BIOLOGY

Paper 5090/11
Multiple Choice

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

General comments

The questions distinguished well between stronger and weaker candidates, while remaining accessible. Plant physiology (**Questions 5, 7, 11** and **12**) and genetics (**Questions 38–40**) proved to be topics that candidates found more challenging.

Comments on specific questions

Questions 1, 2, 6, 10, 30, 34 and **36.**

These questions posed few problems for the great majority of candidates.

Question 4

Few candidates appreciated that, since enzymes may build up molecules as well as break them down, the diagrams showed *two* possible substrates for the enzyme.

Question 5

A large number of candidates indicated that water enters a leaf by active transport.

Question 7

Many candidates suggested that hydrogencarbonate indicator might be involved in this experiment about carbon dioxide and photosynthesis.

Question 9

The role of the lacteals in the absorption of lipids was not well known.

Question 11

Many candidates did not realise that the phloem may transport sugars either up or down the plant, depending on circumstances.

Question 13

This question on the cardiac cycle proved challenging. The most common error was the belief that one side of the heart contracts first, followed by the other side.

Question 15

Many candidates wrongly indicated that a high heart rate is a sign of fitness.

Question 25

Candidates needed to understand that increased reaction time means slower reactions, not faster.

Question 39

The wording of this question was slightly unusual, and the most popular answer, even among some of the stronger candidates, was **B**. However, careful reading of the question shows that individuals with the recessive phenotype must be homozygous (probability 1.0).

Question 40

This question on genes and alleles exposed an area of confused understanding for many candidates.

BIOLOGY

Paper 5090/12
Multiple Choice

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

General Comments

The questions distinguished well between stronger and weaker candidates, while remaining accessible. Genetics (**Questions 39** and **40**) proved to be a particularly challenging topic for candidates.

Comments on specific questions

Questions 1, 6, 16, 17, 20 and **36.**

These questions posed few problems for the great majority of candidates.

Question 2

The interpretation of the graphs proved challenging. Candidates had to appreciate that nitrates are absorbed actively and so they will be absorbed when their concentration is lower (or higher) in the soil than in the plant roots.

Question 7

Many candidates suggested that hydrogencarbonate indicator might be involved in this experiment about carbon dioxide and photosynthesis.

Question 11

Many candidates did not realise that the phloem may transport sugars either up or down the plant, depending on circumstances.

Question 13

Candidates need to be able to interpret photographic material as well as diagrams. Here, the interpretation of the photomicrograph of an artery proved challenging for many candidates.

Question 15

Many candidates had difficulty answering this question on coronary heart disease.

Question 22

Weaker candidates indicated that contraction of the ciliary muscle causes the lens of the eye to become thinner.

Question 23

Most candidates were able to interpret the graphs in this question correctly.

Question 30

There was confusion between the terms nitrification and nitrogen fixation.

Question 39

The wording of this question was slightly unusual, and the most popular answer, even among some of the stronger candidates, was **B**. However, careful reading of the question shows that individuals with the recessive phenotype must be homozygous (probability 1.0).

Question 40

This question on genes and alleles exposed an area of confused understanding for many candidates.

BIOLOGY

Paper 5090/21
Theory

Key Messages

Information, which is beyond the scope of the syllabus, is provided in questions which test the ability of the candidates to use their knowledge to suggest answers for a given problem. This information should be used as a guide and incorporated into candidates' answers to these questions.

General Comments

Candidates are advised to read the question carefully and to assess which biological knowledge is relevant to the answer. No credit is given for any extra, irrelevant information. Candidates should remember that in some answers a well-drawn and fully annotated diagram may be substituted for written text. In **Section C**, only one question should be attempted.

Comments on Specific Questions

Section A

Question 1

Most candidates did not appear to be familiar with this model.

(a) Most candidates identified the straw and the rubber sheet as corresponding to the trachea and diaphragm. Some suggested that the rubber band represented the diaphragm.

(b) Candidates commonly stated that only one balloon was present to represent two lungs. Rarely were the ribs mentioned and candidates did not realise that a rigid cup cannot move, unlike the ribs.

(c)(i) The model is designed to show that increasing the volume in the chamber reduces the pressure, so allowing air to enter the balloon. An excellent answer would explain that the student can pull the rubber sheet downwards to demonstrate breathing in, as the balloon expands. The majority of candidates suggested blowing down the straw to inflate the balloon, which was not credited.

(ii) Many candidates stated that the balloon would enlarge.

(iii) The answer needed to indicate that allowing air to pass through the hole does not allow the pressure inside the cup (and so around the balloon) to be altered. The response ‘air enters through the hole so the pressure is the same outside and in’ was therefore insufficient.

Question 2

(a)(i) Many answers gained full credit here. The differences given should be based on the information provided in Fig. 2.1, so, for example, references to quantity of pollen produced could not be credited. A few candidates indicated wrongly that the larger the magnification, the larger the physical size of the pollen grain.

