BIOLOGY

Paper 5090/11
Multiple Choice

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

General comments

Overall, the paper produced a good spread of marks. Weaker candidates would improve their scores through improved understanding of such areas as eye accommodation, plant transport and microorganisms.

Comments on specific questions

Question 3

Most candidates recognised active transport, but did not always realise that diffusion is also involved.

Question 6

Many candidates opted for D, and did not appreciate that the relationship between temperature and rate will not give a straight-line graph.

Question 7

The most common error was to reverse the correct values i.e. high oxygen concentration in the leaf at night and low concentration during the day.

Question 10

This question proved difficult. Candidates were required to relate the flattening of villi to a reduced surface area for absorption.

Question 16

Candidates needed to read the question carefully, to notice that it referred to two glucose molecules, not one.

Questions 25 and 27

It was pleasing that most candidates coped well with the data interpretation required by these questions.

Question 29

Many candidates simply chose the (incorrect) familiar pyramid shape, without looking carefully at the information in the diagram.

Question 32

A common misconception was that nitrates make river water more acid.

Question 35

As in previous years, a common misunderstanding was that mosquitoes are the pathogens that cause malaria.

Question 36

Many candidates found this question challenging.

BIOLOGY

Paper 5090/12
Multiple Choice

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

General comments

Overall, the paper produced a good spread of marks. Weaker candidates would improve their scores through improved understanding of such areas as eye accommodation, plant transport and microorganisms.

Comments on specific questions

Question 5

It was pleasing that most candidates coped well with a question that required them to apply their knowledge in an unfamiliar context.

Question 7

The most common error was to reverse the correct values i.e. high oxygen concentration in the leaf at night and low concentration during the day.

Question 10

There was some confusion between stomach and pancreas when interpreting the diagram.

Question 12

Some candidates were unsure of the function of the phloem in the stem.

Question 13

Better candidates were able to recognise that the liver receives blood from the hepatic portal vein.

Question 16

Candidates needed to read this question carefully, to spot that it referred to two glucose molecules, not one.

Questions 20 and 22

It was evident from the answers to these questions that candidates could improve their knowledge of the functions of the parts of the brain.

Question 29

Many candidates here simply chose the (incorrect) familiar pyramid shape without looking carefully at the data.

Question 32

This question caused problems to candidates, who needed to understand the problem of insecticides killing beneficial, as well as harmful, insects.

Question 39

The genetic diagram required careful reading and analysis, and proved challenging to all but the best candidates.

BIOLOGY

Paper 5090/21
Theory

Key messages

Some very competent work was seen, although there was some evidence of answers being written without sufficient thought given to exactly what was being asked by the question. In these cases, candidates' answers sometimes fell too far wide of the mark to gain reward or failed to treat the answer in sufficient depth. This may be the result of a lack of care on the part of the candidate, or of a lack of knowledge.

General comments

Handwriting was generally clear and legible, but some difficulties arose when candidates appeared to write an answer in pencil, partly erase their work and then write over it with a revised answer.

It was clear from a significant number of answers that candidates struggled to interpret the photomicrographs of cells that had been placed in a concentrated salt solution, since they often failed to relate these to an effect of osmosis.

Comments on specific questions.

SECTION A

Question 1

(a) (i) Many candidates opted for 'asexual' as their answer, some of whom then deleted the 'a'. This was probably because they failed to carefully read the labels on the diagram, and have the mistaken belief that the term 'flower' refers to the whole plant and not solely to its reproductive part – as labelled on the diagram.

(ii) Those candidates who realised that the question was asking for a description of the growth of the pollen tube followed by fertilisation scored well, though many stated that it is the pollen grain rather than the male nucleus (nuclei) that travel down the pollen tube. There was confusion over the terms 'ovary', 'ovule' and 'ovum', and very few candidates mentioned the growth of the ovary wall after fertilisation. Several felt that the question was solely about the production of carbohydrates during photosynthesis.

(b) This part was usually answered correctly – irrespective of the answer given to **(a)(i)**.

(c) Despite the question asking about the advantages to the plant, several candidates referred to profitability. 'Variation' was most commonly mentioned for reproduction using flowers, though few explored the ways in which variation might be useful to the plant. Few spoke of the high survival rate using plantlets or that the plantlets would be in a suitable environment.

Question 2

(a) (i) This was well answered by the majority of candidates. The most common incorrect responses were 'xylem' and 'phloem'.

(ii) The most common incorrect response was 'photosynthesis'. Relatively few candidates opted for 'growth', but most gave 'germination'. Specific details of any enzyme operating during germination were not as common as might have been expected, and often answers did not venture beyond the need to break down stored food.

(b) This posed few problems for candidates, with large numbers knowing that temperatures above 35^{o}C would denature the enzymes. It was pleasing to see few candidates referring to enzymes being 'killed'.

Question 3

(a) (i) Apart from the very occasional response 'triceps', candidates answered **A** correctly**.** However, many struggled to identify both the scapula and humerus. 'Femur' was quite a common response for **C** – which was surprising, as the femur is not a bone that features in the syllabus.

(ii) Apart from the few who labelled the shoulder joint, this part was correctly answered by a high proportion of the candidates.

(iii) Occasionally answers were reversed, but this question was usually answered correctly.

(b) (i) Some candidates incorrectly supplied the equation for anaerobic respiration, some failed to balance their equation, and several gave the equation for photosynthesis.

(ii) For those who hit upon lactic acid being the cause of the muscle pain, this question provided a relatively easy two marks, but many talked vaguely about 'stress' on muscles/bones/joints and thus failed to gain any credit.

(iii) A few candidates felt that it would take longer but failed to support their argument, but most accurately suggested that it would take less time. However, if they had missed the lactic acid reference in **(b)(ii)** they were usually limited to a possible mention of more energy being required.

