# BIOLOGY

## GCE Ordinary Level

**Paper 5090/01**
**Multiple Choice**

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

**General comments**

The paper successfully separated the candidates, with a pleasing number performing very well. Candidates must remember to read all the words of the stem carefully – there is usually a key phrase which leads them to the correct response or sets the scene of the particular question. For example, in **Question 38**, *all* the $F_1$ are spotted leopards. With no black $F_1$'s the spotted ones must be heterozygous.

Some questions proved very easy, and while they are included to give confidence and encourage weaker or more nervous candidates, they are less help in the grading of candidates. These included **Questions 1**, **7**, **8**, **28**, **33** and **36**.

Straightforward questions, largely requiring knowledge, included **Questions 2**, **11**, **13**, **14**, **17**, **20**, **24**, **26**, **31**, **34** and **37**.

**Comments on specific questions**

**Question 3**

Cytoplasm is not partially permeable and the cellulose wall presents no barrier to biological molecules.

**Question 4**

Option **B** was popular and is true, but the graph refers to the observable release of oxygen.

**Question 5**

Poorer candidates may have confused "high" and "low" – hence the popularity of option **B**. A little thought should remind candidates that in a highly concentrated solution, there is a lot of material dissolved.

**Question 6**

The more discs, the more exposed surface area and hence more enzyme. Boiling will denature the enzyme.

**Question 9**

This was very well known, but shows a pleasing understanding of the topic.

**Question 10**

The 24 hour period is not necessarily one whole day. When oxygen release is maximum, the daylight must be brightest, so **A** must be the Key, while option **C** has no oxygen released and must be night-time.

**Question 12**

The gall bladder stores, but does not produce bile. The pancreas produces a lipase.

**Question 15**

Graphs always need careful examination of their axes. When in doubt, candidates should try reducing the *x*-axis to zero and then consider small increases. No humidity would have a high transpiration rate and the rate will fall as the air becomes more humid. This question was amongst the most successful at identifying the best candidates.

**Question 16**

This recalls William Harvey's classic demonstration of valves in veins. The artery is deeper and will not be prominent when the bandage at P is applied.

**Question 18**

This question caused some problems. The rate of respiration can be higher (option **A**) if more oxygen is supplied to a muscle, but dissociation and the Bohr effect are beyond the expectation of this syllabus. As lactate accumulates and the pH drops slightly, more blood does flow to a muscle (option **B**), but again this is beyond the syllabus. If more lactate can be tolerated, then a muscle can respire anaerobically for longer (Option **C** – the Key ). This is correct and at this level, is the simple answer required.

**Question 19**

The volume of air exchanged is obtained by multiplying the volume of each breath by the number of breaths per minute. Of course not all this air reaches the alveoli.

**Question 22**

Insulin production will follow glucose concentration, so option **A** is the Key. Option **C** shows the insulin level changing before the glucose level. The lines identifying the two substances are vital here.

**Question 23**

The small, but significant, temperature drop is due to the loss of latent heat of vaporisation as sweat evaporates.

**Question 25**

Option **D** was popular – the ciliary body does contain muscle fibres, but these are involved in the focussing.

**Question 27**

Normally any question on the energy source in an ecosystem is very easy. Although the sun is not shown in the scheme, it is still the energy source. There are three plants shown, but all are photosynthetic.

**Question 29**

From the human point of view, as shown in the diagram, the most efficient chains to choose as a food source will be the shortest, since less energy is lost to the intermediate organisms.

**Question 30**

Positions 3 and 4 in the diagram must be either plants or the atmosphere, since they exchange $CO_2$. Since 4, 1 and 2 all pass $CO_2$ to 3, then 3 must be the atmosphere.

**Question 32**

Another graph – but with different measurements on the *y*-axis. The best candidates realised that sewage pollution is a source of nitrogen compounds. Oxygen – and consequently number of fish - will drop at the entry point and bacteria will rise.

**Question 35**

This graph shows 42, not 28 days. The fertile period in most women normally lasts from about day 11 to 19.

**Question 38**

See above.

**Question 39**

This needs careful thought, but is logical. No parent can be group O, since one child is AB. The AB child also shows that one parent must have the $I^A$ allele and the other the $I^B$ allele. The BB child shows that both parents must have the $I^B$ allele, only option **C** will conform.

