BIOLOGY

Paper 5090/01
Multiple Choice

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

This paper proved to be slightly easier than last year. Candidates' knowledge is good although some reasoning still caused problems. The need to read every word of the question remains, examples being in **Question 33**, where many candidates missed the words *genetically identical* and in

Question 37, where those who just read *anaemia* immediately chose the iron deficient diet.

Items that were easy and caused no problems: 2 5 8 9 12 16 17 19 21 22 23 25 27 28 29 31 32 34

Comments on individual items

1 Although **Question 1** is usually straightforward, it is important to examine each label line carefully to see that only 2 points to a partially permeable membrane. The cellulose cell wall is not a partially permeable membrane.

3 There was a lot to read in this question, but the best explanation was well known. Fungi will secrete extra-cellular enzymes and digest the surrounding starch, but this is not significant in barley grains.

4 As a key fits into a lock, the shape of the substrate molecule fits into the enzyme, where the active sites are located.

6 Bicarbonate /indicator solution is now popular as a non-toxic medium. The stem states that the colour will be purple if the CO_2 concentration decreases, so tube A cannot be correct since the light is excluded by the aluminium foil.

7 Oxygen is produced in the light, so dawn must be between A and B and the sun sets at D, so midnight can only be at A.

10 The first tube contains enzyme and acid and the albumen is not digested. The alkaline protease in the next tube is the only effective enzyme, so must come from the pancreas, not the stomach. Those who chose B are confusing albumen with starch.

11 Bark includes the outer protective layers and the phloem, but not woody xylem that carries water and mineral salts. Therefore, these will still be delivered to the leaves and so transpiration will continue. The phloem carries nutrients such as sucrose and so the roots will be deprived of these. The root cells will stop respiring and die. Far too many candidates chose option D.

13 The key, B, represents the aorta, which normally has a pressure of about 16 kPa. The lungs receive low pressure blood from the right side of the heart, with the thinner ventricle wall and the pressure in D is less than 4 kPa. In the pulmonary vein, A, the pressure is even less, after having passed through the alveolar capillaries.

14 In this fundamental graph, the ventricle pressure is rising during period B, so the ventricle must be contracting. The atrio-ventricular valve closes at the start of period B.

15 Blood flowing from the gut directly to the liver, through the hepatic portal vessel, is the only route which does not go to or from the heart.

18 All respiring cells produce CO_2, but saliva contains no cells. Respiration of neurons makes a significant contribution to basal metabolic rate.

20 The pump, Z forces blood through the dialysis membranes. The bubble trap, Y, must be just before the blood is returned to the patient.

24 Blood glucose falls at X, so insulin must be increased. At Y the increase in blood glucose is due to increased adrenalin.

26 Whilst the proteins do coagulate and form curds – the semi-solid part of yoghurt and cheese, it is the acid from the respiration of the bacteria that cause the coagulation. Enzymes are produced, but they are not as significant in the process.

30 The clue here is the relationship between the CO_2 in the air and in plants. Arrow 1 must be respiration and 2 is photosynthesis. 3 represents eating and 4 is also respiration.

33 Option C was surprisingly popular. A fertilised ovule will develop into a new plant, but it will have chromosomes from the pollen grain. Cells from area D can be cultured, using a sterile technique and will develop into genetically identical plants.

34 Both options B and C end with germination, but only C starts with pollination.

35 Ovulation is well known to be from the ovaries, but fertilisation is normally in the fallopian tubes. If an ovum is fertilised in the uterus, as label 3 suggests, it does not normally implant successfully.

36 Both options A and B refer to urine. Sperm are produced in D, the testis, but parts of seminal fluid are secreted by the prostate gland, C and the seminal vesicles, which are not labelled in the diagram.

37 Iron deficiency may lead to anaemia, but sickle cell anaemia is a genetic condition in which the DNA is altered.

38 The cross of mice A and B shows that dark fur is dominant and since no light fur mice appear in family P, then mouse B must be homozygous dominant and no light coloured mice will appear in family Q. Since Family R does have light coloured, homozygous recessive, mice, one recessive allele must come from each parent and hence mouse C must be heterozygous.

39 The 3: 1 ratio is produced when two heterozygotes are mated, so A must be the key

40 Options A, B and C all refer to products which are selected by farmers. The mosquitoes that are resistant to insecticides are produced because only resistant mosquitoes survive and breed. This is natural selection.

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Paper 5090/02

Theory

General comments

Some very high-scores were seen this year with several near-perfect scripts. Generally, candidates seemed more comfortable with ***Section A*** than has sometimes been the case in previous years. The quality of ***Section B*** often depended on how competently the candidate tackled Question 6.