(ii) There were some excellent answers to this question. Some candidates stated that the transfer was between different species of plants, which could not be credited.

(iii) Most candidates correctly identified the method of pollination in each case.

(b) Most candidates were able to give two correct characteristics of insect pollinated flowers.

Question 3

(a) (i) The majority of candidates correctly identified the position of the break. Those who marked an 'X' on the photograph did not gain any credit**.**

(ii) Virtually all candidates answered correctly.

(b) (i) The triceps or extensor muscle was identified by most candidates.

(ii) For this answer an arrow to the left of the humerus, pointing downwards was required. A curved arrow, under the ulna pointing towards the elbow was also acceptable.

(iii) The word 'antagonistic' was well known**.**

(c)(i) Candidates were asked to compare the percentages shown graphically so a reference to relevant figures was required to gain credit. The figures can be expressed in different ways. So 'the percentage of the body mass which is skeleton is 10% more in humans than in birds' or 'the percentage of body mass due to the skeleton in humans is three times that of birds' would both be credited.

(ii) The candidates found this question challenging. Candidates were told that the bones contained air spaces, had more haemoglobin and were asked to relate this information to flight. To be fully credited, many answers needed to add reference to the increase in oxygen and energy needed for flight.

Question 4

(a) (i) For those candidates who realised that 100 cm^3 of bottled milk contained 1/10th of the daily requirements, this was a simple calculation. The majority of candidates also added the correct units expressed either as cm^3 or litres.

(ii) Some very good answers were provided. Candidates were required to state that named parts of a balanced diet would be lacking and to describe the health consequences for the baby. For example, lack of protein would lead to kwashiorkor or lack of iron would lead to anaemia.

(b) (i) The advantages of feeding breast milk were well known by candidates.

(ii) Many reasons were offered by the candidates, a common one being the illness of the mother.

Question 5

This was well answered, with many correctly filling in the missing words. Candidates found the last word (radiation) the most difficult.

Section B

Question 6

(a) This was well answered by many of the candidates. Some appeared to be unfamiliar with the disease.

(b) Many candidates scored well, but few gained full credit. Specific examples needed to be given as requested by the question. Some candidates confused the symptoms with those of gonorrhoea.

(c) This was very well answered by many candidates, although some omitted to state that antibiotics were not effective against viruses.

Question 7

The candidates answered this question well.

(a) The definition of a hormone was well known.

(b) (i) Some very good answers were given here. Some candidates did not say that the blood sugar level had to be too high (for insulin to act) and very few mentioned that the process occurred in the liver or muscle cells.

(ii) This was very well known and candidates throughout the ability range gained full credit.

Section C

Question 8

(a) Some good answers were seen, although some candidates wrote all the information they knew about the topic rather than ensuring they answered the question set. In this question, many of the marks could have been awarded for a well annotated diagram. The names of the blood vessels, or a detailed description of the functioning of the heart, were not required.

(b) Most candidates correctly named a substance which was transferred between the blood plasma and the tissue fluid and mentioned the permeability of the wall. Many candidates stated that it was a single cell, rather than saying that the wall of the capillary was a single cell thick.

Question 9

(a) Some good answers were seen, but weaker candidates found it difficult to relate the management of fisheries to conservation.

(b) Some good responses were given here, although most candidates focused their answers on the human effects. Few mentioned the effect of the reduction in photosynthesis and the consequence of higher levels of carbon dioxide. Even fewer made any mention of the water cycle.

BIOLOGY

Paper 5090/22
Theory

Key messages

Candidates would be advised to read the questions more carefully to make sure they limit themselves to the scope of the question asked, and to avoid lengthy discourses on material that is of little relevance to the required answer.

General comments

Some scripts scored very high marks indicating that these candidates had a sound grasp of the subject matter. However, several candidates supplied answers that were not relevant to the questions set.

It is important for candidates to realise that, although the questions may include material with which they may not be familiar, their answers will be expected to include only material that they will have covered whilst following the syllabus, or having followed the syllabus, might be expected reasonably to deduce.

Section A

Question 1

(a) (i) The most common incorrect answer was 'bacteria', otherwise 'yeast' (or 'fungus') was regularly, and correctly, given.

(ii) This was very well answered, with most candidates gaining credit.

(b) (i) A small minority of candidates drew curves which did not start at the origin and/or were not above the given curve for strain **B**. Many indicated that higher temperatures would yield a much higher volume of carbon dioxide, and a few drew their curves above that shown for strain **A** rather than strain **B** as required.

(ii) This was moderately well answered although relatively few candidates gained full credit. 'Temperature' was often suggested despite the question referring to temperature and then asking for two **other** external factors. References to humidity and light were not uncommon as was the word 'concentration' with no further qualification.

(c) Most candidates realised that bread rather than beer would benefit from the sweet-tasting strain, but only the strongest responses stated that bread-making requires a high volume of carbon dioxide released within a day rather than stretched out over a period of a week.

