BIOLOGY

Paper 5090/01
Multiple Choice

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

General

Principal Examiner reports often tell candidates to "read the question" – and this refers to all the words of the question and all the options. This is shown in **Question 4**, which asks which is digested *first*. Otherwise option **C** is possible. Similarly **Question 28** clearly states that the country has warm summers and that the cool winters are from November to March. These questions gave few problems: **1**, **2**, **3**, **9**, **10**, **11**, **18**, **20**, **21**, **24**, **26**, **27**, **32**, **33**, **35**, **36**, **37**.

Comments on individual items

Question 4

The protease from the stomach will be most active with a low pH. If the protease is pancreatic, then a higher pH than 7 would be effective, but option **C** includes only water.

Question 5

Option **A** can be dismissed since no light allows no photosynthesis. At **B** and **C** the rate increases with light level and only one factor can be limiting. **D** is the key because although the light intensity is increasing the rate of photosynthesis remains the same.

Question 6

Negative questions can be tricky although the "not" is very clear. All the options refer to necessary steps in similar experiments, but to show that CO_2 is produced, the plant's previous treatment is not significant.

Question 7

Stomatal guard cells are the only epidermal cells to be photosynthetic.

Question 8

Fat has the highest energy content per gram; the *lowest* must be the fibre.

Question 12

An easy approach to graphs is to consider one of the axes when it is zero. With no humidity, transpiration will be high, so **A** must be the key.

Question 13

This graph is the essential summary of the cardiac cycle. Blood always flows down a pressure gradient. If lines cross, then a valve opens or closes. At W the ventricle pressure rises above the atrium pressure, so the atrio-ventricular valve must close. The semi-lunar valve will not open until the ventricle pressure rises above the atrial pressure so for the brief time between W and X, all valves are closed.

Question 14

Of the three possible substances, 2, passing from the capillary to the respiring cells, must be oxygen. Similarly, substance 3 must be CO_2.

Question 15

The stem refers to the wide lumen of the veins, so option **D** does not apply, since the blood is returning to the heart, flowing down the pressure gradient. Option **A** refers to capillaries. Option **C** refers to valves although it is a familiar phrase.

Question 16

Cilia are well known, but not where the larynx is. The trachea, which is not labelled, divides into the two bronchi.

Question 17

After exercise the eight breaths taken in the twelve seconds are each of 1 d m^3.

Question 19

The type of joint is well known, but straightening the elbow is due to the triceps contracting.

Question 22

What seems to be a simple question depends on knowing that both the hypothalamus and pituitary gland are on the lower surface of the brain.

Question 23

Cutting the sensory neurone would mean that no pain impulses reach the brain, so no response would occur.

Question 25

Circular muscles are not well understood. When the iris muscles, labelled X, contract, the pupil becomes smaller, as it will in bright light. Contracting the ciliary muscles, labelled Y, reduces the diameter of the ring, slackening the suspensory ligaments and allowing the lens to fatten and focus near objects on the retina.

Question 29
The important ideas are that there are very few top carnivores (sparrow hawks) and that there are more caterpillars than leaves, so **D** cannot be correct.

Question 30

The nitrogen cycle is not well known, although the names of the bacteria are helpful. Nitrifying bacteria make nitrate, from nitrite. Many candidates seemed to be guessing.

Question 31

Malaria parasites are not carried in sewage, so control methods rely on breaking the infection cycle between man and mosquito.

Question 34

Peas do not need light to germinate (option **D**) and although they can respire anaerobically for short periods, they do not normally germinate successfully.

Question 38
There are four blood groups, but there is no intermediate state, so all three traits show only discontinuous variation.

Question 39
The pink F_1 plants are heterozygous, so self pollination will produce a ratio of 1 red : 2 pink : 1 white.

Question 40
The F_2 ratio of 3 : 1 is the clue. Their parents, the F_1, must **all** be heterozygous and can only be produced by HH and hh genotypes.

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Paper 5090/02
Theory

General comments

Candidate performance was generally good both in ***Section A*** and ***Section B*** except in a minority of cases, particularly where **8(OR)** was chosen. In some instances, e.g. **8(E)**, answers were not adapted to meet only the specific requirements of the question.

Comments on specific questions

Section A

Question 1

(a) This was usually correct, with 'withered' and 'plasmolysed' being the commonest inaccurate suggestions.

(b) (i) There was some confusion over whether it is low or high humidity that was a possible cause of the condition. Several did not qualify the condition (offering 'temperature' or 'humidity') and, accordingly, failed to score. 'Sunlight' was a common incorrect response and slightly less common was carbon dioxide.