Comments on specific questions

Section A

Question 1

(a)(i) and (ii) These were almost always correct. Just occasionally, candidates reversed the gases, or offered nitrogen instead of oxygen.

(iii) Candidates regularly experienced difficulty with this part. The error often involved the rather mystifying belief that, at night, the mouse takes in carbon dioxide and gives out oxygen.

(b) This part revealed some very muddled thinking. The question requires candidates to know that, at the times stated, there is enough light for photosynthesis to be taking place at the same rate as respiration. Many said there would be no photosynthesis and just as many believed that respiration would only begin once it had become dark. There were very few references to the light intensity being such that both processes were taking place at the same rate – even from those who clearly otherwise understood the principle involved.

(c) Most were able to select an energy-releasing and a growth inducing chemical – but there was a long list from which the selections could be made. Nitrate, nitrogen and cellulose appeared amongst the incorrect answers.

Question 2

(a) Chromatin, gene and RNA were the commonest unacceptable answers.

(b) Full marks were common, but references to the reduced amount of genetic material in the sperm were not. Candidates should realise that vague answers such as '*The cells differences in appearance are because they perform different functions*' will not gain credit unless there are further specific details given.

(c) (i) Although most managed a reference to a difference in the size or shape of the nuclei, it was not uncommon to read that the sperm nucleus carried genes, while the cheek cell nucleus did not. It was hoped that some might appreciate the presence of one, instead of two, sex chromosomes in the sperm, but references were very rare.

(ii) Those who appreciated the role of the sperm in fertilisation (and there were many), easily scored all three marks. There were again vague answers that spoke only of 'adaptations to their functions'.

Question 3

(a) Candidates are to be congratulated on so often successfully working out the feeding relationships between the mentioned organisms. Some lost marks by referring to the spider's *web* or simply to an unspecified '*bird*'.

(b) (i) This proved more demanding than might have been expected. Answers such as '*energy flow*', '*ecosystem*', '*ecological chart*' and, understandably, '*food chain*' were quite common.

(iii) This part was often correctly answered, even by those who had not shown the spider and the hawk in the correct position in the web, and equally often, incorrectly answered by those who had. All the other heterotrophs were at some time suggested by some candidates.

(c) Only the better candidates were able to score all marks available here.

(i) This was usually correctly shown and correctly labelled. Not uncommonly it was shown as a reverse pyramid, but still with the producer at the bottom.

(ii) This caused considerable problems. Small birds and aphids were often reversed in the sequence (as they appear in the question) and failure to read the question resulted in the same organisms as in **(i)** being used in the labels – or, sometimes, organisms not mentioned anywhere in the question. The majority failed to realise that the bean plant would be represented by the smallest bar.

Question 4

(a) A significant number offered **D** and **E** in reverse order – presumably as they had learnt them in the equation and not as presented in the question. There was the occasional 'glucose' given for **F**.

(b) Amylase was very commonly, and correctly, stated, though 'maltase' was sometimes suggested.

(c) (i) It was common to imply that, as soon as the temperature rises above the optimum, then the enzyme will be denatured. Examiners looked for a reference to the *high* temperatures involved in cooking, or, if specified, then the reference had to be to 60 ^{o}C, or above.

(ii) Although lipase and amylase were quite often suggested, the majority opted, correctly, for protease (or a named protease). Many, however, then suggested that the protein in the meat would be converted to amino acids, which, it was thought, went a good deal beyond mere tenderisation.

Question 5

(a) Roots and photosynthesis were almost always correctly given.

(b) (i) Many candidates offered faultless answers, but others showed a good deal of confusion. Incorrect suggestions for substances absorbed included carbon dioxide, nitrogen (rather than nitrates), protein, starch and glucose. Examiners looked for functions specific to each mentioned chemical rather than a repetition, for example, of the word 'growth'. Candidates might not have known that the hemi-parasite draws substances only from the xylem, thus credit was given if a phloem-borne chemical was mentioned, so long as phloem was referred to in **(ii)**. Some candidates failed to score in **(ii)** by making a vague reference to vascular bundles.

Section B

Question 6

(a) It is accepted that the concept of tasting a substance which is absorbed through the finger would not be familiar to candidates, but the question gave the requisite clue that the chemical would travel in the circulatory system. Many candidates, however, gave long accounts of the nervous connection between the finger and the brain or tongue. Some described dipping the finger into the chemical then putting the finger into the mouth whilst others, who realised that an account of the circulatory system was required, then confused arteries with veins. Several penalised themselves by omitting the section altogether. Such observations should in no way detract from the many very detailed and totally accurate answers that were given.