Question 2

(a) This section was reasonably well answered, with a majority of candidates gaining some credit. Among the weaker responses, **C** was often incorrectly identified as the stigma while **F** was often incorrectly identified as seed. Some candidates identified **E** as pollen.

(b) (i) Although generally well answered with most candidates scoring full credit, occasionally carbon dioxide and oxygen were given the wrong way around. 'Water vapour' was infrequently seen.

(b) (ii) Many candidates incorrectly identified **K** and **L**, usually opting for the same answer they had given to **Question (b)(i)**, and therefore provided incorrect explanations. Reference to the pink colour led

several to refer to insect pollination. Stronger candidates made a correct identification and also provided correct explanations, thereby gaining full credit. 'Water vapour' was again infrequently seen.

(c) A large majority of candidates gained credit for mentioning 'neutralisation'. Few candidates made any reference to bacteria and, of those who did, many did not mention that they would be killed by the extract.

Question 3

(a) (i) A large majority of candidates gained credit here.

(ii) This was reasonably well answered. Common errors included 'carcinogen' and confusion with carbon monoxide.

(iii) Again, this was reasonably well answered. The most common error involved confusion with tar.

(iv) This was generally not well answered although some stronger candidates gave full and correct answers, so gaining full credit. For the majority of candidates however, greater detail was required. Most candidates mentioned an effect on the baby (though relatively frequent references to Down's syndrome and to lung cancer were incorrect). Occasional references were seen to the effect of carbon monoxide on haemoglobin and therefore on its function. References to maternal and foetal blood were infrequently seen.

(b) Many candidates described correct trends but did not link them to correct date ranges, resulting in little credit being awarded. A significant number of candidates managed to gain some credit with a reference to passive smoking but, otherwise, explanations of the trends were rarely mentioned.

Question 4

(a) (i) This was well answered with most candidates realising that LV stands for Left Ventricle, or, equally correctly, by explaining why the object is called an 'assist' device. A small number of candidates made incorrect reference to the control of blood flow.

(ii) This was poorly answered and most candidates did not give muscle as the tissue type required.

(iii) This was also poorly answered with relatively few candidates correctly naming the aorta.

(b) (i) This was only moderately well answered. Many candidates either did not show arrows at all or showed arrows in the wrong vessels, or showed them in the correct vessels but pointing in the wrong direction. A significant number of candidates drew correct directional arrows but positioned them inside the atria and not in the respective vessels which supplied those atria.

(ii) A majority of candidates showed the correct direction of flow and gained credit. Of the remainder, most showed incorrect direction and a few showed no direction.

(c) This was poorly answered with relatively few candidates naming aortic/semilunar valves. Most candidates incorrectly named bicuspid or tricuspid valves.

(d) Very few candidates understood that the device would occupy a similar position to the one illustrated, but in the opposite side of the heart. A wide variety of incorrect structures were named.

Question 5

(a) This part was moderately well answered with the strongest candidates giving full and correct answers to gain full credit. However, many candidates gave vague answers which often confused nitrogen fixing bacteria with nitrifying bacteria. Some candidates made correct reference to decay/decomposition, thereby gaining some credit. A significant number of candidates made simple reference to the faeces and/or urine of a cow, often incorrectly described as 'excreta', and so were not successful.

(b) This was generally not well answered with few candidates able to name a correct protein. Candidates did not appear to appreciate that dicoumarol, as stated in the question, has an effect

on blood clotting and made a link with cattle by naming milk. Reference to platelets was a common but inaccurate answer.

(c) (i) Most candidates gained some credit by making correct reference to an increase. Some, however, then showed misunderstanding by making an incorrect reference to the killing of rats rather than to the change in the LD_{50}. Many thought that LD_{50} is a rat poison.

(ii) Few candidates made the link to natural selection and the evolution of a more resistant strain of rats. The stronger responses gained full credit by giving full and correct answers. Many candidates, however, gave vague and irrelevant answers which were often limited to a reference to a greater amount of dicoumarol now being required to kill (the same number of) rats.

Section B

Question 6

(a) An initial error here was to talk about the 'eye' of a person rather than about the lens. Otherwise this part was reasonably well answered. Many candidates described, in lengthy detail, the role of the lens in focussing light in a young person before going on to describe the differences in an older person. There was confusion between 'refraction' *a*nd 'reflection', and many candidates gave descriptions, often detailed and accurate, of the mechanisms which underlie accommodation. Unfortunately, these were not relevant to the question asked, and no credit was available for such descriptions.

(b) Some candidates appreciated that the eye lens would require spectacles that would compensate for its inability to become sufficiently thick. Otherwise, this part was generally well answered, with a majority of candidates gaining reasonable credit. Common errors included reference to distant objects.

Question 7

The response by candidates to this question was mixed. **Question 7(a)** was moderately well answered, but **Question 7(b)** less so. Very few candidates achieved full credit.