Question 4

(a) (i) Some candidates did not understand the action of breathing. Muscles and ribs were often described as 'stretching' and those who knew that intercostal muscles were involved either had both internals and externals either relaxing or contracting at the same time, or gave the incorrect action for breathing in. Candidates who understood breathing had little trouble scoring all four marks.

(ii) Occasionally this part was not answered, and some candidates were clearly unfamiliar with the appearance of the thorax – as a result, they suggested that mucus-producing cells and alveoli might be found in the heart and/or the rib cage.

(b) The capillary was often said to be 'one cell thick', when it is the <u>walls</u> that are one cell thick. However, it was often correctly mentioned that they provide a large surface area and are able to absorb and release substances into and from the blood that they are carrying. The identity of those substances was much less well known by candidates.

Knowledge of red blood cells was impressive, however a common error was to say that they 'carry oxygenated blood' rather than oxygen.

Question 5

(a) Although many answers were creditworthy, a significant proportion of candidates did not realise that the question was testing their knowledge of the process of osmosis on living cells. These candidates often spoke of cells 'shrinking' but were unable to explain their answers.

Those who knew that osmosis was involved occasionally thought that the concentrated salt solution had the higher water potential.

(b) (i) The majority of candidates scored two marks here, but common errors were 'cell wall' for cell membrane and 'vacuole' (not a visible structure on Fig. 2) for cytoplasm.

(ii) Precision was necessary here in order to score a mark. Candidates need to appreciate the full permeability of the cell wall and thus indicate that both the salt <u>and</u> water would be present in **R**.

(iii) Answers did not always accurately relate to the question, thus there was often a description of osmosis rather than a description of the properties of structure **P.** Answers stated only rarely that salt would be unable to pass through and, overall, candidates found this a difficult question to answer.

SECTION B

Question 6

This question generally scored quite well.

(a) Most of the relevant points were made, though many overlooked the possible harmful effects of the use of farm machinery such as the tractor. Contamination of drinking water was not mentioned often and 'erosion' was a term often used, but not always sufficiently well qualified. With reference to the power station, most candidates mentioned greenhouse gases, though there was some confusion over their identity and effects. Some felt that these gases might be discharged into the river, rather than into the surrounding air. Mention of the power station possibly increasing the temperature of river water was limited to a very few of the best candidates.

(b) The question specifically asked for ways in which people in the town could change their activities, yet many concentrated on what could be done with the power station and the agriculture (often involving re-siting them), though they then usually went on to cover at least some of the relevant marking points. 'Recycling' is a term from the syllabus, yet it was not mentioned by many candidates.

Question 7

(a) (i) This part was almost always answered correctly.

(ii) 'Digestion' rather than peristalsis quite often formed the basis to answers in this part. Those candidates who correctly referred to peristalsis often scored all available marks, with a reference to the wave-like action of the muscles being the point most commonly overlooked.

(b) (i) It seemed likely that most candidates were aware that the pH at **U** was alkaline, but they were confused over which region of the pH scale represents alkalinity. Thus, there were almost as many incorrect answers to this part as there were correct ones.

(ii) This was aimed at testing the candidates' knowledge of the pH of the liquids secreted into the duodenum. Apart from the confusions over the pH scale mentioned in **(b)(i)**, a significant number thought that enzymes are responsible for the pH. Several candidates referred to bile being made by the pancreas, and only the very best mentioned the presence of hydrogencarbonate.

SECTION C

Question 8

This question was the more popular of the ***Section C*** questions, and many candidates presented very competent answers.

(a) The section relating to the effect of pH on enzyme activity did not usually score as well as that on temperature. A common omission was failing to realise that the rate of activity increases up to the optimum, then decreases beyond it. Many suggested that if the pH (or temperature) was not at the optimum, then the enzyme would not operate at all, of if it did, it would be 'slow'. The effect of temperature usually allowed candidates to present their generally sound knowledge on the active site and on the importance of increased kinetic energy. Several, however, appeared to believe that the active site is located on the substrate molecule.

(b) The mistake of not reading the question cost several candidates a mark in this section. Correct reference to an enzyme and its functions were given, but the named part of the alimentary canal was quite often omitted.

Question 9

(a) It was generally well understood that an increase in light intensity increases the rate of photosynthesis. Many candidates also mentioned that the light is absorbed by the chloroplasts/chlorophyll. However, that this is true up to a maximum rate, and that light can operate as a limiting factor were points that were almost never mentioned. As with light, temperature was rarely mentioned as a limiting factor, though an increase in temperature was known to promote an increase in the rate of photosynthesis. Several candidates appreciated that higher temperatures increase the rate of water loss, causing the plant to wilt and the stomata to close, with a resultant decrease in photosynthesis, and many appreciated the importance of enzymes in the process. However, though all the above points were made, a sizeable number of candidates managed only the two marks for mentioning an increase in the factors promoting an increase in the rate of photosynthesis.

(b) Some candidates mentioned only that plants manufacture food for animals to eat. Better candidates extended their answers to include the exchange of oxygen and carbon dioxide between the two kingdoms, but only a few thought to mention that animals are unable to make their own food. That the food supplied by plants is digested by animals and then allows them to perform their metabolic activities was very rarely mentioned.

BIOLOGY

Paper 5090/22
Theory

Key messages

There is evidence this session that a higher proportion of candidates made more specific reference to the aspects of a topic identified in certain questions. Candidates sometimes did not understand the different requirements of a question requiring a description from one requiring an explanation. Centres are reminded that candidates should be guided in the length of each of their responses by the number of lines provided and by the number of marks available. A number of questions required the candidate to study carefully and to understand clearly a significant amount of information provided by the question. Examiners felt that a proportion of candidates may not have allocated sufficient time to this task prior to responding.

General comments

Some very competent work was seen from many able candidates. The causes and effects of an increase in carbon dioxide concentration in **Question 6** were well known by many candidates. The process of genetic modification in **Question 2** and the role of hormones in the menstrual cycle in **Question 5** were often less well understood. Questions requiring tailoring and application of knowledge to an unfamiliar context continued to provide more challenge for even the more highly attaining candidates.