(ii) Candidates often failed to link the condition with how it brought about the change in appearance. The mark for transpiration or evaporation was usually scored, but there was rarely a mention of water leaving the plant's cells and the cells thus loosing their turgidity. Some candidates felt that the appearance was associated with a failure to photosynthesise.

(c) The mark most commonly lost was the result of not showing the guard cells touching at top and bottom – on both diagrams. It was often thought that, when the stoma is open, the guard cells are completely separated by a greater distance or merely separated at one end. The phrase in the question 'as they would appear' was intended to produce diagrams showing a surface view and not in transverse section.

Question 2

(a) A reference to the genotype ratios was often omitted, and the word 'gametes' was either omitted (especially when using the Punnet square), or replaced by 'alleles'. Often, ratios were not adequately linked to the appropriate line on the diagram. Nevertheless, a pleasingly large number of answers were word-and symbol-perfect.

(b) Those that were able to identify the lethal combination were rarely able to adequately describe how they had arrived at their conclusion. A ratio of 2:1 was usually mentioned, but this information is already given in the question, and thus candidates were required to explain that ratio would be 2 yellow : I grey.

Question 3

(a) For the most part, candidates did well in this question, with bacteria and fungi the most usual choices in **(i)**. It was much to their credit that they reasoned through to the correct answer in **(ii)** knowing that viruses are active only within host cells.

(b) The hard work having been done in **(a)(i)**, it is somewhat surprising that candidates usually did not, then, elaborate on their knowledge. A specific substrate and a product from its decomposition were expected, but 'nitrogen' and 'carbon' were commonly suggested, as well as 'urea' - confusion, perhaps, with decomposition in a dung heap.

(c) (i) Although a reference to energy or to heat was quite common, references to respiration were far less so. The vague 'activities' of the microorganisms were more often suggested as the cause of the temperature rise. Even for those who realised that respiration was the cause, 'compost' rather than a named respiratory substrate was usually the substance from which the energy was released.

(ii) Candidates missed the fact that the graph shows the temperature still to be almost 12 ^{o}C above its starting point. Thus there was still microbial action occurring in the compost and the microorganisms were not, therefore, dead or they were of a different type. They also failed to realise that it was the food in the compost that was being used up, not the compost – which would still remain in a modified form. There were very few references indeed to a possible build-up of inhibiting waste products. Some realised that enzymes might in some way be affected by the temperature change, but did not extend their thoughts to possible changes in pH and consequent effects. This was intended to be the most demanding part of the question, and so it proved.

Question 4

(a) (i) This was usually correctly identified, though there were several unacceptable 'catch-all' spellings to cover urethra and uterus, which were also, occasionally, suggested.

(ii) The process of peristalsis seemed well understood, but the word 'muscles' was often omitted. Several candidates seemed confused with peristalsis in the gut, since they suggested that the ureter carries faeces – either towards the bladder or the anus.

(b) Candidates did well here to identify **B** and correctly explain their answer. Apart from a few predictable 'renal veins', the great majority identified the artery, and usually, but not always, then referred to the thickness of the walls and to the width of the lumina. Some failed to gain credit when referring only to **C** *or* to **D** rather than to both.

(c) When referring to the composition of the urine, the knowledge that deamination would increase its urea content was all that was required, though many gave a fairly detailed account of the process. Surprisingly few realised the significance of the *hot* day, and forgot to mention the loss of water through sweating, while many more spoke of the colour, quantity and even the smell of the urine, when the question asked for a description of its composition.

Question 5

(a) This was usually correct, though '*Penicillium*' was sometimes inaccurately suggested. Analgesics (aspirin and paracetamol) were the most common incorrect drugs mentioned.

(b) Although several were attracted by the period 1999 – 2000, most managed to select the correct dates, or to offer a date within the correct range.

(c) Bacteria were usually said to develop a resistance to the antibiotic, though a significant number did not progress beyond restating that more bacteria survived – as mentioned in the question. References to mutations appeared, though not regularly, but it was usually unclear whether it was the original or the mutated forms that then reproduced. The follies of over-prescription and failing to complete a course of antibiotics were well understood.

(d) (i) It was not unusual to read that the patient was becoming immune to the antibiotic.

(ii) There seemed, here, to be some belief that sterilising food is a way of controlling bacterial infections.

