BIOLOGY

Paper 5090/11
Multiple Choice

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

General Comments:

For **Questions 24** and **25**, in particular, it was pleasing to see that most candidates were able to process unfamiliar information effectively.

Questions 9, **12**, **16**, **17**, **21**, **32**, **38** and **39**, in particular, taxed the less able candidates.

Comments on Specific Questions:

Question 10

A consideration of all factors that affect energy requirements, including body mass, was required to determine the correct answer, rather than focusing simply on levels of activity and age.

Question 11

Where incorrect answers were given, it was confusion over the location of the xylem and phloem that led to the most common errors.

Question 13

Significant numbers of candidates traced the blood flow from the leg back through the kidneys to the heart: candidates can improve upon their understanding of the human circulatory system as consisting of two circuits (a double circulation).

Question 14

Close reading of the stem of the question was required to determine the correct answer: the vessel shown was a vein. 'D' was a popular answer: some confusion exists over the name of the vessel carrying blood from the heart to the lungs with candidates erroneously thinking it is the pulmonary vein.

Question 15

Understanding of the function of the heart in terms of muscular contraction and workings of the valves could be improved, and candidates should be aware that the heart valve closes when the pressure lines on the graph shown cross.
All three questions concerning the human circulatory system taxed candidates and understanding of this area of the syllabus could be improved.

Question 22

Knowledge of the functions of the different parts of the brain could be improved.

Question 23

Most candidates knew that adrenaline causes increased glucose uptake by muscle cells, but realisation that it also causes conversion of glycogen to glucose in the liver was not as common.

Question 28

A common misconception was that decomposers are able to pass carbohydrates on to producers.

Question 29

Here, some candidates chose the familiar pyramid–shaped diagram, without relating it to the particular food chain specified.

Question 30

C was not an uncommon answer, with candidates forgetting that proteins contain carbon as well as nitrogen and so proteins participate in the carbon cycle as well as in the nitrogen cycle.

Question 34

Understanding of the differences between mitosis and meiosis could be improved, with confusion between the two leading to some candidates thinking that the chromosome number would be halved in this example.

Question 35

This question tested candidates, with many candidates opting for oestrogen, not recognising that this hormone has a second, lower, peak in the cycle.

Questions 38-40

Candidates performing less well on the paper as a whole found these questions difficult, and understanding of this area of the syllabus could be improved. In **Question 40**, the commonest error was the belief that dominant alleles are always more frequent than recessive alleles.

BIOLOGY

Paper 5090/12
Multiple Choice

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

General Comments:

All the questions were accessible to candidates, indicating that the subject matter had been well learnt, particularly in those areas of the syllabus addressed by **Questions 1**, **3**, **10**, **20**, **21** and **36**.

Comments on Specific Questions:

Questions 7 and **9**

These questions required candidates to deal with unfamiliar information, and the majority of candidates were able to do so.

Question 12

The understanding of transpiration as being powered by the Sun could be improved. The commonest error was the belief that water absorption in the roots causes transpiration.

Question 14

Close reading of the stem of the question was required to determine the correct answer: the vessel shown was a vein. 'D' was a popular answer: some confusion exists over the name of the vessel carrying blood from the heart to the lungs with candidates erroneously thinking it is the pulmonary vein.

Question 15

Understanding of the function of the heart in terms of muscular contraction and workings of the valves could be improved, and candidates should be aware that the heart valve closes when the pressure lines on the graph shown cross.
A majority of candidates were able to answer this question correctly.

Question 17

This question proved taxing for a number of candidates. Candidates could arrive at the correct answer either by realising that three of the given experimental precautions were necessary for the maintenance of anaerobic conditions, or by realising that the indicator liquid in the tube will move to the right during the experiment – so it must be near the left hand edge of the tube at the beginning of the experiment.

Question 28

A common misconception was that decomposers are able to pass carbohydrates on to producers.

Question 31

Confusion between the vector, the mosquito, and the malarial pathogen itself, led to incorrect answers being given.

Question 35

The symptoms of syphilis were not well known and understanding of this area of the syllabus could be improved.

Question 40

The commonest error was the belief that dominant alleles are always more frequent than recessive alleles.

BIOLOGY

Paper 5090/21
Theory

Key Messages

Candidates often have the faulty understanding that energy is produced or made during respiration.

General Comments

Some excellent candidates produced relevant and well-structured answers. These candidates answered the questions concisely and clearly and used the additional information provided in the stem of the question to augment their answers. Many questions ask for specific information, and any extraneous information does not gain any credit. Most candidates tailor their answers to the spaces provided. It is helpful if those that answer elsewhere indicate this to the Examiner.

Comments on Specific Questions

Section A

Question 1

(a) (i) Nearly all candidates identified the red blood cells and stated their function.

(ii) Many candidates stated that the cell was thinner in the middle than at the edges. However they did not relate this to ease of light transmission or to the lack of a nucleus.

(b) (i) The white blood cells were identified.

(ii) Answers should have referred to a reduction in immunity or to a reduced ability to fight disease. Having stated the problem, references should have been made to phagocytosis and antibody formation and also to the type of disease inducing micro-organisms which could be killed.

Question 2

(a) Most candidates correctly named two gases.

(b) (i) As numerical information was provided on the graph, candidates were expected to use this in their answers. So answers such as “The blood gas barrier in mammals is thicker by 0.3 µm” or “The blood gas barrier in mammals is more than two times thicker than in birds” were expected.

(ii) Candidates did not relate the need of the birds for high release of energy with the time taken for the oxygen molecules to pass through a thinner barrier. Very few candidates linked the increased need for energy with an increase in respiration to release that energy.

