BIOLOGY

Paper 9700/01
Multiple Choice

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

General comments

The mean score was 25.8 (64.5%) and there was a very good spread of scores, the standard deviation being 6.65. Nine questions were answered correctly by 80% or more of candidates – **Questions 7**, **15**, **16**, **22**, **23**, **31**, **32**, **38** and **40**. Five questions were difficult, with 40% or fewer candidates answering correctly – **Questions 1**, **18**, **26**, **27** and **30**.

Comments on specific questions

Question 1

The relative difficulty of this item was due to many candidates failing to appreciate that centrioles are the smallest components listed, and that the mitochondria are also larger than nucleoli. In **Question 3**, one mitochondrion is shown that is larger (length) than the nucleolus (diameter).

Question 2

Half of the less able candidates thought that the addition of carbohydrate to protein was the second step in the sequence.

Question 4

Only the more able candidates carefully read the question and correctly identified which structure is present in cells of eukaryotes. Candidates should be taught that prokaryotic ribosomes can be described as small, 70s or 18 nm, whilst eukaryotic ribosomes are large, 80s or 22 nm.

Question 6

Weaker candidates were unable to identify the molecules from the structural formulae provided.

Question 9

Less than half the less able candidates knew that triglycerides are not hydrophilic, but are soluble in alcohol.

Question 11

Even some of the more able candidates did not appreciate that when phospholipids are hydrolysed, the fatty acids will each contain a carboxyl group. The less able candidates did not seem to understand what a carboxyl group is.

Question 13

Whilst most candidates realised that blood plasma should not be sterilised by heating, many candidates incorrectly thought that incubation with lactate dehydrogenase inhibitor would be necessary.

Question 14

Whilst the majority of candidates realised that the enzymes are released by exocytosis, a significant number did not appreciate that ATP is required in order to carry out protein synthesis.

Question 15

This question was correctly answered by all of the more able candidates and by 60% of the less able candidates.

Question 17

Less able candidates did not know that fat-soluble substances could pass through the phospholipids and water-soluble would pass through a water filled pore (protein channel).

Question 18

It is important that candidates are taught that nuclear division does not include interphase. Therefore, semi-conservative replication, which occurs during interphase, is not a feature of nuclear division by mitosis. The mitotic cell cycle is the complete cycle of events from one mitosis to the next and does include interphase.

Question 19

A cell formed by a reduction division contains the haploid number of chromosomes, so the correct answer should be obtained by counting the number of chromosomes and multiplying by two.

Question 20

Only the most able candidates were able to work this out. Following metaphase, the distance between the centromeres and poles of spindle would get a lot closer as the chromatids are moved from the equator to the poles. However, the distance between the two poles would remain almost equal.

Question 23

Although candidates are not expected to know the structural formula of the DNA bases, they should be taught that cytosine and guanine are held together by three hydrogen bonds and adenine and thymine are joined by two hydrogen bonds. However, candidates could still answer this question correctly without knowledge of the number of hydrogen bonds.

Question 26

Many candidates did not know that cohesive tension forces increase during the day causing the diameter to decrease.

Question 27

Whilst the majority of candidates knew that phloem has no lignin, they did not know that a low solute potential means very negative and a high solute potential means less negative.

Question 30

Most candidates did not appreciate that an advantage of swollen leaves is to reduce the surface area to volume ratio so less water is lost by transpiration in comparison to a thin leaf.

Question 31

Most candidates found this question extremely straightforward.

Question 33

Less able candidates did not know that all three tissues are present in a bronchus.

Question 34

A surprising number of candidates were unable to work out that less carboxyhaemoglobin would be produced.

Question 37

Many candidates did not appreciate that the use of a single vaccine, without the need for boosters would be the best way to eradicate measles in developing countries. The main problem with measles vaccines is that children normally need two vaccinations. In developing countries in particular it is difficult to vaccinate all children once and even harder to ensure they have had both vaccinations. Therefore a single vaccine would be more effective.

Question 39

Few of the less able candidates knew that all three of the chemical conversions given involved microorganisms.

BIOLOGY

Paper 9700/02
As Structured Questions

General Comments

There were many encouraging responses to all six questions from the well-prepared candidates, with good use made of previous papers and mark schemes. As usual, several candidates and sometimes whole Centres did produce disappointingly low scores. Even the more able candidates did occasionally have difficulty in answering **Questions 2(b)**, **(d)(i)**, **(d)(ii)**, **3(b)**, **4(a)**, **(b)**, **(c)**, **(d)**, **5(b)(ii)** and **6(b)**, several of which, as in previous sessions, required the use of extended prose in response.

As in previous sessions, candidates lost marks by not using their knowledge and understanding to answer the specific question. For example, in **Question 2(b)**, where candidates described the roles of centromeres rather than the roles of centrioles in animal cells, or merely gave a description of anaphase of mitosis, without stressing the part played by centrioles leading up to the separation of chromatids.

Impreciseness in many responses is still demonstrated by some candidates. For example, in **Question 1(c)**, where candidates referred to heart attacks and damage to blood vessels in describing the effects of nicotine and carbon monoxide on the cardiovascular system.

Some candidates still do not demonstrate awareness of the use of bold type face. For example, in **Question 3(b)**, "...**structure** of DNA...**structure** of collagen...", **Question 4(d)**, "...**structure** of the lungs...", **Question 5(c)**, "...**one** possible way..."

As mentioned in previous reports, candidates should take note of the mark allocations given in brackets when composing their answers, and write within the lines provided.

There were few common misinterpretations of the rubric, although in **Question 2(d)(i)** and **(ii)** many candidates failed to distinguish between the terms **describe** and **explain**. These candidates inappropriately gave reasons for the candidate's result of the beetroot investigation, often referring to betalin levels in the water in **2(d)(i)** followed by a description of, for example, the general trend linking temperature and percentage transmission in **2(d)(ii)**.

In-depth revision and the use of appropriate scientific terminology would significantly improve the scores of many candidates.

Sufficient marking points were available to allow candidates to demonstrate their knowledge and understanding. All candidates appeared to have had sufficient time. Differentiation between candidates was evident on this question paper.

Comments on Individual Questions

Question 1

There were many encouraging answers to the whole of this very accessible first question.

(a) The vast majority of candidates correctly labelled the structures **P, Q** and **R** on Fig. 1.1, showing the heart and associated blood vessels. A few candidates labelled several structures for **each** letter, not all correctly, and in doing so lost the mark. Occasionally label lines from **P** and **R** originated in the heart, from below the semi-lunar valves at **Q** in the pulmonary artery / aorta. Some candidates labelled the atrio-ventricular valve as structure **Q**, whilst others used **R** to label the pulmonary veins on the right hand side of the drawing. Several candidates labelled the right and left atria **P** and **R** respectively.

(b) In explaining why the blood pressures in the atria are the same but different in the ventricles, many but not all candidates referred to both the atria pumping blood over the same distance to the ventricles. Able candidates further indicated that, whilst the right ventricle only has to pump blood a short distance to the lungs, the left ventricle has to pump blood a longer distance around the rest of the body. Few referred to the relative resistance to flow or to the force required to generate these respective pressures. Several candidates restricted their response to the relative thickness of the walls of atria and ventricles, though some still referred to the left ventricle being thicker than the right, rather than stating that the walls were thicker or more muscular. A few candidates continued to confuse the left and right ventricles (and their functioning). Some candidates described the cardiac cycle and its control. Others thought that the pressures reached in the atria were linked to the pressure of blood arriving in the pulmonary veins or venae cavae.