Section B

Question 6

(a) The word 'elements' may not have been familiar to all candidates, since it was often taken to mean the constituent units of fats and proteins. Thus the answers often submitted were 'fatty acids and glycerol', and 'peptides' (or peptones) and amino acids'.

(b) This section was often high-scoring, though there were two errors in particular that appeared regularly when explaining the importance of carbohydrates in a balanced diet. It was not uncommon for candidates to omit reference to respiration, but when mentioned, it was often inaccurately said to 'produce' rather than release energy. Even more fundamentally inaccurate references to 'energy being used *for* respiration' were quite common. Carbohydrates were said to be necessary for activities such as movement, when Examiners were looking for uses of the energy they release.

There was some confusion over the specific uses of vitamins, which was not helped by several candidates quoting examples of vitamins not mentioned in the syllabus. Occasionally, candidates suggested that vitamins provide energy.

The value of water in a balanced diet was generally well answered, though relatively few candidates thought to say that it was necessary to replace the water lost during sweating, urinating or exhaling.

Question 7

(a) Those candidates who were unable to give an accurate balanced equation in symbols, were able to give a correct word equation. The more common errors included a failure to identify the sugar, or to include oxygen or lactic acid somewhere in the equation.

(b) (i) This part was quite well answered, with correct references to faster breathing (less often 'deeper'), faster heart beat (less often 'more powerful' or 'faster circulation of blood'). The intake or carriage of more oxygen was often mentioned, but candidates often failed to develop that concept and talk about the removal of more carbon dioxide. Only very able candidates linked the need for these actions to *compensate* for the lower oxygen concentration in the atmosphere.

(ii) This was rather surprisingly poorly answered. It was hoped that candidates would realise that the provision of more oxygen would allow for faster respiration and the release of more energy to supply more active muscles. Rarely was there any mention of muscles receiving increased glucose supplies. These points were almost always overlooked in favour of a reference to anaerobic respiration, and sometimes to the antagonistic arrangements of muscles (usually the biceps and triceps) in the legs.

Question 8 Either

This was the more popular of the optional questions, and full marks were quite common.

(a) (i) Stunted growth was usually mentioned, though not always as an effect of the inability to manufacture proteins. Nitrates and magnesium were sometimes confused, and thus it was suggested that the leaves would be yellow.

(ii) Magnesium was usually linked with chlorophyll manufacture, but the leaves of a plant lacking in magnesium were often said to simply be 'pale' rather than yellow.

(b) This was generally a very well answered part. Knowledge was sound, with all marking points being regularly mentioned, except the increased surface area provided by the mesophyll cells for the uptake of carbon dioxide. Sometimes guard cells, rather than stomata, were said to open.

Question 8 Or

This question was often attempted by the less able candidates, and, as a result, often did not score as highly as **8 Either**.

(a) This part was accurately answered, with all scoring points being made, though reference to root hairs pushing between soil particles and making contact with soil water was less commonly seen. Occasional errors included reference to hair-like projections that were thought to grow on root hair cells and to root hair cells containing xylem.

(b) The common error here was to explain how leaves are adapted to *reduce* transpiration, and much information was supplied leaving the Examiner to select any relevant points – such as a reference to stomata that were, more often than not, being used to prevent transpiration or it was simply a structural reference. It may be that marks in this part were often low because candidates often fail to realise that evaporation of water takes place inside the leaf, and the vapour then passes along a concentration gradient, diffusing out of the leaf through the stomata. Water arriving in a leaf in the xylem was often the only accurate and relevant statement clearly made.

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Paper 5090/03
Practical Test

General comments

The specimens **S1**, **S2** and **S3** that were provided by Centres for **Question 2** were from various species and showed a range of development, usually at a younger stage than was anticipated. The reports from Supervisors were particularly useful in enabling the Examiners to make fair judgements. Once again candidates would be well advised to follow more closely the instructions given in the questions; a prime example that occurred quite often was to make no attempt to label a drawing when labelling was specifically requested.

Comments on specific questions

Question 1

Candidates were required to examine and count their own teeth, recording their observations in Table 1.1.

(a) (i) The number generally found was 28, the outer molars not yet present.

(ii) The most common mistake was to record a gap, third from the left, rather than at the outer position that matched the pattern on the right.

(iii) It was generally recognised that these, the 'wisdom' teeth, appear at a later stage – sometimes described as 'old age'!

(iv) Biting, crushing and grinding were variously mentioned, often ascribed to specific teeth. The idea that molecules were being broken down was not acceptable, however. Reference to mechanical digestion was good, as was the increase in surface area, promoting subsequent enzyme activity.

