis and the validity of conclusions made from data.

(a) (i) Surprisingly few candidates gave a correct answer. The most common incorrect answers were related to 'taking samples more easily' or 'providing raw materials all the time'.

(ii) Most candidates gave at least one correct answer. The most common was temperature. Many candidates failed to gain the second mark as they referred to 'amount' of nutrient or oxygen. As noted in previous reports, amount is not acceptable, precise statements are expected, such as concentration, volume and mass.

(b) (i) Many candidates found it difficult to give a precise answer. For example, 'the total growth over time'. Some candidates also misinterpreted the information given and described adding the growth from all three pH values and dividing by three. Other candidates referred to the rate of enzyme production.

(ii) Most candidates were able to define standard deviation, although in some cases the answers were too imprecise. For example 'variation from the actual value' and 'the spread from the expected value'. As noted in previous reports candidates confuse reliability with accuracy. It was common to see statements such as 'the results are accurate because the standard deviation is small' or 'a large standard deviation is less reliable so the results are inaccurate'. To obtain both marks candidates were expected to comment on the results in table 3.1. A surprising stated that the standard deviation of 0.011 or 0.013 was very much larger than 0.001, so the results were unreliable. Only better answers showed the understanding that all of the results were reliable.

(iii) Only a minority of candidates answered this part correctly. Candidates variously stated the growth rates were significantly different because the standard deviations were 'very small', 'almost the same as each other', 'were more that 25% different from each other' or alternatively stated that the growth rates were 0.41 different from each other.

(iv) The majority of candidates gave an incorrect answer. The most common was 1, which suggests that candidates were using the two pH values as the categories without taking into account the sample number.

(c) Few candidates gained more than one mark in this section. The only common correct answer was a reference to the small range of pH values tested. Better answers showed an understanding that the optimum must lie somewhere between pH 4.0 and 5.2 so that these pH values should be tested. These candidates also recognised that the conclusion about enzyme production was not related to the data about growth rates. Poorer answers were very rambling comments about 'not enough repeats' or 'there was no mean taken'. Alternatively, answers were in the context of statistics, again suggesting the poor understanding that many candidates have of this aspect of the syllabus, for example ' the wrong degrees of freedom were used' , 'the degrees of freedom is too small' or ' a chi square test should have been done'.