**Question 40**

The last question also picked out the best candidates. P and Q must both be homozygous dominant, since no affected individuals, who would be genotype tt, occur in $F_1$. Since the $F_2$ contain two tt individuals, the $F_1$'s must be heterozygotes, who each inherited the t allele from their affected parent.

**Paper 5090/02**

**Theory**

**General comments**

Some excellent answers were seen to all questions but the examination spread candidates out over a very wide range of marks. The use of technical terms which have not been adequately understood often to lead to some muddled answers and, in **Question 7**, many candidates failed to realise that there is a procedural format in experiments and this resulted in a loss of relatively straightforward marks.

**Comments on specific questions**

***Section A***

**Question 1**

**(a)** Although most identified Plant B and continued curve 1 accurately enough, there was some confusion over the requirements in **(ii)**. Several candidates calculated the average for all 6 days or gave the total amount on day 6. Almost all remembered to give the correct units.

**(b)** There was confusion here, with respiration and photosynthesis being reasonably common suggestions and the polythene bag then having the effect of interfering with light or gas absorption.

**(c)** Although most appreciated the significance of stomatal distribution, several concentrated unproductively on the properties of petroleum jelly with relation to water, light or gas passage.

**Question 2**

**(a)** The two cycles were usually correctly identified, though the 'carbon dioxide' cycle was a fairly common inaccuracy. Process U was customarily correct with bacteria being the appropriately named organism. Process V was far more of a problem with nitrogen fixation or de-nitrification (as well as decomposition, again) being suggested. Even when nitrification was correctly given, the type of organism was often thought to be nitrogen fixing or de-nitrifying bacteria.

**(b)** Urine or urea were the most frequent, if relatively uncommon correct responses for box Y. Box Z (protein or amino acids) was rarely correct, with 'plants' being the commonest answer.

**(c)** Only the very best candidates appreciated the importance of insect protein providing the nitrogen necessary for the manufacture of plant protein. Most candidates thought that insects contain the necessary nitrates.

**Question 3**

**(a)** X and Y were often correctly identified though several failed to appreciate the significance of label X pointing specifically to the remains of the style. 'Cotyledon' was the commonest mis-identification of Y.

**(b)** Apart from a relatively common suggestion that the method of dispersal was 'explosive' (despite the careful wording of the question), most gave sound answers to this section.

**(c)** The only real problem here was to confuse dispersal with insect pollination.

**Question 4**

**(a)** The ribs were commonly labelled as **intercostal** muscles or a line was drawn outside the ribs and labelled as such, but a diaphragm was usually drawn within the fairly generous limits allowed.

**(b)** A significant number managed to describe the reverse effect, but otherwise, **(i)** was well answered. In **(ii)**, all relevant points were made, but only the best candidates managed to find the three features that were required for full marks.

**Question 5**

**(a)** M was sometimes identified as the left atrium or atrium unspecified and sometimes as a ventricle, whilst N was occasionally the pulmonary artery or vein or a. vena cava, but by far the majority were correct.

**(b)** Several confused the direction in which the air flows, but most who thought logically realised the differences that would exist in the proportions of oxygen and carbon dioxide in the air, though several stated, as in **Question 7**, that oxygen is breathed in and carbon dioxide breathed out.

**(c)** This part was usually correct.

**(d)** Though it was common to read that ‘air' passes through the holes, a reference was often made to greater surface area or speed of gas diffusion in **(i)**, the idea was often repeated in **(ii)** rather than realising that the holes must be small enough to prevent other blood components from passing through.

**(e)** This question differentiated well between candidates of differing ability with the better ones correctly identifying white blood cells, but just occasionally going on to confuse antibodies with antigens or to fall short of the requirements by referring to ‘germs’ rather than bacteria.

***Section B***

**Question 6**

**(a)** Most candidates scored highly here, with accurate references to pancreatic juice and to its contents as well as to insulin and its effects. Those who had not thoroughly learnt their enzymes managed to list them, but then confuse their functions. Liver functions were usually correctly stated but some candidates omitted reference to emulsification while others made no reference to storage

**(b)** Candidates unfamiliar with the surgical procedures were given credit for indicating the functions of the two organs concerned, but even so, several forgot to refer to the storage and churning effects of the stomach. Correct references to protein digestion and the effect of hydrochloric acid on bacteria were usually given and many suggested the likely effect on the size and frequency of meals. Although both marks were regularly scored in **(ii)**, many felt that failure to absorb water from the faeces would lead to constipation.