(b) (i) Several different colours were recorded – commonly brown, occasionally black. The expected yellows and greens, darkening or becoming orange or red were less frequently seen.

(ii) Despite the pointer towards dental hygiene, the significance of the results recorded in Table 1.2 was only rarely realised. The increase in acidity shown by the colour change and caused by the activity of oral bacteria on sugar was scarcely seen, even in part. Many referred to the supposed action of amylase on sugar and a few thought the cotton buds contained bacteria or sugar.

(c) (i) The test for starch was familiar, the test for reducing sugar less so, though perhaps the latter was not recognised as 'the product'. It should, in any case, have been made clear what the product was. Many thought it necessary to decolourise and test a green leaf for starch and the addition of starch, or reducing sugar, was often described as being part of the test. Common use of the term blue-black to describe the outcome of the starch test was welcomed. A significant minority used iodine solution to test for the product, taking the negative result to show the presence of the product.

(ii) It should not be assumed that placing the test tube in a water bath necessarily implies heating to the extent required in the Benedict's test – it needs to be hot!

(d) (i) Table 1.3, when completed, was intended to reflect the process of starch digestion by amylase. The first set of tests should have shown the presence of starch and the absence of reducing sugar in the substrate. The small amount, if any, of reducing sugar in the amylase should also have been recorded. The second set of tests, after mixing, should have shown, in a short time, that the starch had disappeared, especially in the presence of salt. This is because it had been digested to reducing sugar, the amount of which should have increased a good deal. Supervisors' reports were very helpful. A significant number of candidates did not understand the table and stated the name of the reagent, iodine solution, in the starch column, and the result of the starch test in the product column. A clear set of results was rarely given.

(ii) It was widely thought that the presence of salt inhibited the action of the enzyme. Relatively few stated the idea of digestion occurring. Many answers consisted of lists – not always accurate – of materials present or absent from each solution.

Question 2

(a) Many candidates made good drawings of the specimens provided. Some of these specimens, because of their limited state of growth made it less easy to show differences, especially when no green leaves were evident in **S3**. However, an attempt at labelling was expected but was not always carried out. Lengths of the specimens should have conformed to the usual criteria, preferably being in mm or, if cm were used, a decimal place was required. There was some confusion when decimal fractions of mm were given, thus it was unlikely that the height of **S1** was 0.2 mm while others recorded this height as zero.

The description section was expected to compare the etiolation of **S2** with the normal development of **S3** in terms of stature and colour, with **S1** having failed to germinate or grow.

(b) In many cases the suggested explanations took the form of describing again the differences between the three specimens. What was required was an explanation of the effects of low temperature and lack of light on the growth of the seedlings. Thus, **S1** germinated hardly at all because the low temperature limited the amount of enzyme activity that could take place in the seed; by contrast **S2** had grown much more rapidly, even in darkness, when enzyme activity took place. The effect of light was shown in the contrast between **S2** and **S3** with the latter showing normal growth as opposed to the etiolation of **S2**. A number of candidates were not clear as to which of the two was normal. Perhaps the key observation was the presence, and action, of chlorophyll in **S3**.

(c) (i) Drawings varied a great deal but credit was given when a recognisable root tip, tapering, and root hairs were shown.

(ii) When this was achieved in **(i)** the necessary reference here to absorption was readily forthcoming.

(d) (i) Mitosis was generally recognised though there was the inevitable confusion with meiosis. Incidentally, it was vital that the key word was written clearly and unambiguously. Binary fission and vegetative reproduction were occasionally suggested.

(ii) Satisfactory answers included lack of differentiation or specialisation, or that cells in this tissue were dividing repeatedly. More specific answers about xylem and phloem, for instance, tended to become confused.

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Paper 5090/06
Alternative to Practical

General comments

It was clear that candidates had plenty of time to complete the paper. Evidence that candidates had performed, or at least witnessed, practical work during their studies were rewarded by the Examiners. There were also the usual indications as to how carefully they had read and followed the rubric. This was especially evident in **Question 3** where labelled drawings were requested – many were unlabelled - and where explanation, rather than further description was required. Graph work was generally good, with many candidates scoring well.

Comments on specific questions

Question 1

(a) (i) The starch test was generally well known, though some described testing a green leaf for starch and others did not state in their answer that starch was the substrate in question. The majority correctly described the result as blue-black rather than some doubtful shade of blue.