(b) A common misconception here was to suggest or, indeed, believe, that the sensation of taste is experienced only when the brain returns impulses to the tongue as in a reflex action. There was also a common confusion between receptors and sensory neurones as well as regular, unacceptable references to '*messages*' and '*signals*'.

Question 7

(a) It was not always stated that the protection provided to the flower by the sepals is largely when the flower is in bud. Although the functions of the petals and of the anthers were usually accurately described, some struggled with the word *carpels* [in **(iv)**] and the answers were almost always given in structural rather than functional terms as required by the question.

(b) (i) Grass, or a named one, was usually the most popular correct answer – of those who gave an answer at all, but there was an extraordinarily high percentage of insect-pollinated flowers and plants with wind-dispersed fruits.

(ii) Anthers, stigma and pollen were regularly confused. Anthers were said to be '*light and feathery so they can be carried by the wind*'. It was rare to read that anthers are loosely hinged on the filaments, and relatively common to read accounts of insect-pollinated features, but, despite these criticisms, there were again some extremely detailed and accurate answers.

Question 8 Either

(a) (i) The main characteristics of viruses were well known. It was, however, a little surprising that so few accurately referred to the size of viruses, but, otherwise, all points were regularly scored.

(ii) Knowledge of fungi was less sound. There were fewer references to hyphae and to their structure than might have been expected. Several believed that photosynthesis is a characteristic of fungi.

(b) It was rare to find an answer that scored full marks for this part. The shortcomings surrounded exactly what bacteria do during decomposition. Often bacteria were said to *feed on* decaying matter rather than *causing* the matter to decay. Very few gave any correct specific detail on what the effect of bacteria is on proteins or on carbohydrates during the process of decomposition.

Question 8 Or

(a) It was not all that common to read that nitrogen-containing fertilisers are used to maintain or improve soil fertility. Perhaps candidates may have felt that this was too obvious to mention. Healthy growth and high yield were commonly mentioned, but the understanding of the processes following eutrophication was very hazily understood. It was very common to read that the lack of oxygen that would occur is a result of the abundant algae '*using it up*', or is associated with the failure of light to penetrate the thick layer of surface algae. Examiners were looking for reference to the eventual death of the increased amount of plant matter and the use of oxygen by the bacteria that then decompose this matter. There is widespread confusion between the terms '*aquatic*' and '*marine*'.

(b) The mention of insecticide '*protecting plants from insects*' left open the possibility that the chemical might operate much as an insect repellent. Only the better candidates referred to the killing of those insects that are vectors of animal diseases. It was quite common to read, accurately, that useful insects might be killed, but so it was that insecticides might destroy plants or cause them to become resistant. A few good answers mentioned the passage of insecticides along the food chain and the possible effects of the organisms at the end of that chain.

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Paper 5090/03

Practical Test

General comments

In general, graphs were drawn correctly and the quality of drawings was good. However, candidates should always ensure that they have followed the instructions as set out in the questions, since some have lost marks quite unnecessarily, for instance by completely omitting labels when instructed to produce a *labelled* drawing.

Basic exercises like calculating the magnification of a drawing using appropriately labelled units should always be well rehearsed.

Designing an experiment proved difficult for some. Although they had an idea of what was required it was not followed through on the basis of giving practical instructions and often the experiment they described did not investigate the correct feature.

Comments on specific questions

Question 1

(a) When tables are required they should be planned so that the correct number of rows and columns are neatly ruled with all the entries enclosed in the spaces. The purpose of a table is to present data clearly and concisely; thus the rows and columns should be headed with the name and unit. Each entry can then be a figure without a unit and all the figures in each column should be comparable. In this particular exercise there was confusion of the units in which the surface area should be expressed – many stated cm^3 or cm rather than cm^2 as it should have been.

(b) (i) The graph was generally well constructed. Many candidates elected to show time / seconds on the x axis, incurring a small penalty, but this did not otherwise affect the outcome. Ruled connection of the plots was accepted, as was a curve of best fit, but not freehand links. Small, but clearly discernible plots were expected. However, a few bar graphs were seen, in which case only the labelling of their axes was rewarded.

(ii) Most candidates recognised that smaller blocks with a large surface area to volume ratio would undergo more rapid diffusion. The question asked for this to be explained in terms of the time taken, although answers that referred correctly to rate were also accepted.

(c) The usual answer here was that the blocks may not have been prepared accurately. For their second suggestion, most candidates referred to timing and this was perfectly valid, provided that it was made clear that the difficulty was in recognising the end point of the colour reaction. Many references to inaccurate timing, often ascribed to a faulty clock, were not accepted. Only a few candidates gained the two marks for this section.