**Question 7**

**(a)** This section usually enabled candidates to score reasonably well. Candidates sometimes became confused with lactic acid being ‘used' in anaerobic respiration, or with alcohol being produced. There were only a few references to the generation of heat but several to a faster pulse rate causing the heart to beat faster. Many lost marks by saying that air breathed in is oxygen and air breathed out is carbon dioxide.

**(b)** There is always a problem with a question such as this which asks specifically about an athlete, yet candidates produce an answer which relates to all non-athletes as well. The result is a list of the contents of a balanced diet, whilst Examiners were looking for some reference to *increased* amounts of energy giving carbohydrates or bodybuilding proteins. Indeed, many dietary constituents were acceptable so long as there was some idea of why they were particularly important to the athlete.

**Question 8**

**(a)** The process of fertilisation in a mammal is clearly well understood. The sperm's entry into the ovum was often described in intricate detail, though mention of the term ‘gametes' was quite often omitted. The oviduct was usually mentioned but not always as the place where fertilisation occurs. Descriptions of the process in plants, whilst still often given in elaborate detail, were generally far less accurate. Several believe that the pollen grain is the gamete, and, for a significant few, confusion reigns over the terms ovum, ovule and ovary. Many candidates, however, produced faultless answers and were rewarded with full marks.

**(b)** This section proved very demanding, even for some of the best candidates. Many failed to realise that genetics was in any way relevant. The most common scoring-point was a reference to plants produced asexually being identical. Explanations for the advantages of sexual reproduction regularly failed to go beyond a repetition of the wording of the question (‘they become better adapted'). The few who realised that *variety* was the key and that this was the result of gene combination could, and just occasionally did, score full marks.

**Question 9**

**(a)** There was an impressive understanding of auxins and how they bring about tropisms. The less-able candidates were struggling to explain how a higher concentration of auxins causes a curvature

in shoots and experienced even more difficulty with a description of positive geotropism in a root, but in general, this section scored highly.

**(b)** There were many problems here, but for those who used some ingenuity coupled with a little Biological knowledge, there were relatively straightforward marks to be gained. Many confused invertebrate with vertebrate, and gave accounts of human reflexes or of Pavlov's dogs. Of those who used invertebrates, several lost marks by using only one organism, rarely repeating the experiment or allowing the organism a reasonable stated time for its response. Multiple choice chambers were often mentioned, but it was not always clear which single stimulus was being examined.

**Question 10**

**(a)** There was a wealth of knowledge on the functions of water in the body. Few candidates who thought carefully enough failed to score highly in this section with all scoring points regularly being mentioned.

**(b)** Perhaps surprisingly, this section did not score anything like as well. Candidates tended to lose sight of the question and instead, they gave an account of substances transported in the blood. The mechanism of transfer via tissue fluid was not a clearly understood process, and there were many detailed accounts of what is carried to (and / or from) kidneys, lungs, liver, pancreas and villi.

**Paper 5090/03**

**Practical Test**

**General comments**

It was difficult to understand why there were relatively few candidates who scored in excess of 37 of the 40 marks available. Many started off well but did not maintain their momentum; others answered the later sections of each question very well, after they had performed less well in the initial stages. There are usually some candidates who are consistently excellent. There were many instances of marks being lost through failure to follow the instructions sufficiently closely. Two of these are mentioned in the next paragraph; inadequate use of the hand lens and failure to label a drawing. This is particularly unfortunate because it is quite independent of academic ability.

**Comments on specific questions**

**Question 1**

**(a)(i)** Candidates were instructed to stain the specimen, and then to observe it, through the hand lens that was provided. Many had not effectively done so, as the lack of detail in their drawing clearly indicated. The approach to making this drawing was generally good, with large, clear, clean-lined drawings in the majority. There were also very few perspective drawings; candidates' attention being focussed, correctly, on the transverse plane of the cut. The principal vascular bundles were generally shown, though some candidates imposed a textbook structure within the outline of the bundle. Use of the hand lens would have revealed minor bundles between the larger ones, an epidermis, and, at the angles of the structure, zones of thickened supporting tissue, which had different staining properties.

A significant number of drawings were completely unlabelled. The labels that were expected were vascular bundle or vein, together with one or more of: epidermis, strengthening tissue, background tissue (parenchyma), or a correctly indicated part of the bundle – xylem or phloem. The clarity of this last point was not always forthcoming. Observational labels such as 'light' or 'stained' regions were not accepted. Some of the misconceptions that were noted included the smaller bundles being labelled mitochondria, and the whole structure being mistaken for a fruit, with seed, mesocarp and endocarp labels.