(a) Answers here were often too verbose with points not made in a logical order. They often contained much detail concerning anaerobic respiration, which was material required in **Question 7(b)**. A common error was reference to the requirement for (more) energy, rather than how it is made available. Many candidates did not link more oxygen, or more glucose to muscle(s). The role of glucagon rather than adrenaline was often incorrectly quoted in the context of the conversion of glycogen to glucose. However, many candidates made correct reference to faster breathing, faster heartbeat, and also to sweat/sweating but, rather than relate this process to its cooling effect, references were most commonly linked to the release of salts, urea and toxins. Very many responses gave quite accurate, but irrelevant, accounts of the general benefits of exercise.

(b) The point most regularly overlooked here was the need to break down the lactic acid.

Section C

Question 8

This question was the less popular **Section C** choice, being answered by approximately a third of candidates. It was generally poorly answered and resulted in limited success for the majority of candidates. Most candidates tended to do better with **Question 8(a)** than **Question 8(b)**.

(a) Most candidates provided answers which lacked sufficient detail to gain much credit here. More usually 'active transport', 'root hairs' and 'villi' were given. The only other relevant points to be mentioned with any regularity were that plants absorb ions from the soil, while humans absorb glucose from the intestines. Confusion was seen with respect to osmosis which was occasionally incorrectly stated as the mechanism by which ions are taken in by root hair cells together with water.

(b) A very few stronger candidates scored well here, but a large number of candidates demonstrated a lack of knowledge/understanding of the subject matter. There was a common misunderstanding

that plants do not absorb amino acids because they don't need them, and very few mentioned that humans rely on other organisms for amino acids while plants make their own.

Question 9

This was the more popular of the **Section C** alternatives. In general, the standard of answers to this question was high with most candidates achieving reasonable credit.

(a) This part was generally well answered with a majority of candidates showing fundamental knowledge/understanding of the subject matter and thereby managing to score higher credit. An omission was often that of a relevant named disease (particularly malaria). Many candidates did not identify a relevant causative organism but simply referred to transfer/injection of 'the disease'. Many candidates did not differentiate between infected and non-infected individuals. Some candidates made reference to the mosquito being the 'carrier' rather than the 'vector' (the syllabus term) of disease.

(b) Again, this was generally well answered by most candidates who managed to gain high levels of credit. Some less able candidates confused the effects of lack of calcium with lack of vitamin D, whilst others confused vitamins C/D and the effects of their relevant deficiencies. A significant number of candidates incorrectly based their answers upon the effects of excess dietary components (especially carbohydrate/fat) rather than deficiencies, as required by the question.

BIOLOGY

Paper 5090/31
Practical Test

General Comments

The questions tested the ability of candidates to follow instructions, make and record accurate observations using written and drawing skills, in addition to taking measurements and performing simple calculations. The ability to accurately plot and evaluate tabulated data was also tested.

Comments on Specific Questions

Question 1

(a) Candidates were asked to measure the time taken for pieces of red coloured agar, cut to three different dimensions (in mm), to change colour to yellow in equal volumes of the same acid solution. Stronger candidates successfully completed Table 1.1 (with units) where precise recordings of dimensions of agar pieces were made and with times noted when pieces were added followed by the timing of colour change. Weaker answers often recorded incorrect dimensions with no units given, or did not complete the table at all.

(b) Excellent responses described correct trends from the results presented in that the largest agar pieces, due to an increase in surface area, took the longest time to change colour. When asked to suggest why typical animal cells are rarely more than 0.1 mm in diameter, successful candidates clearly showed that the movement of molecules in and out of cells is rapid and occurs by diffusion. Weaker responses focussed on animal cells having no cell walls and there were occasional irrelevant references to water absorption during osmosis.

(c)(i) When presented with Fig.1.2 where onion epidermal cells are placed in water (cell E) or in salt solution (cell F) for the same length of time, excellent answers described the lack of a vacuole in cell F and that the cell membrane had pulled away from the cell wall due to shrinkage and plasmolysis. In weaker responses, there were frequent references to the vacuole in cell F being firm and smaller compared with a more flaccid and larger vacuole in cell E.

(ii) The best answers explaining how cell F differed from cell E focussed on the movement of water out of the cell by osmosis due to a concentration gradient, via a partially/semi/selectively permeable membrane, ultimately resulting in plasmolysis. Weaker responses emphasised that the cytoplasm had moved from the cell into the salt solution resulting in the cell becoming turgid. Some candidates simply stated, without qualification, that diffusion had occurred.

(iii) When asked to describe an investigation to determine the concentration of salt solution that caused cell F to be plasmolysed, the strongest answers suggested a range of different concentrations and stated the concentrations of salt solutions (or indicated that there should be a minimum of three concentrations) using the same onion or size of onion and the same temperature or time. The number or presence of plasmolysed cells should also be examined microscopically to confirm the lowest concentration in which plasmolysis occurs. Weaker responses simply stated that onion cells in dilute solutions will be larger when immersed in a concentrated salt solution.

