

BIOLOGY

Paper 5090/11
Multiple Choice

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

General

In questions with graphs it is often useful to consider the effect of one or more of the axes at zero. When it is used in a question, the word “only” is usually significant as in **Question 8**. “Not” is always in bold, but can be missed, as it may have been in **Question 18**.

Unfortunately **Question 22** contained an error and was discounted for this paper.

Comments on individual items.

Question 2

Water moves down a water potential gradient by osmosis.

Question 3

In a solution with a low sucrose concentration, the potato pieces will take in water and gain mass. In a solution with high sucrose concentration the opposite occurs.

Question 4

Active sites on an enzyme are a specific shape and act as the “lock”. The substrate is the “key”.

Question 5

If a factor is limiting, an alteration of its value will alter the rate of the process. During the periods P and R, the rate of photosynthesis does not change.

Question 6

The upper and lower epidermises, labelled 1 and 3 are not normally photosynthetic, but the stomatal guard cells (4) are.

Question 7

The animals – herbivorous snails - may lack either food or oxygen, but the air bubbles from the pump will provide oxygen if the photosynthetic plants are removed.

Question 8

Nitrogen is found in proteins, but not necessarily in fats. The word “both” is critical.

Question 10

The blood capillary (1) carries glucose from the villus, but not fats, which are carried in the lacteal (2). The goblet cell (3) secretes mucus, while the cells labelled 4 absorb nutrients from the intestine.

Question 11

Cell X is a xylem vessel, so the contents will be water and minerals. The phloem element Y carries sugars in solution and boiling the reagents in a Benedict’s test will produce a positive reaction.

Question 12

CO₂ will leave the palisade cells during respiration and O₂ will leave during photosynthesis, so the arrows are the wrong way round at the top of the diagram. Sugars are not translocated out of the stomata, so the correct option is D, transpired water leaving.

Question 14

The word “pulmonary” was missed by 25% of candidates – this being the only vein with oxygenated blood. The thin walls of veins should be better known.

Question 15

Plasma is the fluid part of blood and tissue fluid leaks out into the intercellular spaces. White cells are amoeboid and can pass through the capillary walls into the tissue fluid. The glucose content of each fluid is the same. Many protein molecules are too big to pass out of the capillaries.

Question 17

Breathing in uses both the diaphragm and the external intercostal muscles. Label X is alveoli, which expand as air enters them.

Question 18

Muscles use energy. Secretion of the protein keratin for hair, and secreting the liquid sweat from blood are active and both require energy. Respiration has a net production of ATP.

Question 20

Again the huge relative size of protein molecules is significant. The dialysate is isotonic, but contains no protein.

Question 23

Many candidates did not realise that refraction occurs at the interface of the air and the conjunctiva (2). The lens (3) is obviously involved, as are the muscles (4) of the ciliary body, but the iris (1) plays no part in focusing.

Question 24

Homeostasis is not well understood. Ideally, it is the internal state that is maintained, despite the environment.

Question 25

Heroin is both addictive and a depressant, so the question hangs on carbon monoxide not being addictive or causing emphysema. Alcohol does not cause lung cancer, although it can cause liver damage and slow reactions.

Question 26

The statement has to be supported by the graph. Options **A** and **B** may be true but there is no evidence from the graph, which does show that the numbers of smokers fell.

Question 27

Option **A** is a popular myth. Antibiotics can select resistant bacteria from a population with a diverse gene pool, but cannot cause bacteria to become immune. Viruses are not affected by antibiotics.

Question 29

Organisms 3, 7 and 8 are carnivores; 7 and 3 are shown eating the small tube dwelling worms on the muddy bottom of the pond. 6 and 2 are herbivores. 1 and 4 are green plants.

Question 30

The only arrow from an organic substance is from the plant proteins (**A**). Option **C** was popular and is due to bacteria, but it is not a process of decomposition.

Question 31

Option **A** would prevent *Anopheles* egg laying and larval development. **C** prevents *Plasmodium* infection and **D** can kill adult mosquitoes.

Question 32

Releasing sewage into a river supplies organic material which stimulates bacteria, which in turn consume more oxygen while releasing nitrates, which will stimulate plant growth and the plants will restore the oxygen level. Option **C** shows the initial drop in oxygen and slow recovery as nitrates increase.

Question 33

This longer question was intended to discriminate the good biological thinkers. It was difficult for many. If only group 2 seeds germinated, the testas would seem to have an inhibitory effect. This could be investigated by continually replacing the water to see if this would remove the inhibition.

Question 34

Meiosis produces haploid gametes, so option **A** should have been obvious, but far too many candidates chose **B** which is fertilisation or **C** which is mitosis, producing cloned plants, fragments or commercial cuttings.