(ii) Similarly it was not always made clear that the product was a reducing sugar and when the test was described it was sometimes said that after the addition of Benedict's solution the test tube should be placed in a water bath; this does not necessarily imply heating - the water bath needs to be hot! A significant minority used iodine solution to test for the product, mistakenly taking the negative result to show the presence of the product.

(b) (i) The graph was generally well constructed with the axes correct. It was better to limit the pH range on the x axis; this necessitated careful labelling of the origin; many omitted the squiggle before the 3. When the range from 0 to 7 was plotted there was congestion in the middle and crossed lines often resulted. When the axes were reversed the candidate often joined the plots incorrectly in order to produce a curve of familiar shape. There were very few bar charts on this occasion but many of them did not have labels to distinguish the two experiments.

(ii) This section was often answered incompletely. It was usually stated that the rate increased and then decreased up to and beyond a certain value. This was sometimes identified as the optimum though many took the optimum to be pH 3.5, or even 4.5. A common error was to confuse rate with time taken. Either interpretation was accepted, provided it was correct. There were some attempts to relate the optimum to a neutral pH because of their theoretical knowledge that amylase works best at about pH 7.

It was commonly stated that the effect of the salt was to decrease the rate of reaction or to change the pH. Candidates were expected to note that the optimum was the same for each experiment and that the effect was similar throughout the pH range.

(c) The idea of replication was a favourite answer but was often spoiled when the repeats used different values – usually of pH. Maintenance of constant temperature and use of the same volume or concentration of enzyme and substrate were good points to make. Practical ideas such as preliminary cleaning of the apparatus or stirring the mixture were also accepted. Many suggested investigating a wider, rather than a narrower, pH range.

Question 2

(a) The terms coccus and bacillus, for A and B, were often replaced with Streptococcus and Lactobacillus, probably quoted from **(b)**. These were accepted, as was 'rod', for B. Invented names were frequently given and things like fungi, bacteria and yeast often appeared

(b) (i) Lactose was not widely known as the source of energy and 'milk sugar', though acceptable, appeared rarely. Glucose, fats, protein or casein were frequently suggested.

(ii) Consequently the correct equation, by which lactose became lactic acid, was given only by a small minority. Glucose was the substrate widely suggested.

(c) Many candidates wrote theoretically about the action of the bacteria but the mark for adding the live yoghurt to the milk was frequently given. Suitable time and temperature were less rarely mentioned and the idea of repeating the process serially rarely appeared. 'Bacteria' and nutrients were often added separately showing that the parts played by the milk and the yoghurt sample were not properly understood.

Question 3

(a) Drawings were at least adequate in most cases and often very good indeed. Only minimal labelling was expected but even this was completely omitted by a significant minority. The maximum length that was requested could have been from Fig. 3.1 or from the drawing; many good candidates gave both. But the measurement should have been the total length, not divided into components. A few did not manage units of measurement correctly, omitting the first place of decimals when cm was used. There was occasionally confusion when decimal fractions of mm were given, thus it was unlikely that the height of C was 0.2 mm. or even zero! Many thought that specimen C was a potato.

Description should have brought out the clearly visible differences between **A** and **B**. The white, or pale, elongated (actually etiolated) **A**, as compared with the greener, more sturdy **B** with its more prominent growth of leaves should have been mentioned. The salient feature of **C** was its failure to germinate; 'no growth' was accepted but not 'no development' as this term relates more to the formation of the seed rather than to its subsequent germination. It was often considered that **A** had grown 'better' than **B** as it was taller and **B** may have had too much light, or lost excessive amounts of water by transpiration.

(b) (i) and (ii) This section was frequently used for further, or even repeat, description rather than for explanation.

What were required were explanations of the effects of low temperature and lack of light on the growth of the seedlings. Thus, **C** had not germinated because the low temperature limited the amount of enzyme activity that could take place in the seed; by contrast **B** had grown much more rapidly when normal enzyme activity took place. Deactivation of enzymes was frequently mentioned but this would not have occurred. The effect of light was shown in the contrast between **A** and **B** with the latter showing normal growth as opposed to the etiolation of **A**. Again, water loss from **B** was sometimes thought to have limited the growth of this seedling.

(c) (i) Mitosis was generally recognised though there was the inevitable confusion with meiosis. It was vital that this key word was written clearly and unambiguously.

(ii) Chromosome or chromatid was accepted but not chromatin, DNA or nucleus.

(iii) Many made the point that cell division was frequent in this tissue. Attempts to describe differentiation or specialisation were less successful with reference to root hairs diverting lots of candidates. Some referred to the staining for DNA and suggested that other cells had no chromosomes or nuclei.