(c) In describing the effects of nicotine and carbon monoxide on the cardiovascular system, weaker candidates made simple reference to damage to the lining of arteries, though occasionally atheroma/atherosclerosis was more appropriately mentioned. Many candidates were, however, able to describe specific effects, for example, that nicotine increases heart rate and makes platelets 'sticky', with carbon monoxide combining with haemoglobin to form carboxyhaemoglobin, so reducing the oxygen carrying capacity of the blood. There were many other appropriate responses. Several candidates referred to nicotine contracting the arteries rather than constricting them. Some candidates simply referred to heart attacks and even strokes. A few candidates did not understand the meaning of cardiovascular system or did not read the question carefully, and attempted to give details of pulmonary damage. Weaker candidates often gave details of nicotine addiction, referred to carbon monoxide being absorbed by/reacting with haemoglobin, or mentioned carbaminohaemoglobin. The last three mark points for carbon monoxide were not known by candidates so it was more difficult to gain the marks here than for nicotine.

Question 2

There were several good responses to this question, though **(d)(i)** and **(d)(ii)** caused many candidates difficulty and reduced their final scores.

(a) Most candidates were able to identify structures labelled **A** to **C** on Fig. 2.1 as the nuclear membrane/envelope, mitochondria/cristae and (Golgi) vesicles/lysosome. Many candidates continued to refer to mitochondria even though only one mitochondrion was labelled at **B**. Several candidates referred to **A** as a nucleus, with no qualification. Several candidates identified **A** as the endoplasmic reticulum, tonoplast, or even chloroplast, and **C** as the Golgi apparatus, ribosomes, glycogen particles or lysozyme.

(b) In describing the roles of centrioles in animal cells, the majority of correct responses mentioned the movement of centrioles to the poles and the formation of the spindle during mitosis/meiosis. Able candidates did occasionally refer to the replication of centrioles in interphase (as opposed to during mitosis), assembling of microtubules and occasionally modified centrioles in flagella/cilia. Weaker candidates confused centrioles and centromeres or referred to the role of centrioles in cell division rather than nuclear division. There were many descriptions of chromatid behaviour during metaphase and anaphase of mitosis. Several candidates had centrioles forming microtubules (the centriole being formed itself from a ring of protein microtubules) rather than assembling/organising the microtubules to grow the spindle fibres for nuclear division.

(c) In explaining why it is possible to see the internal membranes of a cell in electron micrographs, but not using the light microscope, excellent responses made reference to the higher resolution of the electron microscope and the ability to see two points that are close together. Able candidates often provided comparative figures, for example, LM – 200 nm with EM – 0.5 nm. Only occasionally did candidates link higher resolution with a shorter wavelength. Weaker candidates gave vague answers relating to clarity and seeing more detail. Only rarely did a candidate give any indication of the significance of the width of membranes at 7 $\pm$1 nm. Several candidates referred inappropriately to the electron microscope having a greater magnification without any explanation in terms of increased resolution. Indeed several confused the terms magnification and resolution. Other candidates gave unnecessary detail regarding the advantages/disadvantages of using the electron microscope. Several candidates confused the term micrograph with microscope, and the units μm and nm.

(d) (i) In describing the candidate's results shown in Fig. 2.2 for the effects of temperature on beetroot tissue, the best answers stated a general trend linking temperature and percentage transmission using comparative figures (with data from both axes) to support this trend. Able candidates further described, in words or with data, the changes over specific temperature ranges. For example, between 60 °C and 70 °C the decrease (in percentage transmission) was steep/from 70% to 19%. Weaker responses, as mentioned under General Comments, often included inappropriate reference to increasing betalin levels in the surrounding water as temperature increased. Knowledge of colorimeters seemed Centre specific. Poor responses included lack of units, no values given, percentage transmission decrease described as 'slow/rapid' (implying a time relationship), and incorrectly read values, the most common mistake being 20%, rather than 19%, at 70 °C and 16%, rather than 6%, at 80 °C.

(ii) Only the most able candidates adequately explained the effect of increasing temperature on the beetroot tissue with reference to damaged vacuolar membranes at 60 °C and above, membrane proteins being denatured and the diffusion of betalin out into the water surrounding the beetroot tissue. Very rarely was reference made to the increasing fluidity of the phospholipid bilayer or precise reference to an increasing rate of diffusion as temperature increases. Weaker responses referred to changes in kinetic energy (but not linked to the rate of diffusion), enzyme denaturation, even water potential and osmotic changes to explain the results described in **(d)(i)**. Several candidates seemed to think that betalin was being produced due to enzyme activity or was itself being denatured at higher temperatures. Many candidates incorrectly gave here a description of the general trend in this section rather than in **(d)(i)** or repeated explanations, misplaced in **(d)(i)**.

Question 3

There were many encouraging answers to the whole question, especially in **(a)**.

(a) Candidates were asked to complete Table 3.1 by selecting the biological molecule from Fig. 3.1 that matched each of the statements in the table. Able candidates often gained maximum marks. A few candidates inappropriately gave several letters in each box. There was no pattern to the errors where they occurred. *A component of RNA* and *an amino acid* were probably the best known molecules. Some candidates gave **D** as *an important store of energy* without noting the *insoluble in water*. Quite a few did not know *a molecule that is polymerised to form glycogen*.

(b) Many candidates were able to describe two ways in which the **structure** of DNA differs from the **structure** of collagen. The most favoured correct responses included some reference to nucleotides (rather than amino acids), four (different) monomers (compared with more than four), the presence of phosphodiester bonds (not peptide bonds), whilst many answers referred to the helices, for example, double as opposed to triple. Some candidates incorrectly compared the functions of the two molecules. It was not uncommon for good candidates to make inappropriate, though biologically correct, comparisons, for example, 'DNA is a double helix whilst collagen is made of amino acids'. A significant number of candidates invalidated their responses by making biologically incorrect statements, for example, 'DNA is a double helix whilst collagen has phosphodiester bonds'. Candidates should be encouraged to make appropriate comparisons, for example, 'DNA has a double helix whilst collagen has a triple helix'. Some candidates described two ways in which the function (rather than the **structure**) of DNA differed from collagen, with references to semi-conservative replication for DNA and tensile strength for collagen. It was very good to see excellent knowledge about DNA structure, though a surprising number thought DNA was a polypeptide or described it as an α helix. Collagen was less well known and it was evident from some answers that candidates were thinking about cellulose – a number gave β glucose as the monomer. There was also a tendency to 'over-answer' and include significantly more than one point per numbered answer line.

Question 4

A significant number of candidates produced disappointing answers to this question, in particular in **(a), (b)** and **(c)**, possibly because this area of the specification had not been examined before. Most wrote a considerable amount but very little was correct.

(a) Many candidates were unable to state precisely what is meant by the term *tidal volume* with suitable reference to the volume of air breathed in/out, with one breath. The word 'amount' was often used rather than 'volume', 'breathed in and out' quoted rather than 'breathed in and then out', whilst the reference to 'a single breath' was often completely omitted or replaced by 'in a minute'.

(b) Again many candidates, in attempting to define *vital capacity* as part of their answer may well have referred to 'forced' or 'maximum' inspiration, but again erroneously stated 'breathed in and breathed out' rather than 'breathed in and then breathed out'. Candidates found it difficult to suggest why researchers also measured *vital capacity* in terms of vital capacity being associated with exercise/fitness or to explain differences between the groups in terms of tidal volume. Some candidates just repeated one or more of the bullet points given in the question. Answers such as 'to give more information' or 'to make it more accurate/reliable' were not uncommon.