SECTION A

Question 1

(a) (i) This was generally well answered, with the majority of candidates scoring both of the available marks. Some candidates confused 'artery' and 'vein' whilst others confused 'vein' and 'capillary'. Other candidates made incorrect reference to named types of blood cell rather than blood vessel.

(ii) The majority of candidates who made reference to named types of blood vessel in **(a)(i)** went on to give a correct explanation here. The mark scheme allowed candidates to gain credit here if their response to **(a)(i)** was incorrect. A number of candidates benefited from this. Candidates who made reference to named types of blood cell in **(a)(i)** were unlikely to go on to gain credit in **(a)(ii)**. References to either the wall of the blood vessel or to its internal space were required. Reference to the diameter or thickness of the blood vessel itself was not sufficient to gain credit.

(b) (i) This was very well answered with the majority of candidates scoring both marks. The most common error was to draw the valve flaps pointing downwards.

(ii) Reference to preventing the back-flow of blood was frequently seen. Candidates often went on to re-state this by making reference to allowing blood to flow only in one direction. Fewer candidates than expected made reference to the 'opening' and/or 'closing' of the valve or to the 'low pressure' of blood in the vessel. Occasional incorrect reference to the valve controlling or altering the pressure of blood in the vessel was seen.

Question 2

(a) (i) Examiners were pleased to see some candidates scoring all available marks here. Incorrect answers were common and included incorrect identification of **F** as the 'gall bladder' and incorrect identification of **G** as the 'liver'. Only the correct spelling of **E** as 'urethra' and **H** as 'ureter' were accepted.

(ii) Most candidates gained the single available mark here. Some candidates incorrectly identified **H** as involving the passage of semen or sperm.

(b) (i) Most candidates gained the mark here for reference to the presence of 'glucose'. Some candidates made incorrect reference to an increased amount or concentration of glucose. Reference to the presence of 'sugar' alone was not sufficient to gain credit.

(ii) Many candidates made reference to 'the gene' without identifying it as the 'insulin gene'. Simple reference to 'plasmids' without reference to inserting material into these bacterial plasmids was common, and was not sufficient to gain credit. Many candidates made correct reference to use of a 'fermenter'. Some candidates made incorrect reference to the reproduction of insulin rather than to reproduction of the modified bacteria.

Question 3

(a) (i) The majority of candidates correctly identified 3% to score the single available mark here.

(ii) The majority of candidates made correct reference to either the accuracy or reliability of the result. Incorrect reference to calculating the 'average length' of pollen tubes was common.

(iii) Many candidates correctly identified 8% as the optimum concentration of sucrose. Candidates who went on to explain this clearly in term of the highest percentage of pollen grain germination and the longest pollen tube growth gained full credit for doing so. It was common for candidates to explain with less precision than required the importance of 8% as the optimum or best concentration. For example, reference to a 'high' percentage of pollen grain germination or to a 'long' pollen tube growth was insufficient.

(iv) Some excellent responses were seen by Examiners, however many candidates who correctly explained the relevant points did not make reference to the term 'osmosis'. A proportion of candidates made incorrect reference to movement of 'sucrose' molecules.

(b) Some excellent responses were seen by Examiners with many candidates clearly identifying the key points and sequencing these points correctly. The most common incorrect reference was to the movement down the pollen tube of the pollen grain itself rather than of the pollen grain nucleus.

Question 4

(a) (i) This was a challenging question requiring candidates to link their factual knowledge with the information provided in the question. Many candidates were able to do this successfully. Candidates' understanding of the role of photosynthesis was often more secure than that of the role of respiration. A significant number of candidates made incorrect reference to respiration occurring only at night. Credit was available for reference to the trends shown by the graph on the question paper, however reference to the concentration of CO_2 being 'high' (rather than higher/increasing) or low (rather than lower/decreasing) was insufficient.

(ii) This was well answered, with the majority of candidates gaining the two marks available. Centres are reminded to advise candidates to follow all instructions given on the question paper. In this case candidates were instructed to 'draw a line on the graph above'. Candidates who did not follow this instruction, perhaps by drawing another graph elsewhere on the question paper as a response, did not gain credit.

(b) This was a challenging question and Examiners were pleased with the high proportion of candidates who were able to link the ideas presented in the question well. The most able candidates made the correct choice of time of day and then gave clear and fully correct reasons for this. Other candidates showed an understanding of the idea that a low CO_2 concentration would be seen and that this would result in a raised pH value. Some candidates incorrectly linked 'ammonia' with 'neutralisation' of the water. Some candidates made irrelevant reference to 'eutrophication' and its effects.

Question 5

(a) In general, answers were characterised by lack of sufficient correct detail. Whilst many candidates scored one or two of the available four marks, it was relatively rare for full credit to be awarded.

Confusion was apparent concerning the role of FSH in ovulation and in the production of oestrogen. Reference to 'stimulation of follicles' without reference to what the follicle was stimulated to do was common. Many candidates made reference to the term 'ovary' but a proportion did so in an incorrect context. Many candidates made incorrect reference to the role of progesterone as leading to a thickening rather than to maintenance of the uterine lining/wall.

(b) (i) This was sometimes well answered. Some candidates did not recognise though that the key issue relates to the presence of sperm, rather than to a possibility that the egg may be released early or at any time. Many candidates did recognise that sperm may survive in the female reproductive system for several days and hence scored full credit.

(ii) Whilst many candidates correctly identified the type of contraception, this was often identified incorrectly with incorrect reference to 'withdrawal' and to 'condoms' being common. When identified correctly candidates sometimes found it difficult to explain sufficiently clearly how sexual intercourse would be timed outside the fertile phase to avoid fertilisation.