Question 35

Scurvy was a popular wrong choice; its signs are largely restricted to skin surfaces and bleeding gums, due to reduced collagen.

Question 37

If a human insulin gene is inserted, the protein produced should not have an antigenic effect in humans, which might occur if an insulin gene from another species were used.

Question 38

Genotypes for a person with blood group A can only be either $I^{A}I^{A}$ or $I^{A}I^{O}$ so the correct option must be **A**, since the I^{O} allele is recessive.

Question 39

The ebony x grey heterozygote cross is a classic backcross and produces the 1 : 1 ratio. Two heterozygotes will produce the 3 : 1 ratio suggested in option **D**.

Question 40

Where “not” is used in a question it is always emboldened. Options **A**, **B** and **C** are all correct, but a recessive homozygote does have a recessive phenotype.

BIOLOGY

Paper 5090/12
Multiple Choice

| <i>Question Number</i> | <i>Key</i> | <i>Question Number</i> | <i>Key</i> |
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| 7 | B | 27 | A |
| 8 | A | 28 | B |
| 9 | D | 29 | B |
| 10 | B | 30 | D |
| 11 | D | 31 | B |
| 12 | A | 32 | A |
| 13 | B | 33 | D |
| 14 | C | 34 | A |
| 15 | C | 35 | A |
| 16 | C | 36 | D |
| 17 | C | 37 | D |
| 18 | D | 38 | B |
| 19 | D | 39 | A |
| 20 | D | 40 | C |

General

All candidates must be encouraged to read every word of every question. In Q15, too many candidates missed the word 'aerobic' and answered for anaerobic respiration. "**Not**" is always emboldened for emphasis, but is still missed by some.

Comments on Specific Questions

There were a number of questions that proved to be easy. These were purely factual, suggesting that candidates were well prepared.

Question 2

Diffusion can occur through any medium and does not require a separating membrane.

Question 3

In a solution with a low sucrose concentration, the potato pieces will take in water. As the sucrose concentration increases, there is less weight increase and eventually no weight increase occurs.

Question 4

Active sites on an enzyme are a specific shape and act as the “lock”. The substrate is the “key”.

Question 5

If a factor is limiting, an alteration of its value will alter the rate of the process in either direction.

Question 6

The upper and lower epidermises, labelled 1 and 3 are not normally photosynthetic, but the stomatal guard cells (4) are.

Question 7

The animals – herbivorous snails - may lack either food or oxygen, but the air bubbles from the pump will provide oxygen if the photosynthetic plants are removed.

Question 9

Option B is correct. A protein in the diet must be digested and the amino acids used to synthesis the enzymes involved.

Question 13

At X, the ventricular pressure is at its maximum, so the semi-lunar valve must be allowing blood into the aorta. Since the ventricular pressure is above the atrial, the bicuspid valve must be closed.

Question 14

Plasma is the fluid part of blood and tissue fluid leaks out into the intercellular spaces. White cells are amoeboid and can pass through the capillary walls into the tissue fluid. The glucose content of each fluid is the same. Many protein molecules are too big to pass out of the capillaries.

Question 15

Aerobic respiration products are CO₂ and water.

Question 18

Air is inhaled through tube X and exhaled through tube Y. Hence the indicator in X remains orange, but the extra CO₂ will turn the Y indicator yellow.

Question 19

In homologous chromosomes, the two sites labelled P will have the same gene, but may be represented by different alleles.

Question 24

Clearly the elbow hinge joint only moves in one plane. The ball and socket at the shoulder can move in two planes, but not three, which would imply that the head of the humerus could move away from its socket.

Question 25

Urea is synthesised in the liver and water is not broken down at all.

Question 26

Decomposition of the oil will be fastest when microorganisms are stimulated by aerobic conditions or raising the temperature. Wave action will result in smaller oil drops with more surface area.

Question 29

Organisms 3, 7 and 8 are carnivores; 7 and 3 are shown eating the small tube dwelling worms on the muddy bottom of the pond. 6 and 2 are herbivores. 1 and 4 are green plants.

Question 30

Decomposing bacteria metabolise organic material, such as proteins (**D**), so ammonium ions (**C**) cannot be their substrate. Option **A** is nitrogen fixation, although if the arrow pointed the other way, **A** would also be correct.

Question 31

Option **A** would prevent *Anopheles* egg laying and larval development. **C** prevents *Plasmodium* infection and **D** can kill adult mosquitoes.

Question 34

Meiosis produces haploid gametes, so the correct answer is **A**. Many candidates chose **B** which is fertilisation or **C**, which is mitosis, producing cloned plants, fragments or commercial cuttings.

Question 37

A codominant heterozygote must contain both I^A and I^B . Option C shows codominance in the male parent.