**(ii)** This familiar exercise to determine the degree of magnification was generally carried out well though there was the usual minority who spoilt their answers by adding a unit of length to the final expression. Equally unwelcome were those unrealistic answers that were read from a calculator and quoted to several decimal places. One place of decimals was perfectly adequate though x 3.25, for instance, was acceptable.

A line ruled on the drawing, with its measurement clearly stated, was given in most cases. It is always sensible to measure in mm as this avoids the problem of stating measurements to an accuracy of 0.1 cm. and the calculation is usually performed more readily using whole numbers.

The instructions to note the times when the celery was placed in water and removed from the water were usually carried out though a few candidates did not comply, giving the elapsed time, which was not required.

**(b)** The phenomenon of osmosis was explained extremely well by much of the entry. This was most clearly achieved in terms of the water potential of the cell sap and of the ambient water, with the flow of water into the vacuoles of the tissue, from higher water potential to lower. The Examiners recommend this approach.

Those who chose to refer to relative concentrations had to make very clear whether it was the concentration of the solute, or the solvent, to which they were referring. Correct use of the terms hypotonic and hypertonic were fully acceptable, however. But reference to 'strong' and 'weak' solutions was inadequate.

Having explained the movement of water it was then necessary to state that the curvature of the celery tissue occurred because the outer epidermis of the stick of celery, with its strong, inelastic cuticle, would not allow the outer region to elongate as much as the softer, inner tissue. The part played by the individual cell, in terms of enlargement, should have been made clear.

Many candidates did not go further than to say that the turgor of the cells caused the curvature; others thought that the xylem was involved, either by its water uptake or (erroneously), because it had been removed earlier in the investigation. There was also some confusion caused by the concept that the celery was bounded by a single, all-inclusive cell wall, rather than by a multicellular epidermis.

**(c)** It was better to have used ink, or a similar blue or black stain, rather than iodine solution because the latter caused confusion with the starch test.

**(i)** When the end to which the stain had been applied was removed it was clear that a part of each vascular bundle was stained where the ink had penetrated. The stained xylem vessels were readily recognised by those candidates who used the lens.

**(ii)** Most candidates had no trouble in revealing the longitudinal course taken by the stain. A significant minority however, did not follow the instructions, drawing the transverse view again.

**(iii)** This section proved to be a good differentiator. The hollow, unimpeded structure of the vessels should have been explained. There were only very few mentions of capillarity as a contributory factor and a fair proportion of answers included confusion with phloem as the conducting tissue. Osmosis was also said to be involved. Generally, marks were gained when it was realised that an explanation of the structure was required.

**Question 2**

**(a)(i)(ii)** Before starting their answer candidates were wise to plan the format that would best convey the information they were required to collect. They might have assessed the extremes of the seed lengths then drawn a table to accommodate this range, with intervals of 0.5 mm. As each seed was measured its length could then have been recorded as a stroke, forming a tally along each line. When 40 seeds had been measured the number for each length could then have been recorded. There were some excellent examples of this approach in which full marks were awarded for the section. The most convenient way to measure a grain was to hold it by means of forceps alongside the ruler. It was readily apparent which of the grains fell more or less midway between the mm marks. A number of candidates made no attempt to measure to this degree of accuracy; a few used divisions of 0.5 cm while others sought to satisfy the Examiners by adopting units of 1 mm between 6.5 mm and 7.5 mm, for example.

Those who listed all 40 measurements were not penalised provided that they showed their analysis of these figures, concluding with a summary of the numbers in each category since these figures were essential for part **(b)** of the question.

**(iii)** By far the simplest way to ensure a random selection was to close one's eyes at the time of selection; also accepted were partitioning off groups of seeds with a ruler, taking the next closest seed, or shaking a number of seeds from a container in some way. But, in general, those who included the term 'random' in their answer did not describe how they achieved this state!

**(b)** The construction of the histogram – surely a familiar exercise – was not well done by the majority. Neat and clearly visible ruling was expected, with most of the grid being occupied. Grain length should have been on the *x*, horizontal, axis, and labelled as such, 'in mm'. Up the *y*-axis the number in each category (the frequency) should have been plotted. A final refinement should have been the placing of the length labels in the middle of each block on the *x*-axis, and of course, all blocks or columns should have been of equal width. All of these requirements were broken, to a greater or lesser degree! Occasionally candidates presented 40 narrow columns – one per seed.