(iii) Where the correct method had been named in **(b)(ii)**, most candidates secured the available mark here. Even where an alternative method had been named in **(b)(ii)**, candidates usually also managed to secure the available mark as error carried forward was applied by Examiners in that case.

SECTION B

Question 6

(a) Most candidate responses contained sufficient correct detail to gain maximum credit. This area of the syllabus appears to be understood well by the majority of candidates. Responses were often expressed clearly and contained a logical sequencing of points. Reference to 'fuels' alone, rather than to 'fossil fuels' or a named example, was sometimes made and was not sufficient to gain credit. Some candidates wrote at length to describe the data provided. As the question asked for an explanation, any descriptive statements in a candidate's response did not gain credit.

(b) Candidates who correctly interpreted this question and who wrote in terms of the effects of the changes in the percentage of carbon dioxide scored well. Reference to 'greenhouse gases' or to the 'greenhouse effect' was common; as was reference to 'global warming'. Other common correct statements referred to the 'melting of ice', to 'rising sea levels' and to the subsequent risk of 'flooding'. Reference to the 'ozone layer' was common, however as this was not relevant to this question Examiners were instructed to overlook such references and to credit all other correct points.

Question 7

(a) (i) This was generally well answered, with the very large majority of candidates scoring the single available mark. Common incorrect responses included 'wilting' and 'drying'.

(ii) Few candidates gained full credit here, with many responses either not naming the relevant microorganisms or not explaining the role of these in sufficient detail. Non-specific reference to 'decomposers' rather than to named microorganisms was common, and was not sufficient to gain credit. Candidates who made correct reference to 'enzymes' and/or to 'digestion' often did not go on to provide a valid example of digestion. Incorrect reference to microorganisms 'eating' or 'feeding on' leaves was quite often seen.

(b) This was well answered by the majority of candidates and some excellent responses were seen. Candidate responses here were often characterised by much correct detail. Most candidates made reference to 'in soil', however more frequent reference to the 'carbon cycle' and/or the 'nitrogen cycle' might have been expected. Candidates were often able to correctly link the requirement by the plant for 'nitrates' or 'ammonium' to the production of 'amino acids' or 'proteins'.

SECTION C

A much lower proportion of candidates answered **Question 8** than answered **Question 9**.

Candidates answering **Question 8** commonly gained less credit than those answering **Question 9**.

Question 8

(a) This part of the question was moderately well answered. Responses were often characterised by lack of sufficient correct detail to score highly. The most common correct point was reference to the number of categories or intermediates seen.

(b) This part of the question was moderately well answered. Again responses were often characterised by lack of sufficient correct detail. DNA was often correctly identified, with reference to chromosomes or genes also being common.

Question 9

(a) Many candidates gained full credit for a correct explanation of the term 'diffusion' and a correct description of an example. Candidates did not always provide an example and when they did it was not always relevant to the question asked. Examples <u>not</u> 'in either an animal or a plant' as required by the question, such as the diffusion of potassium permanganate in water, did not gain credit.

Many candidates gained credit for a correct explanation of the term active transport. A considerable number of candidates contradicted their correct explanation of concentration gradient here; for example by stating correctly 'from low to high concentration' but then going on to state 'down a concentration gradient'. Candidates were often unable to fully describe a correct example, with reference to unnamed 'mineral ions' being insufficient to gain credit. Incorrect reference to 'water' moving by active transport was common.

(b) Very few candidates linked storage molecules to the concept of osmosis. Many candidates wrote about starch or glucose travelling in the blood, and a significant number incorrectly described glucose as a larger molecule than starch. There were many references to starch and glycogen digestion, which did not gain credit as they were not relevant to the question asked.

BIOLOGY

Paper 5090/31
Practical Test

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of a range of practical work, including biological tests and experimental design. Candidates should be able to select suitable apparatus for an experiment, be aware of potential hazards and be able to suggest appropriate safety measures.

General comments

The number of marks awarded to candidates covered the whole range of those available and it appeared that the candidates had sufficient time to complete the paper. There were few instances of questions that were not attempted.

There continues to be improvement in the responses to questions relating to experimental design. More candidates are using precise terminology such as *volume*, rather than *amount* or *quantity* when listing variables to be controlled. To improve further candidates should recognise that when carrying out experiments on human subjects there are many variables which are impossible to control. To overcome this source of error, the whole experiment – including the control – should be carried out on the same subject or better still, on groups of people, in order calculate a mean result and minimise the effect of anomalies.

When asked to plot data, candidates should ensure that instructions are followed. If a bar chart is required, a line graph is not going to receive full credit. The graph or bar chart constructed should make full use of the space provided and any scales used should be linear with a value at the origin. When constructing graphs and bar charts or drawing diagrams, a sharp pencil should be used.

Comments on specific questions

Question 1

(a) (i) There were some good drawings of the banana section. The best drawings were of a good size, not shaded and had a clear continuous outline drawn with a sharp pencil. Most candidates indicated that they had observed the central structures within the fruit and drew the pericarp either with a delimiting line or by drawing vascular bundles. In some cases the pericarp was omitted. A small number of candidates drew a longitudinal section which could not gain full credit.

(ii) Most candidates followed the instruction to draw a line across their drawing and record the length of this line as well as the diameter of the specimen. The majority of measurements were accurate although a few candidates read the ruler incorrectly, recording e.g. 60.2 mm for 62 mm. The answer lines indicated that measurements should be in millimetres, so measurements recorded in centimetres could be credited only if accompanied by *cm*. The majority of candidates correctly calculated the magnification by dividing their drawing measurement by the measurement of the banana. A small number of candidates included units in their answer for magnification, which was incorrect.

(b) (i) The majority of candidates described the banana turning black when iodine solution was added. Some candidates also noted that the black colouration only appeared in *some* of the flesh and that the pericarp remained unstained.