An excellent answer was: “Diffusion of oxygen is a pre-requisite for respiration and respiration releases energy. The thinner the blood gas barrier the faster the diffusion of gases from one side of the barrier to the other. The more oxygen available, the faster the rate of respiration and the more energy is released”.

Question 3

(a) Candidates answered this part of the question well and clearly understood the process.

(b) From the information given in the question candidates were expected to explain how the reduction in the amount of acid would affect the digestion of proteins and mention the reduced killing of bacteria entering the stomach.

(c) (i) Most candidates used the word "antibiotic" or gave a named example.

(ii) This part was not well answered. Most candidates suggested that the bacteria gradually built up resistance to the drug. However candidates did not realise that the remaining bacteria could reproduce and that the symptoms could recur.

A good answer was**:** "Some bacteria will be left, of these some might have undergone mutation to provide resistance to the antibiotic. With time they reproduce and thus the number of resistant bacteria increases, symptoms of the infection start to appear again but the antibiotic is no longer as effective".

Question 4

(a) (i) Correctly identified by most candidates.

(ii) The question specifically asked for the transfer of water from the soil to the cytoplasm of the root hair. No credit was gained by candidates who described the transfer of water beyond the cytoplasm of the root hair cell.

(b) (i) It was expected that candidates would refer to the effect of the increased oxygen uptake in both areas "Y" and "Z" of the graph. Most candidates correctly identified the relationship at "Y", but few mentioned that at "Z" the ion uptake was no longer affected by an increase in oxygen.

(ii) Candidates are confused between active transport and diffusion. Few mentioned that active transport required energy from respiration and that the increase in oxygen concentration allowed more respiration to occur.

A good answer was "In section "X" there is a low oxygen concentration around the cell which limits the rate at which respiration occurs and energy is released. So most of the ions are taken up by diffusion. As oxygen increases during "Y", the cell respires more and releases more energy for active transport."

(iii) Few candidates suggested that this was caused by another factor which limited the uptake of the ions.

Question 5

(a) (i) This was usually correct.

(ii) Many candidates drew incorrect pyramids with the "caterpillar" section being the smallest of the three.

(iii) Candidates found it difficult to explain the difference. A labelled diagram of a pyramid of numbers would have been an acceptable answer.

(b) This question was designed to test if candidates could apply their knowledge to a new situation. From the question the candidates must extract the information that it's of benefit to the farmer to keep animals warm and reduce movement. Then they need to explain why this will reduce the amount of energy used by the animals leaving more available for growth. Economic benefits to the farmer could be mentioned.

A good answer was "The farmers want to restrict movement so that less energy is used up in locomotion, muscle movement etc., and more will be used for growth so that the animals can put on a lot of weight. The temperature control will ensure the optimum temperature for growth so that the energy from food is not used up to maintain the body temperature when it is cold."

Section B

Question 6

(a) As a definition of "homeostasis" was asked for, a general definition was required. Most candidates did this, but a few gave a specific definition, for example for temperature control.

(b) (i) This question had two parts, the first was to explain how negative feedback was involved and the second was to explain the response of the body to rectify the situation.

A good answer: "The skin temperature receptors sense that the temperature is dropping, this causes the blood vessels at the surface of the skin to constrict and less heat is lost from the skin. Shivering may occur in an attempt to raise the body temperature to normal."

(ii) Again there are two parts to the question.

A good answer: "When a person drinks an excessive amount of water it is absorbed by the colon and the blood concentration reduces. This is detected by the brain and information passed to the kidney to absorb more water from the blood so the volume of urine increases."

Question 7

(a) As this was a question comparing two processes it is suggested that a table format should be used. Both sides of the comparison are required in the answer, e.g. mitosis produces genetically identical cells whereas meiosis produces genetically different cells. Candidates tended to give only one half of the point. Amongst the weaker candidates there is confusion between the two processes.

(b)

Many weaker candidates are confused between genes and chromosomes and between the number of sex chromosomes within the body cells and gametes. Most candidates correctly identified that the father determined the sex of the child.

An excellent answer: "The sex chromosomes are the X and the Y chromosomes. The female parent has a pair of X chromosomes while the male parent has one X and one Y chromosome in the cells in their body. During gamete formation the daughter cells which are produced always contain the X chromosome in the female parent however in the male parent may contain the X or the Y chromosome. Therefore the sex of the child is determined by the presence of an X or a Y chromosome in the sperm which penetrates the egg. If it contains an X chromosome the zygote will have a pair of X chromosomes and will be a girl, while the presence of a Y chromosome will make the zygote a boy. Therefore the male parent determines the sex".

Section C

Questions 8 and **9** are alternatives. Credit is gained only for **one** answer.

Question 8

(a) Candidates did not answer this question well. They were asked to explain how humans depended on the process of photosynthesis so needed to consider both the products, carbohydrate and oxygen, and also the carbon dioxide used.

A good answer: "The equation for photosynthesis is carbon dioxide + water → carbohydrate + oxygen. Plants act as a food source for human beings. Plants absorb carbon dioxide and so reduce global warming. Plants produce oxygen which is used in respiration by human beings. The wood from trees is used in building furniture and boats".

Another answer which gained credit: "Humans cannot manufacture food in their bodies but plants can manufacture glucose and oxygen. When herbivores eat plants they obtain the glucose and chemical energy in the plants and the humans also obtain this energy when they eat the herbivores. Also photosynthesis takes in carbon dioxide and so reduces the concentration of carbon dioxide in the air so there is less global warming. The waste product of photosynthesis is

oxygen, so the process increases the oxygen concentration in the air used by humans for respiration and energy release for metabolic processes."