Question 2

(a) When making a labelled drawing of a bean seed containing an embryo, candidates who performed well produced a large drawing with clear, continuous outer lines and no shading but included details of the embryo with the plumule and radicle correctly labelled. In weaker answers both plumule and radicle were incorrectly drawn and labelled, and drawings frequently occupied less than half the space allowed on the question paper.

(b)(i–iv) Testing the bean seed for the presence of protein was generally well done by most candidates in that samples were crushed/chopped, followed by the addition of biuret agent usually resulting in a change from blue to lilac/mauve/purple. Results and conclusions from Table 2.1 invariably confirmed the correct colour change for protein in the bean seed but the lack of protein in maize.

(v) When asked how a comparison of protein content could be made more reliable, excellent answers included the use of tissue with the same mass/surface area, the same volume/concentration of biuret agent, followed by the same amount of stirring over the same period. In contrast, those candidates who did not perform well mentioned breaking up the seed into small pieces or using more seeds in a larger quantity of reagent plus heating.

(c)(i)(ii) The majority of candidates, when asked to measure and record the length of spore **Y** from a fungal culture shown in Fig. 2.1, correctly measured, recorded (i.e. 35 mm) and calculated the actual length of this spore by dividing the length (35 mm) by the magnification of the drawing (×4500).

(d)(i) Table 2.2 contained data on the protein content / g per 100 g in five sources of protein and when constructing a bar chart using these data, excellent answers showed the axes to be fully labelled and at least half of the grid used, plus a linear scale for protein content. Correct plots showed the height of bars to be correct and the sides of bars ruled and of equal width. Weaker responses tended to leave the axes unlabelled, did not use a linear scale and used less than half the grid for plotting.

(ii) On the assumption that the average adult requires 50 g of protein per day to maintain good health (and data from Table 2.2 showed that the single cell protein content was 10.00 g / 100 g), responses that gained full credit correctly calculated the mass of single cell protein required per day to be 50 divided by 10 and then multiplied by 100, or the answer was given as 500 g. Weaker, incorrect attempts tended to multiply 50 g by 10 g and then divided the total by 100, giving an answer of 5 g.

BIOLOGY

Paper 5090/32
Biology Practical

Key Messages

Candidates should always read the questions carefully to ensure that their answers relate to what is being asked.

Candidates should be aware of the nature of the response required when different terms are used in questions e.g. *describe*: they are expected to state the key points that can be seen in the stimulus material; *explain:* they should give reasons for something, leaving the examiner in no doubt why something happens.

Candidates should take care with units, ensuring that they are included with recorded measurements, or, when already present on an answer line, that the measurement is recorded in those units.

When a question asks for answers regarding features that are visible in a photograph or diagram, no credit can be given for answers based on prior knowledge of features that are not visible.

General Comments

The questions tested the ability of candidates to follow instructions, make and record accurate observations using written and drawing skills, in addition to taking measurements and performing simple calculations. The ability to accurately plot and evaluate tabulated data was also tested. Candidates appeared to have more than sufficient time to complete the paper.

Comments on Specific Questions

Question 1

(a)(i) Candidates were asked to describe two visible features of the flower presented in Fig. 1.1 which suggest insect rather than wind-pollination. The strongest answers indicated that the large/broad/wide petals provided a landing platform for insects. There was occasional reference to the stamens being erect/sturdy/not hanging and that the stigma was solid and not feathery. Weaker responses omitted to describe visible features of the flower and mainly referred to the role of colour and scent.

(ii) When asked to make a large drawing of structures shown within the box on Fig. 1.1, excellent answers showed six well-drawn anthers and the stigma using clear continuous lines, with filaments drawn with a double line and anthers placed below the rounded top of the stigma. Candidates who performed less well tended to ignore the requirement to draw only what was shown within the box and often included an incorrect number of stamens, some of which were drawn above the stigma.

(iii) The strongest answers labelled all three structures including the anther, stigma and style. Weaker answers confused the anther and stigma, and the style was frequently labelled as ‘ovary’.

(b)(i) Candidates were asked to test halves of ripe and unripe fruits for starch using iodine and for reducing sugar using Benedict’s solution and a water bath. The majority of answers were correct and most conclusions were consistent with the results. Weaker answers referred to no colour changes being observed.

(ii) When asked to suggest how seeds in the ripe fruit may be dispersed, excellent answers confirmed that this was achieved by animal dispersal as the attractive fruit in terms of taste, smell and colour would be eaten (including the seeds), which would be passed unharmed by digestion/egestion, or rejected by the animal, or spat out. Candidates who did not perform well implied that animal excretion or wind/self-dispersal were involved, or that the seeds were no longer attached to the fruit.

Question 2

(a) Candidates were asked to describe their observations when a large piece of raw potato was placed in a test-tube containing hydrogen peroxide. The majority of candidates correctly observed the release of gas bubbles or foam/froth/effervescence, with only a minority of weaker candidates reporting the appearance of a white emulsion or that oxygen was given off.