(ii) The majority of candidates knew that iodine turning black indicated the presence of starch. Some candidates also noted that the starch was present only in the inner parts of the banana and were credited with the second mark.

(c) (i) The majority of candidates knew how to test for reducing sugar by preparing the material under test, adding Benedict's solution to it and heating the mixture. The most common omission was heating the sample in the Benedict's solution. Some candidates described the biuret test for protein which could not be credited.

(ii) When recording a colour change, the initial colour should be given as well as the resulting one. Some candidates omitted to mention that Benedict's solution is blue at the beginning of the test. Most candidates noted that reducing sugar is present.

Question 2

(a) (i) Candidates were asked to count the number of spines on 5 holly leaves and enter the data on a tally chart. Many candidates correctly counted the numbers of spines on the leaves and added the tally marks to the table. Others miscounted the spines or only added data for 4 leaves. Some did not complete the tally at all.

(ii) The majority of candidates correctly calculated the mean from the data they had recorded.

(iii) Most candidates constructed bar charts from the data as instructed, although a few attempted to draw line graphs. Both axes should have been fully labelled with units where appropriate and bars labelled centrally; in most instances this was the case. Occasionally the unit for 'height' was given as 'h' rather than 'm'. It should be noted that the data to be plotted was the *mean* number of spines so this should have been indicated on the appropriate axis. Candidates should be aware that the scale should be linear and have a value at the origin. The tops of bars should be plotted accurately and bars should be drawn with ruled lines and be of equal width. A small number of candidates used the y-axis for height which would have been acceptable had the bars been drawn horizontally.

(iv) This question was generally well-answered. Most candidates correctly described the relationship between the number of spines on the leaves and the height at which they were collected from the tree. It should be noted that a continuous relationship is required denoting the pattern or trend across the whole range. Answers indicating a large number of spines at a height of 1m and or a small number at 3m did not gain credit.

(v) Candidates were asked to suggest two ways in which the candidates could have improved their investigation to give them more confidence that their conclusion was reliable. This question proved more challenging. Answers in terms of using a larger sample of leaves (from the same heights), using leaves from intermediate or different heights, or from different holly trees all received credit. Answers involving the use of a different method could not be credited e.g. using leaves from other tree species, nor could re-counting the spines of the same leaves (due to the possibility of counting errors in the first instance).

(b) Candidates were required to identify the component parts of the flowers in order to complete the table. Many were able to identify stamens but identifying and comparing the carpels proved to be more difficult. When comparing the carpels, reference to the carpel, stigma, style or ovary would all have been acceptable; references to the petals were not.

Question 3

(a) Most candidates knew where and how to measure a pulse although there were some incorrect references to the pulse being felt in the veins, e.g. in the neck or wrist. The *rate* at which a person's heart beats was required, and so there was a need to count the pulse beats over a given time. Many candidates correctly described counting heartbeats per minute but a number opted for heartbeats per second which could not be credited.

(b) There were some good descriptions of investigations which involved measuring a person's pulse rate before and after drinking caffeine/coffee. A few candidates also recognised that the caffeine would not have an immediate effect and therefore a period of time should be left before re-taking the pulse. Some candidates attempted to compare one person drinking caffeine with another person not doing so. These responses could not gain full credit due to the lack of control of other

factors with such a small sample size. Better answers suggested using larger groups of people – one group drinking coffee and the other drinking water, taking the pulse rates of all individuals before and after the drink and recording the mean pulse rate of each group.

(c) Not many candidates appreciated that the volume of the drinks being compared should be the same, nor that the same person or persons should be used. A few suggested that the time between consuming each drink and taking the pulse rate, or the activity level of the subject(s) should be the same. These suggestions were both creditworthy. A number of candidates suggested that the temperature of the drink should be controlled, which could not be credited here. A significant number of candidates suggested controlling the 'amount of caffeine', which in this instance is the independent variable and therefore not a control variable.

BIOLOGY

Paper 5090/32
Practical Test

Key messages

The main objectives of this paper are to test practical skills and techniques, underpinned by biological knowledge and understanding. Requirements for performing well are:–

In **Question 1**, a clear understanding that, in the production of yoghurt from a yoghurt–milk mixture, bacteria are initially destroyed at high temperatures and a thickening in consistency and a decrease in pH occur during the process.

In **Question 2**, when investigating the sensitivity of the human skin to touch, key requirements include an understanding that the density and sensitivity of receptors in the index finger and thumb are greater than in other areas such as the palm, wrist, forearm, upper arm and shoulder.

In **Question 3**, alongside the application of drawing and measuring skills, an understanding that sample size and random fertilisation/chance or probability are significant factors in the development of round or wrinkled pea seeds.

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 sufficient time to complete the paper.

Comments on specific questions

Question 1

(a) (i)–(iii) Candidates were asked to record the colour, consistency and pH values of known volumes of milk, yoghurt –milk mixture and yoghurt. Many excellent responses showed that no colour changes were observed and the consistencies changed from a liquid to a partially liquid/thick medium together with a decrease in pH. The question proved difficult for some candidates who either overlooked consistency changes altogether and/or recorded the colour of pH indicator paper rather than describing the change in pH during the formation of yoghurt.

(b) (i)–(iii) First class responses confirmed that the use of a thermometer or temperature sensor shows that high temperatures will kill or destroy any bacteria or other microorganisms present and that the transformation of milk to yoghurt will result in a thicker texture and an acidic pH. Weaker responses suggested that heating milk to a high temperature allowed activation rather than the destruction of bacteria and that there were neither specific changes in texture nor pH.

Question 2

(a) (i) (ii) When candidates were asked to investigate the sensitivity of touch to the skin of their hands and wrists using toothpicks 5, 10, 15 and 20 mm apart, the best answers showed that the end of the index finger/thumb was the most sensitive. Some weaker responses suggested that sensitivity was greatest in the palm and wrist.