(b) This was a straight recall of information. Most candidates answered this well, gaining maximum credit.

Question 9

(a) This was a straight recall of information.

(b) Some excellent answers were seen which explained the role of the raw materials used in the production of penicillin by the fungus e.g. a suitable culture medium and oxygen. The need to control the physical environment, e.g. temperature, pH and agitation, should also have been discussed.

BIOLOGY

Paper 5090/22

Theory

Key Messages

This paper revealed a high level of confusion over the processes of respiration and photosynthesis in plants and over the difference between the terms respiration and breathing. These processes are so fundamental to the subject that candidates are ill-advised to enter a biology examination lacking a clear knowledge of the distinctions between these particular very important topics.

General Comments

There was a wide range of ability shown by candidates, with some candidates demonstrating a high level of understanding of the topics tested with some considered, top-quality answers. Some questions did prove demanding of candidates, particularly **Question 6**.

The number of lines given for each question is a guide to the length of the required answers. Candidates with large handwriting are advised to reduce the size of their writing before considering the possibility of writing on additional sheets.

Comments on Specific Questions

Section A

Question 1

(a) A wide range of substances was allowed, and most were given. However, glucose was a common error despite the question referring to the urine of a *healthy* person. Some answers overlapped and thus failed to score more than once (e.g. 'nitrogenous waste' and 'urea').

(b) The references to diet were often sound, with candidates linking increased protein intake with increased urea in the urine, and increased/decreased water or salt intake with the appropriate effect on urine concentration. The stem of the question requested an explanation for these changes and this was often lacking, thus references to amino acids and deamination were rare. Candidates need to ensure all command terms are addressed when considering their answers.

(c) A major misconception in this question was that the drink that produced the greatest amount of urine must contain the greatest volume of water, despite the question stating that the same volume of drink was consumed in each case. Candidates should ensure all information in the stem of a question is carefully read and considered.
Candidates also often felt that urination is a method that is employed to lose heat, thus overlooking the fact that, on a very hot day, much water would be lost with sweating at a maximum. These misunderstandings led to almost as many candidates choosing drink C as chose drink A.

Question 2

(a) Those who realised that this referred to the 1:2:1 genotypic ratio had no problems with the simple mathematics, but it was clear that a not insignificant number did not realise this and offered wild guesses with 20 and 20 being a common inaccurate answer.

(b) Since the exercise was related to the random nature of the results, those who suggested reasons that would still make the results random failed to gain credit, e.g. the effect of wind or the force with which the discs were spun and the evenness of the spinning surface.

(c) (i) Parents was a very common correct answer.

(ii) Fertilisation was often correctly mentioned.

(iii) The (individual) letters on the discs were often thought to be the genotypes rather than the genes (or alleles), though a misunderstanding of the terminology was revealed by those who suggested 'phenotype'.

(d) A range of quality of responses was seen in this question. Some most ably modified the letters on their discs and covered all the relevant points. Most seemed to want to change the number of sides on the discs which was fine if they remembered that they had to have equal ratios of letters – but many did not. Others, surprisingly commonly, managed to produce '2-sided discs', or used one disc with all relevant alleles written on it. Only the most considered candidates thought to say that the discs had to be spun many times and the results needed to be recorded. Less able candidates pinned their faith on a genetic diagram, of variable accuracy, to show how blood groups are inherited.

Question 3

(a) Although this was usually answered correctly, there were several that imagined that an agent of pollination would be involved, thus referred to wind or insect.

(b) (i) Although many gave an accurate description of wind-pollination, there was often mention of air rather than wind, and often no mention of another flower.

(ii) Most candidates appreciated that the pollen might not travel very far, but only a few thought to say that the wind might not be blowing during the short period of time that the flower is open thus reducing the chances of cross pollination and, therefore, of genetic variation in the offspring.

(c) (i) Although artificial selection may be involved at a later date, and although the work may be, relatively loosely, biotechnological, the actual experimental work described is genetic engineering, a fact that by far the majority of candidates realised.

(ii) This question exposed a serious lack of sound knowledge about the nitrogen cycle. Candidates tried to involve decomposition. The wrong bacteria were named and there was a mix of nitrogen fixation and nitrification. Root nodules were described as performing the fixing rather than the bacteria, and ammonia rather than ammonium was often mentioned. Some candidates thought that the bacteria were some sort of protection against diseases/pests.

Question 4

(a) Most candidates had few problems, though a significant number confused rectum and anus, whilst several were unsure of the distinction between the terms ureter and urethra.

(b) Some were not sufficiently precise with their cuts, and extended them to include structures other than those expected. A few others omitted the question completely.

(c) Those candidates who used Fig. 4.1 **(a)** to assist them were able to mention that the urethra would be compressed and thus urination would be difficult. Again, there was confusion between ureter and urethra, but many looked beyond the question to offer answers related to semen production.

Question 5

(a) (i) Most candidates found two accurate answers from the extensive list of possibilities.

(ii) The majority of candidates realised that there would be reduced transpiration, but often went on to relate it to temperature or light intensity, rather than to the scarcity of available water in desert conditions to replace that which is lost.

(b) (i) This part was answered almost universally correctly.

(ii) It was not uncommon to read that stomata on the stems take up water for photosynthesis. However, most were able to link gaseous exchange through stomata with an appropriate process taking place within the stem.

Section B

Question 6

Serious misunderstandings were revealed by this question.