(b)(i)(ii) In order to determine the activity of catalase in both raw and boiled potato pieces placed in a test-tube of hydrogen peroxide, the strongest responses showed that the number of bubbles released within one minute (shown in Table 2.1) was greater in small compared with large raw pieces, and no bubbles were produced in the boiled pieces. These candidates were also aware that the enzyme catalase was denatured by boiling and that cutting the potato into smaller pieces increased the total surface area to such an extent that more bubbles were released from these compared with the large pieces. In weaker answers, candidates tried to explain these results as osmosis-related or that oxygen had been 'boiled out' of the potato.

(c) In order to test that the gas released was oxygen, responses that gained full credit confirmed that a glowing splint should be used and this would be rekindled, whereas incorrect responses proposed the use of a 'lighted' splint that would relight.

(d) Some excellent answers explained what improvements were needed to obtain more valid and reliable results and these included using a constant mass (of potato) or a constant volume/concentration of hydrogen peroxide or a constant temperature for enzyme–controlled reactions. There were also suggestions to repeat the investigation followed by calculating mean/average values (to improve reliability). It was exceptional to see different types of apparatus, for example a gas syringe, being used to determine the volume of gas produced rather than the limitation of counting bubbles. Weaker responses implied that all variables should be changed including the use of different masses of potato, temperatures, volumes/concentrations of hydrogen peroxide or repeating investigations without qualification.

Question 3

(a)(i) By referring to Fig. 3.1, the reactions of two students were tested when catching a falling metre ruler and the process was repeated five times. The strongest responses gave a neatly drawn table with all lines ruled and two columns headed 'student 1' and 'student 2', plus one header column confirming measurement for distance/length/height in cm. Weaker answers lacked a named dependent variable or the unit by which it was measured.

(ii) The calculation of the mean result for student 1 was generally correct.

(iii)(iv) When asked whether the inclusion of a high value of 51.0 cm for student 2 should be omitted from the mean value, candidates who performed well correctly showed that such a value was an anomalous result or outlier, which was too large/far out compared with other measurements and that the mean value would be distorted. Such a result was also due to lack of concentration or distraction of the student, or that the ruler had been placed upside down or that the hand of student 2 was not at zero at the start. Weaker answers implied that 51.0 cm would not give a whole number and that this resulted from the use of a different or broken ruler or reference to slow/late timing in grasping the ruler.

(v) When constructing a bar chart of the mean results obtained for both students and omitting the 51.0 cm from the calculation, candidates who gained full credit correctly labelled the axes with a linear scale on the distance axis and a zero on the *y*-axis. This was accompanied by correct plotting and insertion of bars with ruled lines of equal width, using at least half of the grid in both directions. Weaker candidates neither labelled the *y*-axis nor inserted the zero. In addition, bars were drawn for all results given rather than just the mean values.

BIOLOGY

Paper 5090/61
Alternative to Practical

Key messages

It is important that candidates read the questions carefully to ensure that they answer precisely what the question is asking.

Candidates should consider carefully what is asked for by the terms *description* and *explanation.* If a description of experimental observations is asked for, an explanation for those observations is not required in the answer.

General comments

The number of marks awarded overall covered the whole range of those available and it appears that candidates had sufficient time to complete the paper. The majority of scripts were clearly legible, with the answers written in the spaces provided and there were few instances of questions that were not attempted.

There continues to be improvement in the responses to questions relating to experimental design although more precise terminology such as *mass, length* and *volume*, rather than *amount* or *quantity* should be used when describing measurements or listing variables to be controlled. To improve further, consideration should also be given to the range of values chosen for the independent variable as well as to providing a precise description of how the results can be interpreted.

Comments on specific questions

Question 1

(a) (i) There were many correct answers, but a significant number of candidates had not worked out precisely what was happening in this investigation, which resulted in them adding the two values together instead of subtracting the first time value from the second.

(ii) Many candidates described the trend well, noting that as the dimensions of the agar jelly blocks decreased so did the time for them to change colour.

(iii) Stronger candidates were able to link the relative small size of cells to the speed with which molecules can diffuse in and out, noting that if the cells were larger diffusion would be too slow for the cell to function. Weaker candidates repeated their answers to **Question 1a(ii)** rather than applying this information to a different question.

Some candidates referred to cell walls even though the question referred specifically to animal cells.

(b) (i) Candidates were asked to describe how the two cells differed from each other and there were some excellent answers. Some candidates did not *describe* what can be observed, but gave explanations of what had happened to bring about these observations.

There were some fundamental misunderstandings of cell structure. Some candidates considered the vacuole in **E** to be inside the cell but outside the cell in **F**, or stated that cell **E** had shrunk. These responses seemed to imply that the cytoplasm was the cell itself.