**(c)(i)** If the instructions were correctly carried out a bimodal distribution should have been apparent. This was achieved by a fair number of candidates. Use of the term bimodal was not essential but the double peak should have brought comment. A second mark was awarded in this section for a simple attempt to describe the histogram.

**(ii)** Having been told that all the seeds came from one species candidates should not have said, as a number did, that different species were involved. The Examiners hoped that different varieties, or cultivars, might have been mentioned, especially as many recognised the grains of rice, and in view of the vast number of cultivars in this species. Credit was also given for references to different conditions, or even different locations within the fruiting plant. There were a number of cases of confusion with germination as causing the difference.

**(d)** Many candidates were able to state that some of the grains were red, the others white, though it was perhaps unfortunate that the grains of the two cultivars were not the same colour. There were also possible differences in shape, some being rounder or more slender, for instance. Provided that the answers were comparative and concerned a feature other than length, they were accepted.

**(e)** The purpose of this section was to encourage candidates to use their knowledge of genetics and selective breeding. They might, for instance, have suggested growing plants from each of the two cultivars, carrying out self-pollination (with suitable safeguards), and then comparing the resultant seeds and drawing suitable conclusions. Alternatively, credit was given for suggesting the use of a larger sample or taking more accurate measurements, as with a micrometer gauge. Again, plots of seedlings might have been grown in a specified range of different conditions and the seeds analysed. In this open-ended question credit was given for a wide range of feasible suggestions.

Answers that were not accepted included the application of various food tests to the seeds, soaking the seeds in water, or grinding them for whatever purpose.

There was also a sizeable minority who measured other parts of the plants, surveyed their classmates, or even bred dogs. A few wanted to 'do the DNA' of the seeds!

**Paper 5090/06**

**Alternative to Practical**

**General comments**

It was difficult to understand why there were relatively few candidates who scored in excess of 35 of the 40 marks available. Many gave good answers to one or two of the questions but could not sustain that level whereas there are usually some candidates who are consistently excellent.

There were many instances of marks being lost through failure to follow the instructions sufficiently closely, hence a decline in relevance occurred.

**Comments on specific questions**

**Question 1**

**(a)(i)** The correct answer, 0.05 kg, sometimes stated as 50 g was given by the vast majority.

A common mistake was giving no units, or the wrong unit; occasionally the decimal point was misplaced, resulting in the answer 0.5.

**(ii)** Most had the idea of some soil being lost during the experiment. This was occasionally referred to as erosion, while some related it to loss of water, despite the introduction to the question. Credit was given for reference to inaccuracy of instruments, or readings, however unlikely this was, in the circumstances!

**(iii)** Uptake of mineral ions was generally suggested but very commonly there was a repetition of an experimental error. Uptake of 'food' was too vague and again water was frequently mentioned.

**(b)(i)(ii)** Those who realised that carbon dioxide was the compound to which the question referred had little trouble with these sections, quoting how the gas entered the leaf through stomata by diffusion. But they were a minority. Most cited a mineral, ion or element, while a few gave 'sunlight'. Some credit was given consequentially for related statements of the involvement of root hairs and active transport, but osmosis was often, incorrectly mentioned. The word compound in the question should have given more guidance to candidates.

**(c)(i)** Similar errors occurred here. Nitrogen was the obvious answer - nitrate was frequently given. Carbon dioxide often came up again, as did sunlight. Sulphur appeared very occasionally, as an acceptable alternative.

**(ii)** When magnesium was stated as the element candidates almost invariably followed this up by giving chlorophyll as the compound (some mistakenly said chloroplast), though a few followed the trend that was set when other elements were stated, of citing a compound, often a fertiliser, that contained this element. Those who gave another, acceptable, element such as phosphorus or iron had difficulty in naming a suitable compound.

**(d)** An experiment using culture solutions (with all elements present in a control and omitting the test element as the experimental sample) was the most suitable suggestion and was attempted by many. It was clear that the majority of candidates had not seen, or carried out such experiments and plants were placed in soil with no clear idea of how to deprive the test plant of the element concerned. There was little idea of an appropriate time scale with results sometimes being expected in a couple of days. Many added more nitrogen (or phosphorus etc) to show that it produced better growth. Others gave a more complete comparison. There were also a number who deprived a plant of light and then tested its leaves for starch.