(a) The problem here centred on the terms 'breathing' and 'respiration' which were often considered to be interchangeable. Plants were said to 'get their energy from photosynthesis'. Humans were said to 'breathe to get energy' or to 'breathe but plants photosynthesise'. Many implied that diffusion was a feature of plants but not humans, missing the fact that diffusion occurs in the alveoli. There was the occasional passing reference to the need to supply oxygen to all cells or to remove carbon dioxide. Rarely was there a reference to the importance of mesophyll cells during leaf respiration. References to intercostal muscles, lungs and stomata enabled a few candidates to score well in this part-question.

(b) Even those who showed some knowledge in **(a)** often struggled to make any points of substance in this part. The following are examples of the errors made: 'energy is made from photosynthesis'; 'plants get light energy so there is less need for respiration'; 'humans respire but plants photosynthesise';' humans get energy from respiration but plants from photosynthesis';' humans respire all the time but plants only at night/more at night / less at night'.

Many candidates did not make the link between respiration and energy release. Those that did produced quite accurate lists of what animals need energy for, but suggested that active transport was a uniquely botanical phenomenon. There seemed to be no understanding that animal and plant cells had processes in common. However, references to animals requiring more energy than plants for movement or the functioning of more complex organs were made, as were references to plants requiring more energy at certain stages in their life cycle.

Question 7

(a) This part was generally well-answered, but it was rare to read that viruses have either DNA or RNA, and bacteria were often said to have nuclei. It was common to see references to viruses living in a host rather than a host cell. Otherwise, this part was handled with competence.

(b) Although this is traditionally a relatively straightforward topic, there were many who failed to give a simple account of decomposition and fewer still who answered the part of the question that relates to recycling. Thus there were few mentions of the use to which carbon dioxide and water are put as they are released during decay. This was, in part, due to the fact that many did not appear to realise that bacteria use the materials from the process of decay for their own respiration. Very few thought to mention the importance of converting insoluble materials into soluble ones, and, as in **Question 3**, ammonia rather than ammonium was mentioned. It was, perhaps, the result of having answered **Question 3**, but several wrote at some length, and also with some confusion, on nitrogen fixation and denitrification.

Section C

Question 8

(a) Candidates were able to score highly on this section, though they rarely remembered to say that the contraction of circular muscles must be *behind* the food, in order to push it along. Some referred to radial rather than longitudinal muscles, and a few forgot to mention the rhythmic or wave-like motion of peristalsis.

(b) This question revealed some misunderstandings of how the heart works. Several believed that the entire right side of the heart contracts to send blood to the lungs, then the left side contracts in order to send blood to the rest of the body. There were a few, but only a very few, references to there being no skeletal structures involved.

Question 9

This was, by far, the more popular choice in ***Section C***

(a) (i) Candidates were particularly comfortable with this part. All points were seen, with a reference to social implications being the least common. There was a little confusion over the nature of atheroma. Some thought it occurred in veins, others were non-committal, and thus went unrewarded, with a vague mention of blood vessels. Otherwise answers were very sound.

(ii) The question asked for 'the effects of a low-protein diet' and not for a list of the functions of protein in the diet. Thus some candidates did not score quite as highly as they might have done. Nevertheless, some sound answers were seen with many gaining full credit.

(b) Few failed to make the link between iron and blood, and thus readily referred to blood loss during menstruation. Less common was the important link made between iron and haemoglobin**.**

BIOLOGY

Paper 5090/31/32
Practical Test

Key Messages

The main objectives of this paper were to test not only biological knowledge, with emphasis on structure and function, but also the application of practical skills and techniques. Requirements for doing well included, in **Question 1**, a clear understanding that when investigating the effect of sugar solution on onions, the process of osmosis is the passage of water molecules from a region of their higher concentration to a region of their lower concentration through a partially permeable membrane and that net movement of water occurs out of the onion cells in sugar solution, but into the cells in distilled water. In **Question 2**, key requirements include an understanding that fruits such as apples, during the process of ripening, become less acidic and sweeter to taste due to the presence of reducing sugar and that measuring pH using universal indicator paper and testing with Benedict's solution can be used to demonstrate this. Then, in the latter part of **Question 2**, which concerns the storage of fruit, an ability to carry out calculations and plot data is required, as well as a consideration of the processes such as respiration, evaporation and decomposition that lead to a reduction in mass in stored fruit.

General Comments

The questions tested the ability of candidates to follow instructions and to 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) (i)(ii) Candidates were asked to investigate the effect of sugar solution on 2 mm thick transverse slices of onion, with the outer ring separated from the inner rings (as in Fig1.1A) and cut into two equal halves (as in Fig1.1B). One half is placed in distilled water and the other in sugar solution and candidates were asked to draw both slices at the start and after 30 minutes. The optimum answers showed that both were drawn with similarity in shape / size and the outer layers were clearly indicated and that after 30 minutes the slice in water straightens or the curvature had opened up compared with a more pronounced curvature or bending / shrinkage in the slice in sugar solution. Many candidates neither identified the outer layer nor showed any clear differences in curvature between the slices.

(iii) When asked to describe changes in the shape of slices after 30 minutes, considered answers described the distinct differences in curvature observed in **(a)(ii)**; incorrect responses placed more emphasis on changes in texture / turgidity, rather than in curvature.

(iv) When asked to explain what caused these changes, the more able candidates provided responses that made reference to osmosis, the movement of water across a semi or partially permeable membrane and to the fact that the water potential / concentration is greater in the onion than in the sugar solution but lower than it is in distilled water. There was also correct reference to hypotonic / hypertonic solutions.
Correct observations showed that the slices became more turgid in water and flaccid in the sugar solution with cells undergoing plasmolysis. Less change occurred in the outer layer.
The majority of candidates mentioned osmosis, but there was some confusion with it being considered a method of water absorption rather the movement of water, and some candidates failed to reference a semi or partially permeable cell membrane, or turgidity / plasmolysis when describing the changes in the onion tissue.