(d) Good approaches here were related to the presence of a cell membrane (even better if 'selectively permeable') and the presence of cytoplasm in the living cell. There was frequent reference to osmosis and cells bursting, but this was not accepted. Many also said that animal cells have cell walls – instead of, or in addition to the cell membrane. The variable (non-cubical) shape of animal cells was accepted but it was often stated, or implied, that all animal cells were the same shape as a specific example, usually a red blood corpuscle.

(e) There were five readily available marks: agar blocks of the same size; immersed in the same volume of solution A2; subjected to a range of temperatures (of two or more suitable, stated values such as 10^{o} C, 20^{o} C and 30^{o} C, or a bit higher, though not, as many suggested, as high as 100^{o} C); and recording the time taken for the colour to change.
Diagrams of correctly assembled apparatus, or the idea of replication, were points that many also mentioned. Trying to assess the time taken for the colour to change in a test-tube that was being warmed was not suitable. The suggestion of a suitable range of stated temperatures was preferred to placing a test-tube in a refrigerator, by a radiator or 'in the sun'.

A significant number of candidates outlined the results they would expect, saying how molecules would show greater movement as temperature increased, thus making no attempt to plan an experiment.

Many suggested the use of an electric light source, set at various distances away from the test-tube, to provide heat. And where a water-bath was employed it often had the corollary of being a safeguard for an inflammable liquid.

Question 2

The leaves, L1 and L2, were variegated specimens, from the same plant species. One of them was freshly picked; the other had undergone the starch test.

(a) (i) Drawings, on the whole, were adequate, but a surprising number of them were unlabelled. The main point of the labelling was to indicate which parts of the leaf were green, and which parts lacked chlorophyll. The shape and colour pattern of the leaf was generally well shown, but the shape and attachment of the petiole was frequently unrealistic.

(ii) Correct units were essential here. It was surprising how many candidates did not follow the instruction to draw a line correctly across their drawing. Sometimes it was oblique, or even vertical or omitted and replaced by side lines to indicate where the measurement was taken.

(iii) The calculation was frequently not based on the figures just obtained; otherwise there were many good attempts, though a few were spoiled by the addition of cm or mm in the answer, e.g. 'x 1.8 cm'. There were a few examples of excessive rounding up or down, thus an answer like x 3.46 should not become x 3. Two places of decimals, x 3.46 is perfectly acceptable, as would be x 3.5.

(b) The process of testing a leaf for starch was well known. The most common error was to say that the initial dipping in boiling water was to soften the leaf – normally an additional process after heating in alcohol.

(c) The essence of this section was to relate the different colours of the variegated leaf to the presence or absence of starch, concluding with the idea that chlorophyll was essential to harness the light energy for the photosynthetic process.

(d) Some of the drawings in this section were extremely good. The key points looked for by the Examiners were the cuticle – as a non-cellular layer on the upper surface – and the guard cells, correctly represented in the lower epidermis. A few showed the guard cells in surface view – bean shaped. Accurate labelling of guard cells and stoma ('stomata' was accepted), as well as the palisade and spongy components of the mesophyll, was expected.

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Paper 5090/06
Alternative to Practical

General comments

In general, the quality of drawing was good from many candidates and the procedure for testing a leaf for starch was well known. However, candidates should always ensure that they have followed instructions as set out in the questions, since some have lost marks quite unnecessarily, for instance by completely omitting labels when instructed to produce a *labelled* drawing. However, a few marks were readily accessible to all candidates for quality of drawing and for the general ability to construct a graph.

Other basic exercises, like calculating the magnification of drawing using appropriately labelled units, should always be well rehearsed.

Comments on specific questions

Question 1

(a) When tables are required they should be planned so that the correct number of rows and columns are neatly ruled with all the entries enclosed in the spaces. The purpose of a table is to present data clearly and concisely; thus the rows and columns should be headed with the title and unit. Each entry can then be a figure without a unit and all the figures in each column should be comparable. In this particular exercise there was confusion of the units in which the surface area should be expressed – many stated cm^3 or cm, rather than cm^2 as it should have been. The expression of the time taken for the colour to change in each tube was sometimes a mixture of minutes and seconds together with minutes and decimal fractions.

(b) (i) The graph was generally well constructed. Many candidates elected to show time / seconds on the x axis, incurring a small penalty, but this did not otherwise affect the outcome. Ruled connection of the plots was accepted, as was a curve of best fit, but not freehand links. Small, but clearly discernible plots were expected. However, a few bar graphs were seen, in which case only the labelling of their axes was rewarded.