(b) (i)–(ii) When asked to construct a bar chart from data which provided mean distances detected as two points/mm in areas of the skin from the index finger/palm of the hand to the forearm, upper arm and shoulder, candidates who performed well labelled both axes with units on the *y*-axis and a linear scale with 0 at the origin, plus correctly plotting data with well-drawn bars of equal width. Many responses not only omitted the linear scale with 0 at the origin, but also omitted to label the axes and also units for mean minimum distances. When asked to explain why calculating mean values was required in their calculations, the majority of candidates favoured the terms accuracy or precision rather than stating that such values improved the reliability of their results.

(iii)–(v) When asked to comment on reasons why candidates should close their eyes during testing, the best answers suggested that touch was the main sense being tested. In addition variables that needed to be controlled to ensure valid results included the application of the same pressure on the skin and toothpicks of equal sharpness should be used. The best candidates were able to suggest that differences in sensitivity are related to both the number and density of sensory receptors per unit area. Many other responses omitted to mention the control of variables and made more general statements regarding the role of the central nervous system or skin texture and thickness in relation to sensitivity.

Question 3

(a) (i)–(ii) Candidates were asked to draw and label the cut surface of a developing fruit of a pea flower from the photograph provided and also to calculate the length of the actual fruit based on measurements given in the photograph. Apart from correct measurements and calculations of the fruit, many excellent responses showed large, fully labelled drawings with clear outlines of three roughly circular peas with stalks delimited and joined to the pod with double lines. Weaker responses showed peas drawn with an oval shape and poorly delimited stalks and measurements for calculating the length of the actual fruit were taken from the drawing rather than the photograph.

(b) (i)–(iii) Candidates were given a diagram comprising a random sample of round and wrinkled pea seeds and asked to count and calculate the percentage of wrinkled seeds for comparison with a different ratio of 3 round to 1 wrinkled seeds. Many excellent responses showed that the correct ratio was 4:1 and this is related to the sample size of the seeds and that random fertilisation/chance or probability are responsible. Many responses on the other hand lacked an understanding of sample size or random fertilisation and instead attributed a 4:1 ratio either to a mutation or errors in counting.

(c) When asked what type of test could be used to show that pea seeds contain protein, the majority of answers correctly referred to the Biuret test with the blue solution changing to mauve/purple/lilac in the presence of protein. A minority of answers either failed to mention that Biuret solution is blue or suggested Benedict's reagent or iodine solution as incorrect alternatives.

BIOLOGY

Paper 5090/61
Alternative to Practical

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests and experimental design. Candidates should be able to select suitable apparatus for an experiment, be aware of potential hazards and be able to suggest appropriate safety measures.

General comments

The number of marks awarded to candidates covered the whole range of those available and it appeared that the candidates had sufficient time to complete the paper. There were few instances of questions that were not attempted.

There continues to be improvement in the responses to questions relating to experimental design. More candidates are using precise terminology such as *volume*, rather than *amount* or *quantity* when listing variables to be controlled. To improve further, candidates should recognise that when carrying out experiments on human subjects there are many variables which are impossible to control. To overcome this source of error, the whole experiment – including the control – should be carried out on the same subject or better still, on groups of people, in order calculate a mean result and minimise the effect of anomalies.

When asked to plot data, candidates should ensure that instructions are followed. If a bar chart is required, a line graph is not going to receive full credit. The graph or bar chart constructed should make maximum possible use of the space provided and any scales used should be linear with a value at the origin. When constructing graphs and bar charts or drawing diagrams, a sharp pencil should be used.

Comments on specific questions

Question 1

(a) (i) There were some good drawings of the banana section. The best drawings were of a good size, not shaded and had a clear, continuous outline drawn with a sharp pencil. Most candidates indicated that they had observed the central structures within the fruit and drew the pericarp either with a delimiting line or by drawing vascular bundles. In some cases, the width of the pericarp was too great to be credited and occasionally was omitted completely. A small number of candidates drew a longitudinal section which could not gain full credit.

(ii) Most candidates followed the instructions to draw lines on both the photograph and their drawing. The majority of these measurements were accurate, although a few candidates read the ruler incorrectly, recording e.g. 60.2 mm for 62 mm. The answer line indicated that measurements should be in millimetres, so measurements recorded in centimetres could be credited only if accompanied by *cm*. The majority of candidates correctly calculated the magnification by dividing their drawing measurement by the photograph measurement. Those who also recognised that the slice in the photograph was already magnified ×1.5 and included this in the calculation, were given extra credit.

(b) (i) The majority of candidates knew that iodine turning black indicated the presence of starch. Some candidates also noted that the starch was present only in the inner parts of the banana and were credited with the second mark.

(ii) The excess iodine was rinsed off so that any colour changes in the tissues could be seen clearly. Not all candidates realised this and there were a number of vague answers suggesting that 'the results would be more accurate'.

(iii) It is expected that candidates will have carried out practical work. If they have used iodine solution, they will be aware that it does stain skin and may cause skin irritation; both good reasons for using forceps to handle material covered in iodine solution. Many thought that handling the banana would crush it or without forceps it would be dropped – ideas which were not creditworthy.

(c) (i) The majority of candidates knew how to test for reducing sugar by preparing the material under test, adding Benedict's solution to it and heating the mixture. A few candidates tested a sugar solution rather than the banana. The most common omission was heating the sample in the Benedict's solution. Some candidates described the biuret test for protein which could not be credited, and a small number tested with iodine solution.

(ii) When recording a colour change, the initial colour should be given as well as the resulting one. Some candidates omitted to mention that Benedict's solution is blue at the beginning of the test.

(iii) Many candidates knew how to perform the Benedict's test safely, e.g. wearing goggles to protect eyes from any spurting liquid when heating. Others suggested the use of a water bath to minimise any spurting, or if not, holding the test-tube pointing away from oneself and others when heating. A few responses also mentioned the use of tongs. These suggestions were all worthy of credit. Many suggested using forceps or gloves – neither of which could be credited.