(b) First class responses indicated that the source/ type of onion tissue should be kept the same to avoid any cellular variation. In addition, if the onion remained the same size / thickness, this would allow similar distances for movement of water and the same opportunity for water movement would occur if onion pieces were kept in solution for the same length of time.

Question 2

(a) (i) Candidates were asked to make a drawing of the cut surface of an eating apple and excellent answers produced a clear drawing with continuous lines and no shading, the central part drawn in proportion to the size of the entire section. The seeds and remains of sepals were also correctly labelled. Credit was lost where candidates produced poor quality or shaded drawings, did not include a central part containing seeds and / or incorrectly labelled sepals as the stalk.

(ii) The line drawn on the widest part of the apple was usually correctly measured with appropriate units given.

(iii) Measurements of the length of the line drawn on Fig. 2.1 were generally correct, but only the best answers followed this by calculating the magnification: divide the measurement given in **(a)(ii)** with the measurement in Fig. 2.1, and allow for the x3 magnification shown in this figure. Answers gaining less credit not only showed incorrect calculations but failed to allow for the x3 magnification.

(b) (i) When asked to record the colour of the universal indicator on the freshly cut surface of the eating apple, the majority of responses were excellent, candidates correctly recording a range in colour from yellow / green to yellow / orange and noting that the apple juice was acidic or below pH 7. Some candidates did not indicate the correct colour change nor record the pH and made reference to alkalinity rather than acidity.

(ii) A description of the test to show that sweetness in ripening apples is due to the presence of reducing sugar was, overall, well done. First class responses mentioned the need to crush / cut up / extract juice from the apple, followed by the addition of Benedict's solution and heating in a water bath to show that colour changes from blue to green / orange / red-brown / red were positive for reducing sugar. Less creditworthy answers either failed to prepare the apple for the test and / or omitted the heating process and some even confused the issue by using iodine for testing starch.

(c) (i) This part relates to the tradition of storing eating apples in cool and dark conditions to preserve them and Table 2.1 presented five data sets of the masses of wrapped compared to unwrapped apples over a storage time of 0, 2, 5, 7 and 10 days. Candidates were asked to calculate the total loss in mass of the unwrapped apples relative to storage time / days. This was generally well answered resulting in full credit being awarded, but some candidates made the error of deducting the data in Table 2.2 on unwrapped apples from the data on wrapped apples.

(ii) Using data given in Table 2.2 to construct a graph, excellent answers showed evidence of correct labelling of the x (storage time / days) and y (loss in mass / g) axes, together with correct plots and two identified lines drawn by straight lines between points or lines of best fit, and using at least half the grid.
Candidates should be careful to ensure that axes are fully labelled, with appropriate units, and that if two or more lines are plotted on the same graph they are clearly identified.

(iii) When calculating differences in the loss of mass between wrapped and unwrapped apples after 8 days of storage, excellent answers provided correct readings and precise calculations in contrast to candidates who recorded inaccurate readings and calculations or incorrectly compared readings on day 8 with those on days 9 or 10 and occasionally mixed them up.

(iv) Candidates were asked to suggest two processes by which apples lost mass. Creditworthy answers made reference to respiration / fermentation / use of stored sugars and evaporation / 'water loss' / dehydration or decomposition / decay / microbial action / rotting. Incorrect responses included references to osmosis, diffusion, or attack by insects.

BIOLOGY

Paper 5090/32

Practical Test

Key Messages

The main objectives of this paper were to test not only biological knowledge, with emphasis on structure and function, but also the application of practical skills and techniques. Requirements for doing well included, in **Question 1**, a clear understanding that when investigating the effect of sugar solution on onions, the process of osmosis is the passage of water molecules from a region of their higher concentration to a region of their lower concentration through a partially permeable membrane and that net movement of water occurs out of the onion cells in sugar solution, but into the cells in distilled water. In **Question 2**, key requirements include an understanding that fruits such as apples, during the process of ripening, become less acidic and sweeter to taste due to the presence of reducing sugar and that measuring pH using universal indicator paper and testing with Benedict's solution can be used to demonstrate this. Then, in the latter part of **Question 2**, which concerns the storage of fruit, an ability to carry out calculations and plot data is required, as well as a consideration of the processes such as respiration, evaporation and decomposition that lead to a reduction in mass in stored fruit.

General Comments

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Comments on Specific Questions

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(iii) When asked to describe changes in the shape of slices after 30 minutes, considered answers described the distinct differences in curvature observed in **(a)(ii)**; incorrect responses placed more emphasis on changes in texture / turgidity, rather than in curvature.

(iv) When asked to explain what caused these changes, the more able candidates provided responses that made reference to osmosis, the movement of water across a semi or partially permeable membrane and to the fact that the water potential / concentration is greater in the onion than in the sugar solution but lower than it is in distilled water. There was also correct reference to hypotonic / hypertonic solutions.
Correct observations showed that the slices became more turgid in water and flaccid in the sugar solution with cells undergoing plasmolysis. Less change occurred in the outer layer.
The majority of candidates mentioned osmosis, but there was some confusion with it being considered a method of water absorption rather the movement of water, and some candidates failed to reference a semi or partially permeable cell membrane, or turgidity / plasmolysis when describing the changes in the onion tissue.