(c) In explaining how the minute volume **at rest** would be determined, few candidates were aware of the use of a spirometer and the taking of recordings from a trace. Candidates inappropriately referred to a graph, although a few did refer to a kymograph. A significant number of candidates confused a spirometer with either a sphygmomanometer or a respirometer or even a potometer. There were also descriptions of gas syringes and collection under water. Examiners looked for **at rest** to indicate before exercise or recovery from physical activity, for example, checks on normal breathing/pulse rate, but for many this was explained as sitting/lying down or whilst asleep. A simple method involving the measuring of tidal volume, by breathing out into a bag was infrequently mentioned, although multiplying the tidal volume by the number of breaths per minute was occasionally stated.

(d) Candidates had some difficulty here in suggesting two differences in lung **structure** to account for the greater oxygen uptake by the Tibetans as shown in Table 4.1. Good candidates suggested, for example, the presence of more/wider bronchioles, more alveoli/greater surface area or more capillaries (around the alveoli). A significant number of candidates ignored the reference to '**structure** of the lungs' and referred to larger lungs or described increased chest/thorax sizes and associated muscles (including the diaphragm). There were also answers linked to possible differences in health, exercise and smoking levels of the Tibetans and Han Chinese, and the latter being more subject to pollution in their past.

(e) In explaining why the red blood cell count increases so much when people visit places at high altitude, many candidates using appropriate wording made reference to the idea that the low partial pressure of oxygen required the synthesis of more haemoglobin to compensate for the smaller volume of oxygen absorbed. Weaker candidates may well have referred to a low concentration of oxygen at altitude, but merely restated that the red blood cell count would be higher with no reference to its significance in enabling more oxygen to be carried (per unit of blood). Others carelessly referred to pressure being low at altitude or to the red blood cells becoming more saturated.

Question 5

A sound overall level of response from many candidates though several failed to give clear, precise answers. **5(a)** and **(c)** proved easier than **(b)**.

(a) The most knowledgeable candidates made precise reference to the female *Anopheles* mosquito sucking blood from an infected person and injecting (in saliva) parasites/plasmodia into an uninfected person. Weaker candidates simply referred to any mosquito/vector biting (with no reference to blood meals), to persons, or reference to the mosquito transmitting a disease/virus/bacterium rather than transmitting the parasites/plasmodia. Many gave unnecessary detail of the life cycle stages of *Plasmodium falciparum* that take place in the mosquito. Occasionally candidates made suitable reference to transfusion malaria/mother-foetus malaria/needle-sharing which was credited. There were many different spellings of *Anopheles* and this mark point was not always gained because one of the three words (female, *Anopheles*, mosquito) was absent from the answer. Several candidates cited contaminated food and water or sexual intercourse as modes of transmission.

(b) (i) In explaining how a vaccine against malaria may give long-term immunity, a significant number of good candidates fully and clearly appreciated that proteins from the surface membrane of *P. falciparum* would act as antigens. These would stimulate (clonal) selection of the appropriate B cell followed by division/mitosis of the B cell (clone) (to produce plasma cells) which would secrete the specific antibodies which can attach to the surface proteins/antigens on the parasite. Memory cells were frequently mentioned by such candidates in referring to the idea of a more rapid secondary response in conferring long term immunity. Even able candidates did not always indicate this would prevent the parasite attaching to/entering red blood cells. Weaker responses may well have mentioned the terms antigen, antibody, B cells, plasma cells and memory cells, but not always in the correct context as given above. For example, 'the body produces antibodies' rather than 'B cells/plasma cells secrete antibodies', and 'memory cells remember what to do when the parasite infects' rather than 'memory cells help with the rapid production of antibodies' (in the secondary response). Others confused antigens and antibodies or stated that 'antibodies killed antigens'.

(ii) Many candidates could not clearly explain why the development of vaccines against malaria has proved so difficult. Only the most able candidates made any reference to the genetic complexity of the eukaryotic *Plasmodium* producing many antigens, with different antigens being present in the many stages in the life cycle (within humans). More candidates did appreciate that *Plasmodium* lives within cells, though they did not state that antibodies cannot work against stages within cells. Many inappropriately linked the presence of many antigens and the idea of antigenic variation with the existence of four species of malarial parasites rather than the different stages in the parasite life cycle. Weaker candidates confused antibiotics with antibodies, referred in their responses to antibiotic resistance by the pathogen or mentioned the occurrence of mutation, poor sanitation, lack of funding for research and not completing a course of drugs.

(c) Candidates were asked to explain how a drug might act on the enzyme produced by *P. falciparum* (which enables the parasites to enter red blood cells) to prevent it from functioning. Triggered by the use of the word 'inhibit' in the information provided, many made suitable reference to a competitive inhibitor molecule fitting into and blocking the active site of the enzyme. Others made suitable reference to a non-competitive inhibitor fitting into a site other than the active site, in doing so altering the shape of the active site so that the substrate (surface protein) no longer fits. Others appreciated that some non-competitive inhibitors do actually bind permanently to the active site, blocking access and increasing the substrate/surface protein, having no effect. All three different responses were credited. Some candidates inappropriately gave a combined response despite the instruction to describe <u>one</u> possible way in which the drug might work. Weaker candidates gave vague and imprecise answers in which the enzyme was altered and was no longer able to bind to the substrate. Some candidates continue to refer to the active site fitting into the substrate. Others referred to the active site being denatured or to the drug having a similar structure rather than a complementary shape to the active site. Some candidates went down the wrong route and thought the drug would somehow alter the pH or the temperature of the environment and cause denaturation.

Question 6

Again a significant number of candidates produced disappointing answers to this question, particularly in **(b)**.

(a) (i) Not all candidates were able to name **two** organisms from Fig. 6.1 that were feeding as secondary consumers, e.g. amphipods, shrimps, Arctic cod, little auk. Weaker responses included reference to almost any of the other organisms named in the feeding relationships described in Fig. 6.1, including those from the right hand side of the figure, for example, eider duck and bearded seal.

(ii) Good candidates, in explaining why it is difficult to assign some organisms to trophic levels, understood that some animals feed at different levels, often naming appropriate consumer levels, or occasionally gave named examples from the food web in Fig. 6.1. For example, Arctic cod feeds on herbivorous copepods and shrimps. Only rarely did candidates refer to organisms feeding at different levels at different times/seasons. Few mentioned the difficulty of some food chains starting from decomposing matter rather than producers. Not all candidates understood that trophic levels are feeding levels and vaguely referred to organisms occupying a particular level. A not uncommon explanation was to state that some organisms consume more than one type of food. Many candidates did not follow the instruction to use information from Fig. 6.1 which could have given them a second mark.

(b) Energy loss/availability between trophic levels was not always expressed clearly in stating two factors that influence the efficiency of energy transfer by herbivorous copepods. Some candidates simply wrote one or more of the words *respiration*, *excretion*, *egestion*, *movement*, without qualification, or inappropriately referred to energy used up by or through the above processes. Good candidates expressed their answers in terms of energy loss or energy availability, or referred to not all parts of the phytoplankton/copepods being digestible including cell walls. A few correctly referred to the proportion of digested food that is absorbed. Many thought that they should mention sunlight and photosynthesis efficiency or wrote about factors affecting the numbers of organisms and the numbers being eaten or dying.

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 candidate papers. Centres are reminded how important it is that the Examiner receives the report with the scripts, so that candidates are not penalised for any problems encountered with the practical.

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 be familiar with all food tests, including the safety requirements for adding sodium hydrogen carbonate to hydrochloric acid after hydrolysis. It is inappropriate to give additional guidance to candidates. One of the skills being tested is for candidates to be able to make decisions about the work they have to carry out, including being able to select the correct tests and the order in which these tests are carried out. As part of the course it would be expected that candidates would have used all the food tests and had the opportunity to identify unknown solutions using techniques used by scientists to identify molecules.