Question 2

(a) (i) Candidates were asked to count the number of spines on 5 holly leaves and enter the data on a tally chart. Many candidates correctly counted the numbers of spines on the leaves and added the tally marks to the table. Others miscounted the spines or only added data for only 4 leaves. Some did not complete the tally at all.

(ii) The majority of candidates correctly calculated the mean from the data they had recorded.

(iii) Most candidates constructed bar charts from the data as instructed, although a few attempted to draw line graphs. Both axes should have been fully labelled with units where appropriate and bars labelled centrally; in most instances this was the case. It should be noted that the data to be plotted was the *mean* number of spines so this should have been indicated on the appropriate axis. Candidates should be aware that the scale should be linear and have a value at the origin. The tops of bars should be plotted accurately and bars should be drawn with ruled lines and be of equal width. A small number of candidates used the y-axis for height which would have been acceptable had the bars been drawn horizontally.

(iv) This question was generally well-answered. Most candidates correctly described the relationship between the number of spines on the leaves and the height at which they were collected from the tree. It should be noted that a continuous relationship is required denoting the pattern or trend across the whole range. Answers indicating a large number of spines at a height of 1m and/or a small number at 3m did not gain credit.

(v) Candidates were asked to suggest two ways in which they could have improved their investigation to give more confidence that their conclusion was reliable. This question proved more challenging. Answers in terms of using a larger sample of leaves (from the same heights), using leaves from intermediate or different heights, or from different holly trees all received credit. Answers involving the use of a different method could not be credited e.g. using leaves from other tree species, nor could re-counting the spines of the same leaves (due to the possibility of counting errors in the first instance).

(b) Candidates were required to identify the component parts of the flowers in order to complete the table. Many were able to identify stamens but identifying and comparing the carpels proved to be more difficult. When comparing the carpels, reference to the carpel, stigma, style or ovary would all have been acceptable; references to the petals were not.

Question 3

(a) Most candidates knew where and how to measure a pulse although there were some incorrect references to the pulse being felt in the veins, e.g. in the neck or wrist. The *rate* at which a person's heart beats was required, and so there was a need to count the pulse beats over a given time. Many candidates correctly described counting heartbeats per minute but a number opted for heartbeats per second which could not be credited.

(b) There were some good descriptions of investigations which involved measuring a person's pulse rate before and after drinking caffeine/coffee. A few candidates also recognised that the caffeine would not have an immediate effect and therefore a period of time should be left before re-taking the pulse. Some candidates attempted to compare one person drinking caffeine with another person not doing so. These responses could not gain full credit due to the lack of control of other factors with such a small sample size. Better answers suggested using larger groups of people – one group drinking coffee and the other drinking water, taking the pulse rates of all individuals before and after the drink and recording the mean pulse rate of each group.

(c) Few candidates appreciated that the volume of the drinks being compared should be the same, and that the same person or persons should be used. A few suggested that the time between consuming each drink and taking the pulse rate, or the activity level of the subject(s) should be the same. These suggestions were both creditworthy. A number of candidates suggested that the temperature of the drink should be controlled, which could not be credited here. A significant number of candidates suggested controlling the 'amount of caffeine', which in this instance is the independent variable and therefore not a control variable.

BIOLOGY

Paper 5090/62
Alternative to Practical

Key messages

The different command words used in questions, e.g. 'Describe' 'Explain' and 'Suggest', should be clearly understood so that candidates appreciate what is being asked of them and can answer appropriately.

All of the information provided in a question should be read carefully.

It is expected that candidates will be familiar with using standard laboratory equipment.

The differences between accuracy, reliability and validity in investigations should be appreciated.

Units should be given when measuring and when doing calculations.

General comments

Candidates seemed to have adequate time to complete the paper.

Almost all scripts were clearly legible, with answers written in the spaces provided or, if not, with clear indications of where they had been written.

The bar chart and answers involving calculations were generally well answered.

Scientific terms such as mass or volume are becoming more widely and correctly used, rather than general words such as 'amount'.

Comments on specific questions

Question 1

(a) (i) It was expected that candidates would be familiar with measuring volumes of liquid in the laboratory and so would realise that 100 cm^3 is best measured in a measuring cylinder whereas a syringe would be better for measuring the smaller volume of 5 cm^3. However, only a few candidates scored both marks.

(ii) Many candidates correctly described either dipping the pH paper into each sample or adding some of the sample to the pH paper. A colour change in the paper was observed which was then compared to a pH chart to give a pH value. Some candidates referred to pH solution although the question referred to pH paper.

Some candidates described using a pH meter although the question clearly asked about the use of pH indicator paper.

Using litmus cannot determine the precise pH of a substance – only whether it is acidic, neutral or alkaline.

Candidates who simply wrote about pH values and what they indicated in terms of acidity and alkalinity did not receive credit.

(iii) Many candidates correctly recorded that the pH decreased or became acidic as yoghurt was formed. Some candidates did not use the information given in the table and made general statements about pH that could not be credited.

(b) (i) Heating the milk to 85°C would kill the bacteria or microorganisms in it as some candidates correctly suggested. General terms such as 'remove' and 'germs' were not creditworthy. Suggestions that the temperature was the optimum temperature for enzyme activity or that it increased the rate of reactions or removed impurities could not be credited.

(ii) The majority of candidates correctly stated that a thermometer should be used to measure the temperature. Qualitative methods, e.g. looking for bubbles to appear, were not acceptable.

Although it did not affect the assessment of answers to the **Questions 1(b)(i)** and **1(b)(ii)**, it was apparent that, for some candidates, the words 'heating' and 'boiling' are incorrectly considered to be synonymous.

(iii) The question asked for information given in the table to be used. Many candidates did this, correctly looking for the end points of pH5 and a thick and creamy consistency to show that yoghurt had been formed. Simply measuring pH or testing the consistency were insufficient for credit as these were just the method to be used; yoghurt may not have been formed.