(b) First class responses indicated that the source/ type of onion tissue should be kept the same to avoid any cellular variation. In addition, if the onion remained the same size / thickness, this would allow similar distances for movement of water and the same opportunity for water movement would occur if onion pieces were kept in solution for the same length of time.

Question 2

(a) (i) Candidates were asked to make a drawing of the cut surface of an eating apple and excellent answers produced a clear drawing with continuous lines and no shading, the central part drawn in proportion to the size of the entire section. The seeds and remains of sepals were also correctly labelled. Credit was lost where candidates produced poor quality or shaded drawings, did not include a central part containing seeds and / or incorrectly labelled sepals as the stalk.

(ii) The line drawn on the widest part of the apple was usually correctly measured with appropriate units given.

(iii) Measurements of the length of the line drawn on Fig. 2.1 were generally correct, but only the best answers followed this by calculating the magnification: divide the measurement given in **(a)(ii)** with the measurement in Fig. 2.1, and allow for the x3 magnification shown in this figure. Answers gaining less credit not only showed incorrect calculations but failed to allow for the x3 magnification.

(b) (i) When asked to record the colour of the universal indicator on the freshly cut surface of the eating apple, the majority of responses were excellent, candidates correctly recording a range in colour from yellow / green to yellow / orange and noting that the apple juice was acidic or below pH 7. Some candidates did not indicate the correct colour change nor record the pH and made reference to alkalinity rather than acidity.

(ii) A description of the test to show that sweetness in ripening apples is due to the presence of reducing sugar was, overall, well done. First class responses mentioned the need to crush / cut up / extract juice from the apple, followed by the addition of Benedict's solution and heating in a water bath to show that colour changes from blue to green / orange / red-brown / red were positive for reducing sugar. Less creditworthy answers either failed to prepare the apple for the test and / or omitted the heating process and some even confused the issue by using iodine for testing starch.

(c) (i) This part relates to the tradition of storing eating apples in cool and dark conditions to preserve them and Table 2.1 presented five data sets of the masses of wrapped compared to unwrapped apples over a storage time of 0, 2, 5, 7 and 10 days. Candidates were asked to calculate the total loss in mass of the unwrapped apples relative to storage time / days. This was generally well answered resulting in full credit being awarded, but some candidates made the error of deducting the data in Table 2.2 on unwrapped apples from the data on wrapped apples.

(ii) Using data given in Table 2.2 to construct a graph, excellent answers showed evidence of correct labelling of the x (storage time / days) and y (loss in mass / g) axes, together with correct plots and two identified lines drawn by straight lines between points or lines of best fit, and using at least half the grid.
Candidates should be careful to ensure that axes are fully labelled, with appropriate units, and that if two or more lines are plotted on the same graph they are clearly identified.

(iii) When calculating differences in the loss of mass between wrapped and unwrapped apples after 8 days of storage, excellent answers provided correct readings and precise calculations in contrast to candidates who recorded inaccurate readings and calculations or incorrectly compared readings on day 8 with those on days 9 or 10 and occasionally mixed them up.

(iv) Candidates were asked to suggest two processes by which apples lost mass. Creditworthy answers made reference to respiration / fermentation / use of stored sugars and evaporation / 'water loss' / dehydration or decomposition / decay / microbial action / rotting. Incorrect responses included references to osmosis, diffusion, or attack by insects.

BIOLOGY

Paper 5090/61
Alternative to Practical

Key Messages

This paper tests the ability to use a range of practical skills. It is important that candidates have experience of practical work, including biological tests and experimental design. In particular, candidates should be familiar with the concept of variables and the reasons why they should be controlled. Candidates should use precise terminology such as *mass, length* and *volume*, rather than *amount* or *quantity* when describing measurements or listing variables to be controlled.

All the information provided with each question should be read thoroughly as this information may well be necessary for answering the questions that follow. This includes information provided with Figures, such as the magnification of a specimen. Where the measurement of a specimen is required, a line should be drawn to indicate where the measurement has been taken.

General comments

The majority of scripts were clearly legible, with answers written in the spaces provided or, if not, with clear indications of where they had been written. Candidates should ensure that any alterations to answers are clearly legible, i.e. not written on top of their original answer.

It is important that candidates understand the difference between the meanings of key terms used in the questions, such as *describe* and *explain*.

Comments on specific questions

Question 1

(a) (i) Candidates were asked to describe the changes visible after 30 mins. Many candidates correctly noted that the strips of onion placed in water had become less curved or straighter, whereas the ones in sugar solution had become more curved. However, a significant number of responses referred to the onion strips as stretching or shrinking, which is incorrect.
Further credit was available for noting that the strip placed in water had begun to curve in the opposite direction with respect to the epidermis. Few candidates made this observation.
A small number of candidates described changes in texture and mass, which are not visible, or tried to explain what had happened to cause the changes, which was not required in this question.

(ii) There were some excellent answers showing a good understanding of what had happened to the strips in terms of osmosis. A few candidates wrongly described movement of solution or sugar instead of water. Some only referred to one strip, e.g. “one strip was placed in a high water potential”, without comparing it to the solution in which the other strip was placed, in this example one with a lower water potential.
Few candidates mentioned that the water moves through a partially permeable membrane.
It should also be noted that although changes in turgor are valid, describing changes to the strips in terms of plasmolysis is not creditworthy when discussing the strips of onion rather than individual cells.

(b) (i) Candidates were asked to select a factor that was kept the same in this experiment and to explain the reason why. This was generally not well answered. Those who did identify a factor usually were not able to explain why it needed to be kept constant. Of those that attempted to explain, many answers were vague, e.g. “the size of the pieces was kept the same for accuracy”.