The syllabus shows that this component has a microscope activity and it gives the required specification for the microscope lenses. It is expected that all candidates will have access to a clean, working microscope in order to complete the activity. Slides were provided on the basis that each candidate would need a slide for approximately half the examination time, so therefore each Centre should have received sufficient slides for half the number of the total candidate entry. Eyepiece graticules and stage micrometers, which can be made using microscope slides, were also supplied. The instructions needed to be tried prior to the examination, because in some cases placing the plastic scale between two slides would make it too thick to fit under the high-power lens. This varies depending on the particular microscope. If this is the case, the scale can be attached using clear tape, or under a coverslip using clear glue. Candidates need to be familiar with using a microscope at low $\times$10 and high $\times$40. If additional lenses are present they should be removed for the examination.

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. The stage micrometers provided should be used during the examination unless all candidates can be supplied with the Centre's own stage micrometers.

It is important that there is no opportunity for the candidates to see other candidates' work.

For the microscope question it is important that candidates have had the opportunity to become familiar with their microscope so that they know that all focussing should take place by turning the lens away from the slide so that slides are not broken. It is not acceptable for candidates to be given help in using the microscope as the use of the microscope is one of the skills being assessed.

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

Centres are reminded that this paper is skills based and that candidates should be made aware of the possible skills that will be assessed. These skills are clearly explained in the syllabus.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. For example, the questions 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) It was pleasing that most candidates organised the space into a table. The table should have shown the test or reagents used and then the results. The results needed to be the colour change observed and not just + or – as this does not record the observations made. This was particularly important as the colour recorded for the glucose test was then needed as evidence for the answer to **(a)(iii)**. The most common mistake was where candidates concluded that the carbohydrate was sucrose. From the reagents provided, it is only possible to identify **S3** as a non-reducing sugar or the carbohydrate other than glucose as given in the question.

(ii) There were two ways in which the candidate could have identified the carbohydrate. The most common answer was that a negative test was observed with Benedict's test, and so a sample had hydrochloric acid added. This was boiled and then neutralized with sodium hydrogen carbonate. Benedict's was then added and the solution boiled or heated to over 80 °C. Few candidates included all three points and there were still too many candidates who did not realise the importance of heating to over 80 °C. When the question asks 'how', the full method is needed, not just the Benedict's test. The other alternative answer was to clearly explain how the other two samples were eliminated and then that testing with starch was negative for **S3**.

(iii) Many candidates correctly selected the closest colour to the result obtained with the glucose and Benedict's. However, some candidates failed to gain the mark because they did not include the units. It is important for candidates to realise that they cannot estimate a value, and it is better, for example, to state that the value lies between two of the values in the table.

(iv) One of the most significant errors in estimating the concentration was matching the colour. However, as no details were given of the test used for finding the glucose concentrations in the table, comparing their test was invalid, because, for example, the volumes, temperature or heating time may have been different. Candidates are advised that the use of the word 'amount' is not acceptable at this level and 'volume' should be used instead.

(v) Too often candidates did not read this question carefully enough. They needed to concentrate on having a wider range or more concentrations of the glucose, then make the Benedict's tests the same by using the same volumes for each test, having a constant temperature by using a water bath and heating for the same length of time. It was pleasing that many candidates were aware that using a colorimeter would improve the accuracy of the measurements. It is not necessary for candidates to have seen or used a colorimeter for them to have been taught how to improve the accuracy of measuring colours. Candidates do need to be careful of their spelling as if the word is misspelt it can mean something completely different. For example, 'calorimeter' cannot be given credit in this question. Again the use of 'amount' is not acceptable at this level.

(b) (i) The majority of candidates correctly calculated the mean as 30. A few candidates lost this mark for not considering the correct number of significant figures and leaving their answer as 30.2.

(ii) Many candidates identified the value as anomalous, although again it is important that candidates learn how to spell this word. However, explaining that the value did not fit or was too high to fit the trend was also acceptable. Candidates should be reminded that this questions of this type do not require a reason for the result being anomalous, but simply an explanation of why the reading was discarded.

(iii) It was pleasing that many candidates were able to draw the graph with the *x*- (the independent variable) and *y*- (the dependent variable) axes orientated correctly and labelled with units, using an easy scale, which in this case just fitted each axis, plot the points accurately as crosses or dots in circles and then draw the line as a smooth curve through each point or join each point with a ruled line. Awkward scales were penalised. Examples of the scales most likely to be needed are in the syllabus section on practical skills. The plotting of points is also described in the syllabus and candidates who use large 'blobs' more than 1 mm in diameter instead of a dot in a circle or a cross,

were not able to gain the plotting mark. Some candidates used 'blobs' in circles which were also not credited. If candidates are not sure what a dot in a circle is, then using a small cross, which clearly shows at the intersection of the cross where the point is being plotted, will always get the plotting mark. Lines should not be more than 1 mm wide, so it is important that candidates have sharp pencils.

(c) In answering this type of question candidates need to make a clear statement as to whether the hypothesis is correct, partly correct or not correct. They should then use the information given 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.

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 leaf which was required.

Candidates drawing the whole section could gain only one mark for drawing no cells and making the diagram larger than 6 cm.

There are still a number of candidates who draw lots of cells when no cells should be drawn in the low-power plan. A mark was available for showing that the candidate had observed that the vascular bundle was positioned nearer to the epidermis than the top of the fold and that the mesophyll clearly did not go right to the top of the fold. In order to gain marks for low-power plan diagrams candidates need to have seen as much unfamiliar material as possible and practised drawing them.

(ii) Centres are reminded to make their candidates aware of the importance of the use of significant figures and that this applies in all situations, including where calculations are being made, i.e. that the number of significant figures is generally no more than those used in the data. For example, if the number of eyepiece graticule units is a whole number then the calculated answer should also be a whole number.

Candidates are also reminded that some marks are awarded for their reasoning of how to carry out a calculation, so when asked to show their working, it is important to do so.

A range of values was accepted for the measurement of the trichome. The other marks were gained for correctly calculating the actual width and rounding the answer to one decimal place. In cases where the answer was incorrect, marks could still have been awarded if the candidate had shown clearly how each of the numbers had been used to get the answer. Many candidates failed to multiply by the length of the smallest division on the stage micrometer. Others who had obtained an answer of 1, also failed to show how this number would be used in their working. A mark was available for showing the correct conversion from mm to μm. Some candidates confused themselves by converting first to metres, and then trying to convert back to μm.

A few candidates tried incorrectly to include the magnification in their calculation. This may have been because they did not realise that if the trichome is measured using the high-power lens, then the eyepiece graticule has to be calibrated using the high-power lens.

It is important that candidates become familiar with using the eyepiece graticule to measure material on slides and calculating the actual size by calibrating the eyepiece graticule using a stage micrometer. The calibration will change as the magnification changes, so candidates should realise that they need to calibrate the eyepiece at the same magnification which is being used to observe and measure the material on the slide.

(iii) Parallax error is not a significant error when viewing a slide directly through a microscope. The most significant error will be in exactly identifying where the base of the trichome starts and finishes. Alternatively, lining up the eyepiece graticule scale with the stage micrometer can be difficult and the lines on the stage micrometer appear very thick using the high-power objective lens.

A few candidates appeared to have difficulty lining up the eyepiece graticule with the trichome. This should have been possible by rotating the eyepiece lens with the graticule.

(iv) Most candidates were able to suggest that the purpose was to reduce water loss or transpiration. However, trichomes do not absorb water and some candidates confused them with root hairs.