(ii) Here the candidates were asked to suggest an explanation for the appearance of cell **F**. There were some excellent answers, although some candidates failed to mention osmosis despite accurately describing water moving out of cell **F** down a concentration gradient. Very few responses made any reference to a partially permeable membrane. A few candidates gave a clear definition of osmosis but did not apply it to the situation presented in the question.

(iii) There were some excellent answers as well as some with fundamental flaws. Candidates frequently described placing individual onion cells in test-tubes of various concentrations of salt solution, which would be impractical. Others were vague about making up the solutions, for example, using a specific mass of salt but with no reference to the water. Some candidates did not understand that a range of different concentrations of salt solution would be required and consequently used only a hypertonic solution and water, with a few including a hypotonic solution as well. Some candidates suggested that using different volumes of salt solution was equivalent to using different concentrations of salt solution.

Most candidates appreciated that they would have to use a microscope in order to observe the plasmolysed cells, although few were able to describe clearly how they would identify which of the salt concentrations caused the cells to become like cell **F**.

Question 2

(a) There were some excellent correctly labelled drawings of a good size, drawn with clear, clean outlines and in which the embryo was well drawn. A significant proportion of candidates were unable to identify the radicle and plumule correctly or drew the embryo out of proportion with the rest of the seed.

(b) (i) Food tests are generally well known and many candidates were able to gain full credit here. Some did not describe preparation of the sample to be tested and many suggested adding the wrong test reagent, usually Benedict's or iodine solution. In some cases, the correct reagent (biuret) was stated but then candidates went on to say that it would be heated, which is incorrect. Many candidates correctly described the colour change to lilac or purple, but did not specify the colour of the mixture before it changed.

(ii) This question proved challenging for many candidates. Some responses stated that the mass of protein in the food should be controlled, even though the question was about comparing the protein content of the two foods. Even when variables were correctly identified, vague terms such as 'amount' were used instead of mass or volume by some candidates.

(c) (i) Most candidates measured the spore accurately. A common error was not to notice that the units given on the answer line were millimetres and to give measurements in centimetres without specifying centimetres. There were occasional measurements in inches which are not acceptable.

(ii) Many candidates calculated the length correctly. Care should be taken in rounding answers up or down and there should not be an excessive number of decimal places in the answer. Some candidates used the wrong method to do their calculation resulting in spores of over 150 000 mm in length.

(d) (i) There were some excellent graphs and many candidates gained full credit. In some cases, responses could not be fully credited because the axes were not fully labelled or there was no value at the origin on the *y*-axis. In some bar charts, the vertical scale on the *y*-axis was too small or the plotting was not precise. Most candidates correctly drew complete bars with ruled lines and constructed bars of equal width.

A few candidates drew line graphs although the question specifically asked for a bar chart.

(ii) This calculation proved difficult for many, the majority citing 5 g as their answer.

Question 3

(a) There were some very good descriptions of how to calculate the percentage of the leaf that was damaged. Although the grid was provided, some candidates did not refer to it in their answer.

(b) Many candidates suggested that the growth of the plant *would* be affected but did not state *how* it would be affected. Better responses suggested that photosynthesis would be reduced because of less surface area or less chlorophyll for light absorption. Many candidates knew that photosynthesis would be affected, but few gave any details regarding the effect on the production of glucose and/or protein.

BIOLOGY

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Alternative to Practical

Key Messages

Candidates should always read the questions carefully to ensure that their answers relate to what is being asked.

Candidates should be aware of the nature of the response required when different terms are used in questions e.g. describe: they are expected to state the key points that can be seen in the stimulus material; explain: they should give reasons for something, making these clear to the Examiner.

Candidates should take care with units, ensuring that they are included with recorded measurements, or, when already present on an answer line, that the measurement is recorded in those units.

When a question asks for answers regarding features that are visible in a photograph or diagram, no credit can be given for answers based on prior knowledge or features that are not visible.

General Comments

The majority of candidates expressed themselves well and their writing was clearly legible.

Although the vast majority of candidates completed the paper in the time given, it appears that a few did not organise their time well enough to enable them to answer the final questions.

Comments on Specific Questions

Question 1

(a) (i) There were some good answers relating to features visible in the photograph e.g. large petals, petals forming a landing platform. Some candidates cited features of insect-pollinated flowers that were not visible e.g. colour, sticky pollen grains and nectar, which could not be credited.

(ii) There were some excellent drawings, larger than the actual specimen, made with clear, clean lines drawn with a sharp pencil. Good observation of the six stamens and stigma with a rounded surface were made and well represented in drawings without any shading. Some ruled lines appeared as a part of some drawings - all lines in a drawing should be drawn free-hand. Ruled lines are acceptable for label lines, when asked for.

Some candidates did not read the instructions carefully as they drew drawings of the whole flower instead of only that part of the flower within the box, and, in a few cases, drew a diagram of a flower recalled from a textbook instead of the flower in the photograph.

(iii) There were some excellent answers but many candidates did not follow the instruction to label the structures with a label line, letter and the biological name. Often, the structures were correctly identified simply by an adjacent letter; such answers could not be fully credited. There were candidates who could not identify the structures correctly.