(ii) The relationship between the surface area to volume ratio of the blocks and the time taken for the colour to change was recognised by many candidates. The question asked for this to be explained in terms of the time taken, although answers that referred correctly to rate were also accepted. Some stated that as time increased the ratio decreased, implying that the surface area was affected by time, but this was probably a linguistic problem and, when possible, was accepted.

(c) The usual answer here was that the blocks may not have been correctly prepared, though many said that the measurements were inaccurate. For their second suggestion, most candidates referred to timing and this was perfectly valid, provided that it was made clear that the difficulty was in judging the end point of the colour reaction. Many references to inaccurate timing, often ascribed to a faulty clock, were not accepted. Only a few candidates gained the two marks for this section and the idea of the blocks clumping together, so affecting diffusion, was rarely mentioned.

(d) Good approaches here were related to the presence of a cell membrane (even better if 'selectively permeable'), active transport and the presence of cytoplasm in the living cell. There was frequent reference to osmosis and cells bursting, but this was not accepted. Many also said that animal cells have cell walls, instead of, or in addition to the cell membrane. The variable (non-cubical) or irregular shape of animal cells was accepted but it was often stated, or implied, that all animal cells were the same shape as a specific example, usually a red blood corpuscle.

(e) There were five readily available marks: agar blocks of the same size; immersed in the same volume of solution A2; subjected to a range of temperatures (of two or more suitable, stated values such as 10^{o} C, 20^{o} C and 30^{o} C or a bit higher, though not, as many suggested, as high as 100^{o} C); and recording the time taken for the colour to change. Some candidates did not always make it clear in the design what was being timed.

Diagrams of correctly assembled apparatus, or the idea of replication, were points that many also mentioned. Trying to assess the time taken for the colour to change in a test-tube as it was being warmed was not suitable. The suggestion of a suitable range of stated temperatures was preferable over placing a test-tube in a refrigerator, by a radiator or 'in the sun'.

A significant number of candidates outlined the results they would expect, saying how molecules would show greater movement as temperature increased, thus making no attempt to plan an experiment.

Many suggested the use of an electric light source, set at various distances away from the test-tube, to provide heat. And where a water-bath was employed it often had the corollary of being a safeguard for heating an inflammable liquid. There were frequent references to enzyme activity being affected by temperature changes, but these had no relevance to the question. Other candidates duplicated the range of sizes in the agar blocks, from the earlier experiment, thus introducing a second variable. Another unsuccessful approach was to leave the various test-tubes for the same length of time and then to observe what had happened.

The outcome was that many candidates readily gained full marks for this section while others struggled to make any valid points.

Question 2

(a) (i) Most candidates made good attempts at drawing the leaf, L1, but, too frequently, labels were omitted.

(ii) There were problems with the units of measurement being omitted or confused and even those who sensibly chose to work in mm sometimes introduced a decimal point and, for example, mistakenly referred to 30.7 mm when they meant 37 mm. More commonly, no line was drawn across the widest point of their drawing; it was sometimes replaced by guide lines alongside the drawing, or completely omitted. So, it was impossible to check their measurement.

(iii) Many calculated the magnification correctly and expressed it correctly. Some inverted the formula or added units e.g. 'x 1.8 cm'. There were a few examples of excessive rounding up or down, thus an answer like x 3.46 should not become x 3. Two decimal places, x 3.46, is perfectly acceptable, as would be x 3.5. A significant minority of candidates introduced an additional factor into their calculation, like '97 mm over 67 mm, x 100' (or even 1000). This clearly produced a completely unrealistic answer.

(b) The process of testing a leaf for starch was well known. The most common error was to say that the initial dipping in boiling water was to soften the leaf – normally an additional process after heating in alcohol. The mention of alcohol triggered, in some, the idea that the ethanol emulsion test for fat was involved.

(c) The essence of this section was to relate the different colours of the variegated leaf to the presence or absence of starch, concluding with the idea that chlorophyll was essential to harness the light energy for the photosynthetic process. For some, 'variegated' seemed to mean 'without chlorophyll', and so thought that only part of the leaf was variegated. Only a few mentioned that chlorophyll harnessed light energy.

(d) Some of the drawings in this section were extremely good. The key points looked for by the Examiners were the cuticle – as a non-cellular layer on the upper surface – and the guard cells, correctly represented in the lower epidermis. A few showed the guard cells in surface view – bean shaped. Accurate labelling of guard cells and stoma ('stomata' was accepted), as well as the palisade and spongy components of the mesophyll, was expected. Nearly all candidates confined themselves to drawing the correct sector, between the two lines.