(b) In order to gain marks here, it was very important to follow the instructions carefully. First the candidates needed to be able to find and observe the required cells at high-power. A disappointing number of candidates drew more than three cells for each layer. Candidates should have been able to draw three cells for each without shading any cell walls. All candidates should have been able to draw the two groups of three cells using sharp, unbroken lines, and each drawing should have been at least 6 cm.

The other marks available were for observing carefully that the **X** cells had thin cells walls and formed a curve at the base of the fold. The other group of cells had much thicker cell walls and formed a chain. It is therefore important that candidates are given the opportunity to draw using high-power small groups or layers of cells, which show distinctive features. With such practice candidates will be able to draw what they see more confidently.

(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, but some candidates seemed unfamiliar with leaf structure and had difficulty describing structures such as vascular bundles, often confusing epidermis with epithelium or stomata. Again those candidates who had seen and compared different structures were able to apply this skill to the more unfamiliar material using different shapes, rolled and unrolled, position, numbers or relative sizes of the vascular bundles and numbers and distribution of stomata as distinguishing features. They were also able to observe that both had features in common.

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 candidate papers. Centres are reminded how important it is that the Examiner receives the report with the scripts, so that candidates are not penalised for any problems encountered with the practical.

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 important that the Supervisor returned the results gained for the particular tissue, which was used by the candidates. Centres should not be concerned about the actual results as this is taken into account when the papers are marked.

Many candidates were aware of how to make up dilutions and some demonstrated that they were familiar with the equation $C_1V_1 = C_2V_2$ where the volume of C_1, in this case 0.6 mol dm^{-3}, needed to make a concentration of C_2, for example 0.3 mol dm^{-3}, could then be calculated by taking C_2 (0.3 mol dm^{-3}) and multiplying by the volume required, V_2, for example 10 cm^3, and then dividing by C_1 (0.6 mol dm^{-3}).

So 5 cm^3 of 0.6 mol dm^{-3} concentration was needed, and therefore 10 – 5 = 5 cm^3 of water needed to dilute the 0.6 mol dm^{-3}.

Those candidates who had had the opportunity to use this technique as part of their course gained full marks for showing how the concentrations were made up keeping the volumes the same. The equipment provided enabled the candidates to use the measuring cylinder to make up their concentrations, and it was therefore not necessary to supply additional apparatus. Candidates should be familiar with various different methods for measuring volumes and be able to adapt to the apparatus provided.

It was of concern that a few candidates were unable to cut the tissue without cutting themselves. Again for the majority of candidates this did not pose any safety hazard as they were familiar with using blades to cut materials.

The syllabus shows that this component has a microscope activity and it gives the required specification for the microscope lenses. It is expected that all candidates will have access to a clean, working microscope in order to complete the activity. Slides were provided on the basis that each candidate would need a slide for approximately half the examination time, so therefore each Centre should have received sufficient slides for half the number of the total candidate entry. Eyepiece graticules and stage micrometers, which can be made using microscope slides, were also supplied. The instructions needed to be tried prior to the examination, because in some cases placing the plastic scale between two slides would make it too thick to fit under the high-power lens. This varies depending on the particular microscope. If this is the case, the scale can be attached using clear tape, or under a coverslip using clear glue. Candidates need to be familiar with using a microscope at low ×10 and high ×40. If additional lenses are present, they should be removed for the examination.

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. The stage micrometers provided should be used during the examination unless all candidates can be supplied with the Centre's own stage micrometers.

It is important that there is no opportunity for the candidates to see other candidates' work.

For the microscope question it is important that candidates have had the opportunity to become familiar with their microscope so that they know that all focussing should take place by turning the lens away from the

slide so that slides are not broken. It is not acceptable for candidates to be given help in using the microscope as the use of the microscope is one of the skills being assessed.

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

Centres are reminded that this paper is skills based and that candidates should be made aware of the possible skills that will be assessed. These skills are clearly explained in the syllabus.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. For example, the questions 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) It was pleasing that most candidates organised the space into a table. This needed to show the concentration with units and then the results. These results should have shown the length after 20 minutes with units. Candidates were penalised if the heading units did not correspond with the recorded lengths, for example mm used in the heading and lengths recorded in cm. Many candidates were able to include in one table the volumes used to make up the different concentrations and their results. A significant number of candidates did not include 0.0 mol dm^{-3} (distilled water) and/or 0.6 mol dm^{-3} sucrose solution in their experiment.

It was pleasing that fewer candidates lost the mark for their column headings by putting the units in the body of the table. The readings for **X1** were needed to provide the evidence for **(b)**.

(b) The results for **X1** were used to find the nearest concentration of sucrose. However, some candidates failed to gain the mark because they did not include the units. It is important for candidates to realise that they cannot estimate a value, and it is better, for example, to state that the value lies between two of the values in the table.

(c) A pleasing number of candidates were able to describe their results and then explain that this was caused by the movement of water, correctly identifying which way the water was moving. Fewer candidates included that the water moved from a high to lower water potential and even some excellent answers did not include osmosis as the process involved.

(d) (i) The most significant errors were the difficulty of measuring the strips, especially if they had curved, with a ruler whose error if the smallest division was 1 mm would be ±0.5 mm at each end of the measuring and therefore having a total error of ±1 mm. The difference measured was often only 1 mm. Other obvious errors were in the thickness of the strips, that the strips floated or were not covered by the solution, or that some of the solution evaporated. Weaker candidates made excuses or implied that they were not able to work accurately.

(ii) Candidates answered this question well suggesting the use of vernier callipers to measure the strips, using more strips or repeating the experiment and covering the test-tubes. A number of candidates suggested using more accurate equipment, but only a few candidates suggested using graduated pipettes or a burette to measure the volumes for the concentrations. Weaker candidates did not select three improvements or did not explain how the experiment could be improved.

(e) (i) The majority of candidates correctly calculated the mean as 5.6 and the mean change in diameter as –1.4. A few candidates lost this mark for not considering the correct number of significant figures and not rounding their answer.

(ii) Many candidates identified the value as anomalous, although it is important candidates learn how to spell this word. However, explaining that the value did not fit or was too low to fit the trend was also acceptable.

(iii) It was pleasing that many candidates were able to draw the graph with the *x*- and *y*-axes orientated correctly and labelled with units, using an easy scale, which in this case just fitted each axis, plot the points accurately as crosses or dots in circles and then draw the line as a smooth curve through each point or join each point with a ruled line. Awkward scales were penalised and this meant that the plotting could not be awarded either. Examples of the scales most likely to be needed are in the syllabus section on practical skills. The plotting of points is also described in the syllabus and candidates who use large 'blobs' more than 1 mm in diameter instead of a dot in a circle or a cross were not able to gain the plotting mark. Some candidates used 'blobs' in circles which were also no credited. If candidates are not sure what a dot in a circle is, then using a small cross which clearly shows at the intersection of the cross where the point is being plotted, will always get the plotting mark.

A number of candidates did not read the question carefully and incorrectly plotted the change in the mean diameter and not the mean diameter. The mark scheme enabled candidates to score the O mark for just the *x*-axis with units and the line mark. The scale and plotting mark, however, could not be awarded as the wrong data had been plotted.

(f) In answering this type of question candidates need to make a clear statement as to whether the hypothesis is correct, partly correct or not correct. They should then use the information given 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.

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 in a quarter, for example four to seven vascular bundles should have been drawn. Some candidates are still not aware that no cells should be drawn and the drawing should occupy at least 6 cm in one direction. Proportions are also important especially observing the spacing of the vascular bundles, which were much nearer to the epidermis than the pith. Some candidates failed to observe the pith and a few did not realise that this was a stem and not a leaf. It was also very obvious that there were large and small vascular bundles. Candidates need to have the opportunity to explore different slides and practise drawing what they see. There was a pleasing improvement in the standard of drawing with pencil and with clear and unbroken lines.