(iv) There were some very good, clear descriptions of investigations using yoghurt in which the bacteria had been killed to show that more yoghurt cannot be made from it. This 'dead' yoghurt was added to a volume of milk and left for 8 hours at 45°C as it was known that they were good conditions for possible yoghurt formation. A control experiment was also set up using similar volumes of live yoghurt and milk under the same conditions. After a given time, either the pH or the consistency of the samples was tested to see if yoghurt had been formed. The sample containing yoghurt in which the bacteria had been killed would not have formed yogurt whereas it would have been formed with the sample with containing bacteria.

Some candidates simply repeated what had already been given using yoghurt with live bacteria to produce more yoghurt. They did not seem to realise that they had to prove that a yoghurt/milk mixture with 'dead' bacteria did not produce more yoghurt whereas a yoghurt/milk mixture with live bacteria did.

Others wrote descriptions of how yoghurt may be made commercially or about the theory of yoghurt production. Neither of these answered the question set and could not be credited.

Question 2

(a) (i) The sense of touch was under investigation in this question. Being able to see how many points were being placed on the skin would have meant that the investigation was not valid as the sense of sight was also involved. Using a blindfold meant that touch was the only sense being investigated. Some candidates recognised this.

(ii) Answering this question well called for careful reading of all the information provided and imagining what was actually happening. Those candidates who did this were able to correctly place ticks and crosses in the table. With the thumb they were told that the minimum distance that could be felt as two points was 3 mm. This meant that at any distance less than that, i.e. at 2 mm, two points could not be felt (✗) and at any distance greater than 3 mm, i.e. at 5 mm, 10 mm, 15 mm and 20 mm, two points could be felt (✓). With the palm, at distances shorter than 16 mm, i.e. 15 mm, 10 mm, 5 mm and 2 mm, two points could not be detected (✗) but at a distance greater than 16 mm, i.e. 20 mm (✓), they could.

It was obvious that some candidates did not understand this concept and guessed where to put ticks and crosses in the table.

(iii) The most sensitive part tested would be the one where the two points could be felt at all the distances and therefore had all distances ticked i.e. the end of the index finger. The majority of candidates correctly stated this.

(b) (i) There were some excellent bar charts drawn, with fully labelled axes, a linear scale for mean distance, accurate plotting and ruled bars of equal width. The most common errors were axes not being labelled and scales not being linear because no value was given at the origin.

A few attempts at line graphs were seen even though the question asked for a bar chart.

(ii) If an investigation can be repeated with similar results it is reliable. A mean/average result obtained from repetitions of the same investigation is more reliable than the results of carrying it out once.

By the candidates testing each other in this investigation and calculating a mean result they were increasing the reliability of the investigation. Many candidates confused reliability and accuracy.

(iii) The wire and the distance between its points were independent variables in this investigation. The question asked for another variable that should be controlled, so those who gave answers in terms of the wire could not be credited. Some candidates correctly recognised that the pressure with which the points were applied to the skin should be the same each time or that the points should be applied to the same part of the area under test e.g. the shoulder. A few candidates recognised that the time the points were in contact with the skin should be the same.

(iv) **Question 2** began 'Human skin is a sense organ containing sensory receptors that can detect touch'.

The whole question was about the distribution of these sensory (touch) receptors. Having been given information about an investigation into their distribution and its results, **Question 2(b)(iv)** was asking candidates to think through what those results might indicate about that distribution. Other details of the nervous system, e.g. references to neurones or nerves, were not required in answers. Some candidates correctly suggested that the results indicated that there were different numbers of sensory receptors in different areas of the skin. A few went on to relate that to the outcome of this investigation, e.g. more touch receptors meant that the area was more sensitive. A very small number pointed out that a greater number of sensory receptors was related to the function of the area e.g. tips of fingers with most receptors are most used for sensing touch.

Common suggestions for the differing sensitivities in this investigation that could not be credited referred to variation in the thickness of skin, that the time taken for nervous impulses to reach the central nervous system would differ between the sites or to illness or disability in the individuals being tested.

Question 3

(a) (i) There were some excellent drawings of the developing pea fruit. Credit was given for drawings larger than the photograph, with clear continuous outlines made with a sharp pencil and no shading. The seeds should have been of a good shape and clearly delimited from their stalks. Stalks drawn with single lines could not be credited.

Some candidates omitted the required labels. Of those who did label their drawings, the majority did so correctly. The most common error was to identify the outer layer of a seed as the pericarp.

(ii) Generally the accuracy of the measuring was good. A small minority of candidates recorded their measurements in centimetres although mm was written on the answer line provided; if they included cm in their answer they were credited. An even smaller minority of candidates were confused about measuring in millimetres, recording e.g. 0.61 instead of 61.

To calculate the actual length of the fruit, the length of the fruit in the photograph should have been divided by the stated magnification, 1.2. Many candidates did this, and included the correct units in their answer. There were those who, in error, multiplied their measurement of the fruit by 1.2 or who divided the measurement of their drawing by 1.2.

Measurements should always include the correct units used if not already given on the answer line.

(b) (i) The vast majority of candidates counted the seeds accurately.

(ii) The error made by a few candidates was to divide the number of wrinkled seeds by the number of round seeds instead of the total number of seeds, before multiplying by 100. However, the majority of candidates calculated the percentage correctly at 20%.

(iii) Some correctly suggested that if a larger sample of seeds had been counted then the ratio may have been as predicted instead of the actual ratio of 4:1. A few recognised that the random nature of fertilisation could result in a different ratio of seeds but often the word 'random' was incorrectly related to the selection of the seeds rather than to fertilisation.

Comments in terms of human error in counting, genetic mutation and differing environmental conditions resulting in a different ratio from that predicted, were not creditworthy.