(b) (i) Many candidates correctly stated that the rough surface of the pollen grain, or the spikes or projections on it indicated that it was insect-pollinated. There were no hooks visible. From the photograph, it was not possible to determine the pollen grain's mass, whether it was sticky or its

size compared to a pollen grain from a wind-pollinated flower, so answers in terms of mass, stickiness or size could not be credited.

(ii) The majority of candidates measured the pollen grain accurately either in mm or cm. Measurements in inches are not acceptable. A good proportion of candidates were then able to calculate the actual diameter of the pollen grain, again in mm or cm.

Working for calculations should be shown; sometimes a mistake is made in the calculation but marks can still be awarded for use of the correct method.

There were candidates who used the wrong method in their calculation, resulting in a pollen grain diameter of e.g.10 800 mm. Common sense should tell candidates that no pollen grain is that large and make them examine the method they have used. Encouraging candidates to consider the reality of their answers is important.

(c) (i) Food tests should be well known and many candidates gained full credit for this question. They described a method of preparing the fruit for testing, adding Benedict's solution, heating the mixture and noting the colour change from blue to green/yellow/orange/red. A number of candidates omitted the heating of the mixture and/or did not state the initial blue colour of the Benedict's solution or mixture.

A few candidates used the wrong reagent e.g. biuret, iodine or ethanol, having confused the reducing sugar test with that for protein, starch or fat.

(ii) Some candidates had an excellent understanding of how to design an investigation with controlled variables, making the results comparable. Equal masses of test materials were used, to each of which the same volume of reagent was added, then the mixtures were heated to the same temperature for the same length of time or for however long it took for colours to change. Candidates went on to draw conclusions from their observations.

Some candidates simply repeated their answer to Question 1(c)(i) which would not have led to a reliable comparison.

Question 2

(a) (i) Many candidates interpreted the diagram well, recognising that the unshaded part of the test-tubes represented the oxygen collected. Most measured the heights accurately and in mm as given in the table. Some recorded their measurements in cm without including the units (cm) in their answers; these answers could not be fully credited. A minority measured the shaded contents of the test-tubes, i.e. the water, which could not be credited.

(ii) Many candidates answered this well with descriptions and explanations. Some merely quoted the heights from Question 2(a)(i) without describing what those heights meant in terms of the comparative volumes of oxygen liberated. Many candidates correctly explained that no oxygen was released from the boiled potato because the catalase would have been denatured at the high temperature. There were a few who referred to the enzyme being 'killed' which cannot be credited as active enzymes are not living.

A few candidates did not relate the results to enzyme action on the hydrogen peroxide but erroneously answered in terms of the potato being full of oxygen that somehow was released.

(b) There were candidates who suggested good ways in which the method of the investigation could be improved to obtain more valid and reliable results, and a few did score full credit. However, many answers were incomplete e.g. repeating the investigation several times without stating that a more reliable mean/average result could then be calculated. Often, answers referred to size or amount instead of quantifiable terms such as volume or mass. Some candidates incorrectly changed the method of the investigation itself by altering the variables e.g. by using different potatoes, different vegetables, varying the temperature or the concentration of hydrogen peroxide used. There were candidates who wrongly interpreted the question as asking how the method might be improved in order for more oxygen to be produced.

Question 3

(a) (i) The majority of candidates constructed a table with ruled margins and columns or rows. Most candidates prepared two separate columns/rows for the results, one headed student 1 and the other student 2. However, very few candidates included a header, e.g. distance / cm, common to both students.

(ii) The vast majority of candidates were able to calculate the mean correctly. However, there were a few who, having added the five measurements, obtained a total of 60 cm but then did not divide that total by the number of measurements.

(iii) Many candidates correctly stated that this result was so much greater than the others that it should not be included, some describing it as 'anomalous' or 'an outlier'. Some said that the student must have made a mistake but that was not creditworthy as they needed to say why it was a mistake.

(iv) There were many candidates who simply stated that the student reacted slowly, which could not be credited. A suggestion as to why his reaction was slow was needed e.g. he was distracted or not concentrating. Some candidates incorrectly stated that the result was a misreading of the distance on the ruler due to parallax. This indicated a misunderstanding of the nature of the scale of error that may occur due to parallax.

(v) Although this may have seemed a straightforward bar chart, few candidates gained full credit. Some did not label the axes fully, did not plot the mean or omitted units from the distance. Most candidates chose a linear scale that made good use of the whole grid but there were those who chose one that occupied less than half of it, which could not be credited. There were many who omitted a value at the origin of the mean distance / cm axis. Most correctly constructed bars of equal width with a ruler and plotted the two values accurately. However, a number carelessly plotted 15 instead of 14.5 for Student 2.

A few line graphs were attempted despite the instruction to construct a bar chart and in some, all of the results obtained were plotted instead of the two mean results, indicating the need to read the question carefully.