(ii) Centres are reminded to make their candidates aware of the importance of the use of significant figures and that this applies in all situations, including where calculations are being made, i.e. that the number of significant figures is generally no more than those used in the data. For example, if the number of eyepiece graticule units is a whole number then the calculated answer should also be a whole number.

Candidates are also reminded that some marks are awarded for their reasoning of how to carry out a calculation, so when asked to show their working, it is important to do so.

A range of values was accepted for the measurement of the vascular bundle. Allowances were made for those candidates who thought that the radial width was from the outer edge of the vascular bundle to half way as they were confusing the idea of radius.

The other marks were gained for correctly calculating the actual width and rounding their answer to one decimal place. In cases where the answer was incorrect, marks could still have been awarded if the candidate had shown clearly how each of the numbers had been used to get the answer. Many candidates failed to multiply by the length of the smallest division on the stage micrometer. Others, who had obtained an answer of 1, also failed to show how this number would be used in their working. One mark was available for showing the correct conversion from mm to μm. Some candidates confused themselves by converting first to metres, and then trying to convert back to μm.

A few candidates tried incorrectly to include the magnification in their calculation. This may have been because they did not realise that if the vascular bundle is measured using the high-power lens, then the eyepiece graticule has to be calibrated using the high-power lens. This is why it is important that Centres provide the specification of microscope stated in the Confidential Instructions.

It is important that candidates become familiar with using the eyepiece graticule to measure material on slides and calculating the actual size by calibrating the eyepiece graticule using a stage micrometer. The calibration will change as the magnification changes so candidates should realise that they need to calibrate the eyepiece at the same magnification which is being used to observe and measure the material on the slide.

(iii) Parallax error is not a significant error when viewing a slide directly through a microscope. The most significant error will be in exactly identifying where the edges of the vascular bundle start and finish. Alternatively, lining up the eyepiece graticule scale with the stage micrometer can be difficult and the lines on the stage micrometer appear very thick using the high-power objective lens.

A few candidates appeared to have difficulty lining up the eyepiece graticule with the vascular bundle. This should have been possible by rotating the eyepiece lens with the graticule or selecting a suitable vascular bundle to measure.

(iv) There were some very good drawings of the correct cells, which showed that the candidates had made the correct decision in drawing five phloem cells, and had included at least one companion cell.

Again those who carefully observed, and did not put in details which could not be seen such sieve plates, gained the highest marks. Only a few candidates drew textbook drawings or longitudinal drawings.

It is important that candidates have the opportunity to observe tissues and draw a few cells accurately and only include those features they can see such as cell wall thicknesses, shapes and relative sizes.

(b) (i) Many candidates appeared to recognise that this tissue was collenchyma found as a support or strengthening tissue. Candidates need to be familiar with the tissues found in stems so that they can apply their knowledge to unfamiliar material.

(ii) 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, but some candidates seemed unfamiliar with stem structure and so found it difficult to describe structures such as vascular bundles, often confusing epidermis with epithelium or pith. Again those candidates who had seen and compared different structures were able to apply this skill to the more unfamiliar material using different shapes of the stems or vascular bundles, and by recognising that the slide **K1** had a space/no cells in the middle whereas Fig. 2.2 had cells/no space. A common mistake was to think that **K1** had a pith and Fig. 2.2 no pith. The position, numbers or relative sizes of the vascular bundles and that **K1** had no region **Y** whereas Fig. 2.2. had Y were also used as distinguishing features. They were also able to observe that both had features in common, such as small and large vascular bundles.

BIOLOGY

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 highly.

Candidates from some Centres had been thoroughly prepared, but others struggled to recall basic factual material or to apply their knowledge appropriately. It was evident that some candidates had not prepared themselves properly for questions on some parts of the syllabus, particularly **Questions 5** and **8**. The better candidates had no problems with the more straightforward questions such as **1**, **2** and **6**. Many candidates are still not reading the command words carefully and tending not to distinguish between *describe* and *explain*. Consequently, although sometimes much knowledge has been displayed by the candidate, few marks were awarded because the candidate had not answered the question.

Comments on specific questions

Section A

Question 1

(a) Good answers seen here seem to suggest that time has been well spent in learning how to interpret graphs. Most candidates recognised the overall trend and that Vietnam did not fit. The mark for supporting figures could not always be given due to insufficient data being provided to illustrate the trend. A minimum of two countries should have been quoted, together with their annual population growth and annual deforestation rates.

(b) (i) Few candidates were able to explain the meaning of *biodiversity* beyond the basic idea of the variety of species present. References to variation within a species or the genetic variation that exists between different species were expected.

(ii) Explanations of the economic reasons for maintaining *biodiversity* were generally given well. Most responses included the potential for medicines, food and tourism, and some went further and described other resources such as timber or the use of fibres for clothing. Few references were made to being of use in the future or as a genetic resource. The role of biodiversity in prevention of natural disasters such as flooding or erosion could also have gained credit but was rarely mentioned.

Question 2

(a) Some candidates confused the micrograph of the pancreas with the kidney despite being told this was the pancreas. Few candidates recognised **A** as a pancreatic duct despite its obvious lumen. More correct answers were seen for **B**, usually the islets of Langerhans. Some candidates mentioned either alpha or beta cells, but both were required here to qualify for the mark.

(b) The majority of candidates appreciated that hormones were carried away in the blood but many omitted to state that these were produced by the tissue in **B** (islets of Langerhans, α or β cells).

(c) Candidates usually scored well on this section. The conversion of glucose to glycogen, increased uptake by cells and use of glucose in respiration were commonly described. A few references were made to protein or fat synthesis.

(d) This was well-known and candidates noted the more rapid response, fewer rejection problems, ethical/religious issues, reduction in disease risk or tolerance problems that arose with animal insulin. Reference was occasionally made to unlimited availability.

Question 3

(a) (i) Some confusion was seen in describing the various parts of the flower. Often references were made to irrelevant structures such as the shape and size of pollen grains, instead of describing flowering habit. Better candidates used terms correctly, referring to versatile anthers or long filaments. It was not always clear from the descriptions that the anthers and stigmas were situated outside the flower or that the stamens were above the leaves, thus aiding wind pollination.

(ii) Many good answers were seen here. The idea of increased genetic variation or heterozygosity, together with hybrid vigour was understood. The decreased likelihood that harmful recessive alleles will be expressed and an increased ability to respond to changing conditions were also known.

(b) (i) Candidates who knew this procedure scored well and with little difficulty. A few references were made confusing DNA and amino acids but the majority of responses included most of the relevant facts. Cutting the DNA with a restriction enzyme, loading it into a gel and applying an electric current were well described. Usually the fragments were mentioned as travelling towards the anode, with shorter ones travelling further. Better answers included further detail of the technique, such as how the DNA might be visualised.

(ii) Many candidates appreciated that there would be a change to the primary structure of the protein. Few went on to explain that this would result in a changed function. Detail of this could have included enzymes needed for a metabolic pathway or in the control of the expression of another gene. Alternatively a changed protein with a structural role could have gained credit.

(iii) The majority of responses stated that only one base needed to change. Some noted that this could have occurred as a result of a mutation. Only rarely did a candidate attempt to explain that the new variant would look different so could have been selected easily for breeding or that the single base change would mean that a simple breeding programme would be sufficient.

Question 4

(a) This question scored highly, largely because of the generosity of the mark scheme. Most candidates were able to describe the increase in permeability of the pre-synaptic membrane to calcium ions and that as the ions diffused in there would be an effect on the vesicles of Ach. Some candidates still mentioned that ions diffuse into the membrane rather than through it.