**Question 2**

**(a)(i)(ii)** Before starting their answer candidates were wise to plan the format that would best convey the information they were required to collect. They might have estimated the extremes of the seed lengths, then drawn a table to accommodate this range, with intervals of 0.5 mm. As each seed was measured its length could then have been recorded as a stroke, forming a tally along each line. When 40 seeds had been measured the total for each length could then have been recorded. There were some excellent examples of this approach in which full marks were awarded for the section. It was readily apparent, when measuring, which of the grains fell more or less midway between the mm marks but a large number of candidates made no attempt to measure to this degree of accuracy. Others sought to satisfy the Examiners by adopting units of 1 mm between 6.5 mm and 7.5 mm, for example.

Those who made a list of all 40 measurements were not penalised provided that they showed their analysis of these figures, concluding with a summary of the numbers in each category since these sub-totals were essential for part **(b)** of the question.

**(iii)** A simple way to ensure a random selection was to close one's eyes at the time of selection; also accepted were partitioning off blocks of seeds with a pencil line, or taking the next closest seed in a

certain area. A number of candidates answered as though they had been provided with a container of actual seeds, which was not appropriate. But, in general, those who included the term 'random' in their answer did not describe how they achieved this state!

**(b)** The construction of the histogram – surely a familiar exercise – was not well done by the majority. Neat and clearly visible ruling was expected, with most of the grid being occupied. Grain length should have been on the *x*, horizontal, axis, and labelled as such, and 'in mm'. On the *y*-axis the number in each category (the frequency) should have been plotted. A final refinement should have been the placing of the 'length' labels in the middle of each block on the *x*-axis. Of course, all blocks or columns should have been of equal width. All of these requirements were broken, to a greater or lesser degree! Occasionally candidates presented 40 narrow columns – one per seed.

**(c)(i)** If the instructions were correctly carried out, especially regarding the degree of accuracy in the measurements, a bimodal distribution should have been apparent. This was achieved by a fair number of candidates. Use of the term bimodal was not essential but the double peak should have brought comment. Others might have described their distribution as normal, or skewed, as appropriate. A second mark was awarded in this section for a simple attempt to describe the histogram.

**(ii)** Having been told that all the seeds came from one species, candidates should not have said, as a number did, that different species were involved. The Examiners hoped that different varieties, or cultivars, might have been mentioned. There were, however, numerous attempts to involve genetics in a number of ways. Most of these were accepted. Credit was also given for references to different conditions under which the parent plants had been grown.

**(d)** Despite being asked for differences other than length, many mentioned length. We looked for reference to the more slender as opposed to rounder shape of some of the seeds.

**Question 3**

**(a)** Not infrequently, the drawing was completely unlabelled. The drawing was expected to be at least 7 cm across and constructed with clear, clean lines. The central region should have been delimited in reasonable proportion to the whole, with the tri-partite structure shown. Around the outside the vascular bundles should have been indicated and a measure of the accuracy of the candidate's observation was whether the bundles were correctly aligned with the angles and flatter portions of the outer layer of the pericarp. Seed, vascular bundle and pericarp were the labels that were expected. Those who chose to subdivide the pericarp were given credit for the combination of epicarp and mesocarp.

**(b)** The instruction to indicate on Fig 3.1 which of the seeds was drawn was not always clearly carried out in the bold and unambiguous way that was expected. Many clearly did not know which were the seeds and pointed to an entire loculus. Only a realistic outline of the seed was required; this then was the basis of the calculation in part **(c)**.

**(c)** It is again worth advising Centres that measurements in this type of exercise are best carried out in mm, not least because this avoids the risk of error and confusion in using decimals. Answers ranged from 100 m to 0.4 mm for either of the required recorded measurements – indicating a total lack of awareness of size – and, occasionally, no units were stated. The minimum amount of working required was the expression of drawing size over size of subject in Fig. 3.1, with an adjustment for the fact that Fig. 3.1 was reproduced x 0.5 of the size of the original specimen. Some 50% of all candidates tried to make this adjustment but a few of them halved, instead of doubling, to arrive at a final figure. However, the working that was given could frequently have been set out much more clearly.

The magnification was generally well stated. Very few made the usual errors of adding cm., (e.g. x 4 cm), or giving a string of decimal places from their calculator, or of excessive rounding up or down.