Many stated *temperature* or *volume of solution*, neither of which featured in the description of the investigation, highlighting the need, as mentioned in the key messages, for candidates to carefully read all information provided to them in the stem of a question.

(ii) More candidates gained credit in this part, usually by referring to temperature, size of the onion pieces or volumes of solution. A small number of candidates incorrectly gave the concentration of sugar solution as a factor to be controlled. Note that candidates need to refer to precise quantities and not use vague terms such as *amount*.

(iii) Generally this question was not well answered. A few candidates did refer to comparing measurements of length and there was an occasional reference to comparing changes in mass. Many candidates did not specify what was to be measured, e.g. "measure the pieces of onion before and after". Some candidates just referred to observing the change in shape with no reference to measurement at all, whilst a few others selected incorrectly from a variety of biological measurement methods including pH, temperature and using Benedict's reagent.

(c) Candidates were asked to explain why the shape of the onion remained unchanged in one of the sugar concentrations. A few candidates stated that there was no net movement of water, but many stated wrongly that no osmosis took place or that water did not move.
The word equilibrium appeared a few times. More candidates referred correctly to the solution being isotonic, or described the water potential inside the onion cells as being the same as that of the external solution.

Question 2

(a) (i) The drawing was generally well done. A few drew sketchy, rather than clear continuous lines and a few were heavily shaded. Some did not follow the instruction to make their drawing the same size as Fig. 2.1, but many were drawn clearly and to the correct size. The proportion of the central part to the outer fleshy part was usually good, and the vast majority were able to label their drawing correctly.
A small minority of candidates only drew the centre portion of the apple.

(ii) Most candidates measured the apple correctly although some did not draw a line as instructed. A number of measurements were inaccurate or did not include units. Candidates must ensure they carefully follow the requirements of the question.
Some candidates attempted to change the units, but did so incorrectly.

(iii) Many candidates answered this question well and gained maximum credit.
Some omitted to draw a line on Fig. 2.2 as instructed, measured it inaccurately or failed to record units: again, candidates must carefully follow instructions.
The majority of candidates knew that the Fig. 2.1 measurement should be divided by the Fig. 2.2 measurement, although many omitted to take the different magnifications of the Figures into consideration. Some candidates incorrectly subtracted one measurement from the other.
Most candidates were able to calculate the answer but some expressed the answer with units that were irrelevant or with too many decimal places. It should be noted that answers should not be expressed in fractions.

(b) Candidates were asked to describe how the apple could be tested for reducing sugar. Many described the Benedict's test for reducing sugars well, preparing the sample by crushing it, heating the mixture of Benedict's and apple and observing the positive colour change from blue to red. Some confused the name Benedict's with biuret but still described the correct colour change. Common omissions included no reference to the initial colour of blue and placing the sample in a water bath but without reference to heating the mixture.
A few candidates described the wrong test and used iodine solution or litmus paper, whilst others tasted the apple to determine its sweetness.

(c) (i) Many candidates completed the table correctly, although some calculated changes in mass between the various times of sampling rather than overall changes from the beginning.

(ii) There were some excellent graphs, drawn to a good size with axes fully labelled. Most candidates made good use of the whole grid. In the best examples, the points were clear, without being too large, and lines were smoothly and cleanly drawn.

Errors included using a non-linear scale, not fully labelling axes, the most common omission being 0, or wrongly orientating the graph. Others omitted plots (most commonly 0,0), or plotted points incorrectly. Some drew lines that were very sketchy or too heavy, or lines that did not relate well to the points plotted. Some did not identify the two lines drawn.
A few candidates erroneously attempted to plot a graph of the loss in mass of wrapped apples against that of unwrapped apples.

(iii) Candidates were asked to use the graph to calculate the difference in the loss of mass between the wrapped and unwrapped apples and most did this well. Some omitted units and some did not appear to read the question properly and as a result calculated the difference in mass after 10 days instead of 8 days as requested.

(iv) Candidates were asked to suggest two processes by which the apples lost mass. A number of candidates made two creditworthy suggestions including, most commonly, loss of water. However, quite a few candidates gave no response to this question.

BIOLOGY

Paper 5090/62
Alternative to Practical

Key Messages

Candidates should read the information given in questions carefully and follow any instructions precisely.

There is no need to repeat the question when answering it.

Candidates should be able to design a simple investigation so that its results are reliable.

In describing or designing an investigation, specific units, e.g. of mass, volume, length should be used appropriately rather than references to amounts, quantities and sizes.

General Comments

Many of the scripts showed that advice from previous examinations had been heeded, especially regarding graph construction and magnification calculation.

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

There were very few instances of candidates not attempting a response to a question.

Comments on Specific Questions

Question 1

(a) (i) This was generally well answered with labelling lines indicating a chloroplast and the cell membrane.

A few candidates confused cell wall and cell membrane. Candidates should be aware that labelling lines must end precisely on the structure being labelled.

(ii) The question asked for suggestions about changes in the cell membrane that may have been caused by boiling. Candidates were therefore being asked to use what they know about plant cell structure to account for the water becoming green. Many candidates worked out that the green pigment in the chloroplasts must have been able to enter the water. The membranes in the cell that are normally partially permeable and do not allow the passage of large molecules must, therefore, have been damaged in some way by the boiling and made fully permeable. Some candidates wrongly thought that the chloroplasts themselves had entered the water. Other candidates answered this question in terms of osmosis which was not relevant here.