(b) (i) Many candidates read the information carefully and were then able to say that there is a greater fluorescence in wild-type sperm than mutant sperm because the wild-type had the **P** proteins and therefore calcium ions could pass into the sperm. Some just described the graph without giving an explanation.

(ii) There were many accurate descriptions here but only the better candidates made a good comparison between the difference between the heads and flagella and the reasons for this difference. Some confused candidates thought that this question required reference to neurophysiology and answered accordingly.

(c) (i) Most candidates were awarded at least one mark, but often referred to the removal of gametes and replacement of embryo, rather than fertilisation being outside the body, although many mentioned the use of glassware.

(ii) This question proved to be very discriminatory because candidates were continuing to describe the graphs when they were clearly asked to explain what had happened. It was expected that candidates would be able to build on the previous information earlier in the question in their answers. Only good candidates were able to do this.

Question 5

It was clear that this question examined an area of the syllabus that was not as familiar to the candidates as other areas. Consequently this question was a good discriminator.

(a) Very few candidates were able to mention any benefits to the bacteria because they had misread the question and wrote about benefits in general. It was hoped that candidates would refer to the fact that the bacteria would gain energy and then be able to use it for growth, cell division, etc.

(b) The most common disadvantage given was pollution of water by the acid or the metals. There were very few answers that mentioned the fact that it takes up a large area or that it requires a continuous water supply.

(c) Many candidates were able to score well on this section. The most common answers referred to the lack of a need for heavy machinery, fewer workers and that the bacteria could be found locally and would reproduce themselves.

Question 6

This proved to be a very accessible question with many candidates scoring full marks.

(a) Most candidates were able to define an *allele* as a different form of a gene and that the word *recessive* meant that this allele would not be expressed except in a homozygous genotype.

(b) Candidates were usually able to notice that this was an example of sex linkage and went on to state that a female would need two recessive alleles to be colour blind. A few mistakenly stated that the gene was carried on the Y chromosome.

(c) Despite mentioning sex linkage in **part (b)** some candidates then wrote genotypes without X and Y chromosomes, thereby limiting their marks. Most were able to score well here.

Question 7

(a) (i) Some candidates simply quoted a lot of figures as their answer rather than use them to support comparative statements regarding the light absorption peaks of chlorophyll a and chlorophyll b. Teachers should encourage candidates to answer direct comparison questions by comparing the two within the same sentence, instead of merely describing the features of one, followed by the features of the other. Points of comparison could have been made regarding which chlorophyll absorbed most light in the blue and red ranges and that both had very low light absorption between 500 and 600 nm. Few candidates commented that chlorophyll a had an extra peak whilst a few made it difficult for themselves by confusing the two curves with each other and with the curve for action spectrum.

(ii) This question required candidates to explain the action spectrum and unfortunately many candidates merely *described* the shape of the action spectrum, in many cases without even mentioning the word 'photosynthesis'. Better candidates noted that the light absorbed was used for photosynthesis and that the greater the absorption of light, the higher the rate of photosynthesis. The fact that other pigments may be involved was rarely commented on.

(iii) Most candidates were able to note that chlorophyll reflects rather than absorbs green light.

(b) Whilst most candidates were able to correctly identify the stroma and granum it is worth mentioning that label lines need to be drawn very precisely to score the marks.

(c) Many candidates answered this well and demonstrated good knowledge and understanding. Most recognised that light would not be a limiting factor at high light intensity, whereas CO_2 would. More CO_2 would then be fixed as the Calvin cycle begins to produce more TP and then eventually more hexose. Candidates who failed to show these increases were often less successful.

Question 8

Many candidates made no serious attempt at this question, suggesting a lack of familiarity with this topic.

(a) (i) (ii) Many were able to show that the mean of the graph would be the same but that the graph would be narrower. They were also able to correctly name the type of selection as stabilising.

(b) (i) (ii) A lot of candidates were able to show that the mean would be displaced to the left however some displaced it to the right. Directional and evolutionary selection were commonly given.

(iii) Many candidates gave vague examples of natural selection in quite different species rather than sticking to the herring as required. Correct answers included a reference to increased fishing and predation.

Section B

Question 9

This was by far the most popular of the two questions in ***Section B*** with many candidates displaying excellent knowledge.

(a) This question was about oxidative phosphorylation in the mitochondrion and a large minority of candidates included descriptions of glycolysis and Krebs cycle which were irrelevant. Most appreciated that red NAD or red FAD goes to the ETC and that hydrogen is removed which then splits into protons and electrons. The rest of the sequence was usually well described although the pumping of protons through the inner membrane was not always clearly expressed. The presence of stalked particles or ATP synthase was generally known but some candidates thought the protons were pumped through the stalked particles rather than diffusing back due to the gradient.

(b) This part was not always as well answered as **part (a)**. Most candidates appreciated that red NAD is involved but not that it is produced in glycolysis and that reduction of pyruvate ensures that NAD is regenerated for glycolysis to continue. The fate of pyruvate in plants and animals was usually well described.

Question 10

This was not very popular and was not usually chosen by better candidates.

(a) Only a few candidates noted that the object of the question was to compare endocrine and nervous systems. Many just wrote down everything they knew, often with little attention to detail. Credit was given to candidates mentioning that the endocrine system was slower, longer lasting and had a widespread effect.

(b) Candidates found it difficult to score well on this part of the question with many writing long passages about phototropism which was irrelevant to answering the question about apical dominance. Some better candidates were able to describe the production of auxin in the apical bud, how it travelled down the stem and the inhibitory effect it had on lateral growth.

BIOLOGY

Paper 9700/05

Planning, Analysis and Evaluation

General comments

It was pleasing to note that candidates showed great improvement in their planning skills. The answers to **Question 2** were considerably better organised than the answers to a similar question in June 2007. There was also improvement in the ability of candidates to correctly identify the different types of variable. Interpretation of data and the use of statistics, however, showed a wide variation in the abilities of candidates. In **Question 1** many candidates did not seem familiar with data which does not have any pattern, so that answers tended to refer to proportionality and correlations which were not supported by the data. The use of probability tables remains a problem for a large number of candidates, so in **Question 3**, answers were often incorrect as a consequence of misunderstanding of degrees of freedom and how these relate to the critical value. As mentioned in previous reports, there are many candidates who do not appear to understand the difference between accuracy, reliability and significance. This meant that answers, particularly in **Question 3**, failed to gain marks. For example, common statements included 'the results are not due to chance and are therefore reliable' and 'the standard deviation is narrow so the results are accurate'.

There was a tendency for candidates to write too extensively and repeat the same idea several times. For example in planning, there is no need to list all the variables and then describe each in more detail. Candidates should be encouraged to select the relevant material and to avoid repetition. Similarly, if a question asks for a specific number of answers, than only that number should be given as information that exceeds the required limit will not be credited.

Comments on specific questions

Question 1

While it was clear that many candidates had not carried out any field work, the majority were able to use the information supplied to answer the questions.

(a) (i) Most of candidates answered this correctly. A minority of candidates reversed the two variables. Weaker answers suggested that the equipment used, for example quadrats and transect lines, were the variables.

(ii) The question expected candidates to identify how the procedures described enabled standardisation. Although many answered correctly, there were also a large number who referred to 'taking means' and 'carrying out repeats', rather than specifying how this was achieved. Other weaker answers referred to using quadrats and transects, but without any further qualification. The most common correct answers were references to standard sized quadrats, uniform placement of quadrats and a standard number of measurements per transect. This was also an example of a question where candidates gave more than the required number of answers. Candidates should be encouraged to use the numbered lines for their answers and give only one answer for each.

(b) (i) Overall this question was answered poorly. Most candidates repeated the information in the table or stated that it was not possible. Candidates were expected to refer to other data in the table and explain why the specified sample might be anomalous when compared to samples with similar percentage cover of seaweed.

(ii) Most candidates answered this correctly. The most common error was to omit 'mean' from the label.

Candidates found **parts (iii)** and **(iv)** difficult to answer and these were marked together to allow for mixed answers. The major problem seemed to be that although there was no clear pattern in the data, candidates assumed that there must be relationship.

(iii) Almost all candidates tried to describe either a proportion or a correlation. Some tried to draw best-fit lines which appeared to ignore most of the data on the graph from 0 to 30 mean percentage cover of *Fucus spiralis*.

(iv) The term 'the extent to which' should be a familiar scientific phrase to candidates at this level, however, many answers did not make any reference to the hypothesis. Some answers were very muddled, often contradictory, with answers in **(iii)**, for example, saying 'no relationship' and then in **(iv)** saying 'some relationship'. A variety of answers were acceptable provided that candidates made a link to the hypothesis. For example, for candidates who thought there was proportional relationship, credit could be gained by referring to data that supported this view. Similarly, candidates who thought there was a relationship, but that it was not proportional could gain credit by referring to the clustering of data within ranges. Very few candidates mentioned that there might be limited support for part of the hypothesis, but that the data was too inconsistent for a definite conclusion.

(v) Most candidates gave a correct answer, although again, there was tendency to give a list. The most common correct answer was a reference to predators.

Question 2

(a) (i) Overall, the plans showed improvement as more candidates were describing how the investigation might be set up and how variables might be standardised or measured. It was also pleasing to see references to safety, examples of potential hazards and the precautions that might be used. There were some excellent answers giving all of the points on the mark scheme.

There is still a tendency to write extensive descriptions of the apparatus and how it works, before actually explaining how to use it. Consequently answers ran into margins and blank pages. Most candidates varied the carbon dioxide using hydrogen carbonate, although in many cases the range of concentrations was too limited. Candidates should be aware than a minimum of five concentrations is expected. The majority of candidates measured the volume of oxygen using the syringe, but in some cases there was no reference to time. Poorer answers referred to measuring the fall in carbon dioxide using the sensor, suggesting that these candidates had not fully understood the apparatus design from the diagram. These candidates often failed to draw a suitable graph in **part (ii)**.

Although many candidates did suggest suitable methods of standardising variables, there were still a large number who simply stated 'control the light intensity' or 'keep the temperature the same', without giving a suitable procedure for this. Many candidates also referred to repeats, but did not always state the number of repeats or why they were necessary. Candidates should be aware that a minimum of three repeats should be carried out to obtain a mean value.

(ii) The majority of candidates drew a correct graph and were able to give a correct explanation. The most common errors on the graph were incorrect axis labels and failing to show a plateau at high carbon dioxide concentrations. The most common error in the explanations was to state that at high concentrations carbon dioxide in no longer limiting, without stating that some other factor then becomes limiting.

(b) (i) Answers to this part of the question were surprisingly poor. Only better answers mentioned using subtraction of values before and after using the oxygen absorbent to obtain the actual quantity of oxygen released. Candidates tended to refer to 'a difference in the absorbent'. Many candidates referred to 'amount' throughout their answer and consequently failed to gain marks. Use of specific units of measurement is expected. For this question either volume or mass of oxygen was acceptable as some candidates used a change in mass of an oxygen absorbent, rather than a change in volume of gas in the syringe. Similarly, time in minutes or seconds was acceptable.

There were also some candidates who had clearly carried out the June 2007 investigation, possibly as a mock examination and were confused about which calculation was required and described how to find an RQ value. These were often the same candidates who measured the disappearance of carbon dioxide from the apparatus instead of gas produced.

(ii) There were some good answers to this question, but there were many that were far too vague, referring, for example, to 'impurities from the absorbent' and 'minerals or particles in the water'. A common incorrect suggestion was carbon dioxide from respiration.

Question 3

(a) (i) Relatively few candidates gained full marks for describing the use of the stage micrometer to calibrate the eyepiece graticule, and the eyepiece graticule to measure the diameters. However, some candidates who described the use of both, did not make clear which was being used for measuring the tubule diameters. There were also many candidates seemed to be aware of the processes but confused size calculation with magnification calculation.

(ii) Most candidates gave a correct answer. The only common error was to refer to accuracy rather than reliability. A few candidates confused standard deviation with standard error.

(iii) Although there were candidates who had a clear understanding of degrees of freedom and how to use a probability table, there were also a great many who were clearly confused. Although some candidates correctly stated that the results were significant, their reasons for doing so were not always based on a correct interpretation of a probability table. For example, a common error was to subtract the value of $t = 2.02$ at 40 degrees of freedom from the actual value of $t = 2.09$ and then state that the difference was significant. Other incorrect answers included those of candidates who tried to explain how degrees of freedom are obtained, and those who compared the calculated *t* value with the probability table and stated that the degrees of freedom must be incorrect and should be 20. Another common misinterpretation was to state that the probability was greater than 0.5 and was therefore due to chance. Contradictory statements were also common, for example some candidates correctly stated that the calculated value was more than the critical value but then went to state that this meant it was not significant. There were also candidates who confused the interpretation of *t*-test probability with chi-square probability.

(b) Candidates found this part difficult to answer. As in **question 1**, the term 'extent to which' caused some problems. Candidates were expected to look at the evidence from the experimental procedure and decide whether the conclusion was justified based on what had been measured and the statistical analysis carried out. Most candidates did not seem to realise that the only measurements made were the diameters of the tubules and their lumens, so that a conclusion based on a cellular structure was not justified as the evidence. Similarly, candidates did not recognise that the *t*-test was only carried out on the total diameters, not the lumen diameter so the conclusion can only be supported as far there is a difference in the thickness of the walls, not the cause of the difference.

The two sections of this part of the question were marked together. To access maximum marks, candidates were expected to give at least one piece of evidence that supported the conclusion in the first part and, in the second part, one piece of evidence which did not support the conclusion. There were some candidates who misinterpreted the question and tried to explain why there would be differences in the brush border in different parts of a nephron in relation to the different functions of these parts of the tubule. Others tried to explain why there would be differences in the tubule wall thickness at different parts of the nephron in relation to the flow of urine.

The most common correct answers that supported the conclusion were references to reliability linked to a large number of measurements, the use of mean values and the small standard deviations. The only common error was to confuse reliability with accuracy. Better answers also correctly stated that a significant *t*-test indicated a casual factor for the overall difference in tubule diameters, but the reason for the difference in thickness was not supported. However, many candidates attempting to use the *t*-test result incorrectly related it to the lumen diameter and failed to note that the standard deviations of the lumen values meant there was overlap in the range of diameters. Many candidates also failed to notice that the mean value for the proximal tubule was in fact greater than that of the distal tubule. Other common errors by candidates trying to use the *t*-test values, was to incorrectly state that a significant value meant either that the results were reliable or that a mistake had been made.

The most common correct answers to the second part were references to the size of the brush border making it difficult to see or measure the lumen reliably. Better answers supported this by commenting on the greater standard deviation of the mean value for the lumen diameter. Credit was also allowed if candidates stated that the brush border was too small or too varied to be measured. Very few candidates, as already stated, noticed that neither the brush border nor the cells of the tubule wall had been measured, so the conclusion was not based on any actual experimental evidence. Other correct answers were references to the limited range of specimens used and the difficulty in recognising the different types of tubule from the slide.