(b) (i) There were many very good graphs drawn which gained full credit. Most candidates knew that the independent variable, boiling time/min, should be plotted on the x axis with the dependent variable, vitamin C /mg per 100 g, on the y axis and that both axes should be fully labelled. Most candidates chose a good-sized linear scale for their graph but a few plotted 0, 1, 2, 4 evenly along the x axis which could not be credited. A few candidates omitted plotting points at 0,0 or 0,50. Some candidates drew plotting points that were so small that they could not be seen once a line had been drawn through them, while others' points were over-large. Most candidates drew clear lines, correctly identified as 'cabbage' or 'water', but a few drew sketchy or very thick lines or omitted labels. There were very few bar charts drawn in error.

(ii) If working is asked for in a question then working should be shown. In this question working could be shown on the graph itself or in the space provided. Many candidates correctly used their graph to calculate the time in minutes at which the vitamin C level in cabbage had fallen by a half. Some candidates incorrectly converted their answers to minutes and seconds e.g. 3.5 minutes was expressed as 3 minutes 50 seconds. A few candidates incorrectly took a reading from the 'water' line of their graph instead of the 'cabbage' line.

(iii) There were many clear answers describing that the vitamin C content in cabbage decreased. More discerning candidates noted that this happened more quickly at first then more slowly. Candidates scored marks by recording that in water there was an increase in vitamin C content for the first 4 minutes or until it reached 26 mg per 100 g and then a decrease after that time or level. Some candidates simply quoted figures from the Table 1.1 without explaining what those figures showed about any changes.

(c) This question proved to be one that really tested the candidates' understanding of controlled variables in an investigation. There were many factors that could have been described. More able candidates were aware that, for a fair comparison to be made, the volume of oil used should be the same as the volume of water used, the mass of the cabbage added to the oil should be same as the mass of cabbage added to the water and that the cabbage used in the second investigation should be of the same type, age or from the same plant as in the first. They recognised that the temperature of the oil should be the same as the temperature of the water, that the cabbage should be left in the oil for the same length of time as the cabbage had been left in water, that samples from the oil should be taken and tested at the same time intervals as they had been from the water, using the same test for vitamin C and that the volume of the sample size should be the same throughout. There were thus many different ways of scoring all 4 available marks. When credit could not be given to answers, it was most frequently because of the use of 'amount' and 'quantity' instead of mass and volume. Also 'constant' was used incorrectly. Stating that the temperature of the oil and water should be kept constant is not the same as saying that the temperature of the oil should be the same as the temperature of the water. 'Constant' could mean, for example, that the temperature of the oil should stay at 150^{o}C throughout the investigation and the temperature of the water should stay at 100^{o}C.

(d) Some candidates suggested two good ways of improving the method used in the investigation in terms of the samples being taken at regular intervals or more frequently within the 10 minutes**,** using a larger mass of cabbage, using a water bath for heating or repeating the investigation and finding the mean of the readings taken. Many candidates mentioned repeating the investigation without referring to why this was an improvement, namely that the mean value is more reliable. Other candidates did not improve the method but extended the investigation, e.g. by sampling other vegetables, which makes it a different investigation and is thus not a credit-worthy answer.

Question 2

(a) (i) Few candidates gained full credit for the drawing. Although they were asked to draw the rose hip shown in the box, some candidates did not follow this instruction and drew leaves as well as the rose hip. Many candidates made a drawing of a reasonable size but those of others were too small. Generally the lines drawn were clear, clean and continuous, but some poor sketchy, broken lines were seen as well as lines drawn with very blunt pencils. There was no justification for using shading in this drawing. Some candidates omitted the label asked for; others did not know which structures were sepals. The sepals were often drawn too short in proportion to the body of the fruit showing that observation had not been good.

(ii) This question was generally well answered; most candidates knew how to calculate the magnification. Measuring was generally well done, but some candidates did not record units. Some measured from X to X although they were asked to measure the widest part of the rose hip. Even when some candidates had measured and recorded the two widths, they then used different measurements, usually lengths, to calculate the magnification. Perhaps they had only used lengths in magnifications they have calculated previously and thought that only lengths could be used. Some candidates did not take into consideration that the rose hip in Figure 2.1 was magnified x2.

(iii) A fruit contains at least one seed and more able candidates realised that if you opened up the rose hip and found seeds it would prove it was a fruit. Using the Benedict's test is not an appropriate

test here as that shows only the presence or absence of reducing sugars not whether the structure is a fruit or not.

(b) Figure 2.2 presented the candidates with some information about a fruit. Many were able to suggest, using that information, that it was flat and thin and had a large surface area to volume ratio or was 'winged', all of which were adaptations that would help in its dispersal. Some said that the fruit was light but this cannot be determined from what is visible so could not be credited. Some candidates did not note what the question was asking and gave answers relating to different methods of fruit dispersal.

(c) (i) Many candidates were able to state that the dispersal of fruits away from the plant that produced them prevented competition for light, water or other resources and also gave a chance for the species to colonise new areas. Some candidates thought that dispersal led directly to genetic variation without explaining that it might lead to out-breeding that might then lead to genetic variation.

(ii) Few candidates provided good descriptions of an investigation that could be carried out using the materials listed. Some would have been better had precise, scientific terminology been used, e.g. mass or volume instead of amount or quantity. Many failed to explain that variables should be controlled, e.g. that the same volume of water should be added to each dish containing seeds and that they should be kept for the same length of time under the same environmental conditions. Many understood that they should set up a dish containing seeds close together and another with seeds far apart but very few recognised that both dishes should contain the same number of seeds so that the only difference between them was their spacing - the factor under investigation. In order to discover the effect of overcrowding, the growth in the two dishes would have to be compared, which some candidates did not state.