Question 38

DNA is the basis of transcription and then translation, producing protein.

Question 39

Two heterozygotes eg. Aa and Aa, could produce two phenotypes if the "A" allele is dominant to "a", Statement 2 refers to the phenotype of the genotype "aa".

In the cross of Aa and Aa, there will be a probability of one AA : 2 Aa ; one aa.

Question 40

There are two distinct groups of offspring, such as in the cross of a heterozygous tall strain of pea with a homozygous short one. The groups are separated by 21cm. Within each group there is continuous variation.

BIOLOGY

Paper 5090/21
Theory

Key Messages

Candidates should acquire good biological knowledge during their course of study and be able to use this to analyse and answer the short, structured questions in **Section A** and to write comprehensive accounts in **Sections B** and **C**.

General Comments

The majority of candidates were able to give relevant answers to the questions and generally presented their work in a neat and orderly manner. There was no evidence to suggest that the time available was other than adequate. A small number ignored the rubric in **Section C** and attempted both **Question 8** and **Question 9**. There were not many misconceptions though some parts of the structured **Section A** questions were found to be challenging. It is necessary to read and study the questions carefully before framing an answer. In particular, any data given in the question will not gain credit if repeated as an answer. Noting the number of marks allocated to a section is a useful indication of the depth and scope of the answer required.

Comments on Specific Questions

Section A

Question 1

- (a) (i) This was very well answered with almost all correctly naming photosynthesis.
- (ii) Not many candidates scored highly. The most common response was to repeat the statements of the comparative solubility of starch and glucose, as given, but make no deductions. The fact that starch would not move out of the cell gained credit but reference to any osmotic effect was rare.
- (b) The 'lock and key' hypothesis of enzyme action is well known and understood, however, many answers did not give accurate details. The substrate was frequently referred to only as a substance, the 'complementary shape' idea was known but not always clearly expressed and the 'active site' not always given or said to be on the substrate. Those candidates who gave a general answer more often gained credit for products than for describing the breakdown of starch.
- (c) This question had disappointing responses and many candidates failed to score. The credit for root and respiration was most often awarded, though the connection between roots and oxygen was missed by most candidates. The energy requirement of active transport for ion uptake was given by the good candidates however, magnesium and/or nitrate were rarely selected for special comment and there was some confusion as to whether nitrates or nitrites would be absorbed. There were some candidates who described oxygen as being needed to change the ions into an absorbable state whilst some said it was needed for photosynthesis.

Question 2

- (a) The requirement to complete a table was challenging for some candidates who first had to select their criteria and then be concise and comparative in their answers. The various characteristics were all given; the size difference was sometimes too ambiguous to gain credit; reference to hyphae/mycelium was well subscribed; the presence of chitin in the fungal cell wall was frequent though knowledge of bacterial cell wall structure was limited. There was some difficulty in describing the bacterial nuclear material. Overall, candidates were not confident with this topic, some scored minimal credit and very few scored full credit.
- (b) This was well done and usually correct.
- (c) (i) This was also well done, although a few candidates gave meiosis.
- (ii) Many candidates gained credit for reference to only one parent being necessary, but since the question stated that the offspring would be 'genetically identical' the candidates found it difficult to explain how this would be achieved. Many stated that the offspring would have the same number of chromosomes.
- (d) Many candidates gave both word and correctly balanced equations. Others added energy and in doing so omitted either the carbon dioxide or water. Some odd products were occasionally given e.g. alcohol.
- (e) (i) Not many candidates made reference to enzymes. That an increase in temperature would increase the rate of a reaction was given in general terms but there were few references to digestion. A fair number of candidates gained credit for the increased numbers of microorganisms at higher temperatures.
- (ii) The majority of candidates scored partial credit. A frequent error was to give 'refrigerate the fruit' and 'keep in a cool place' as two *different* ideas. All the mark scheme options were seen, though only a few mentioned vacuum packing or drying the fruit. Keeping the fruit 'in a plastic bag' was allowed credit.

Question 3

- (a) Many candidates were able to answer this part correctly, although some thought that genes are found in the DNA.
- (b) (i) The instructions were followed, the correct letters were used to represent the alleles and the majority were able to construct an acceptable genetic diagram or Punnett square. A common error was to give the parental genotype and use this to represent gametes as well, instead of spacing out the letters to show the gametes on a separate line. The overall weakness was the inability to distinguish between phenotype and genotype and not to identify which of the offspring would suffer from cystic fibrosis.
- (ii) The ratio was more often given as 3:1 but many gave the genotype ratio of 1:2:1 and the minority of candidates correctly identified the cystic fibrosis connection.
- (c) Most of the candidates correctly named the duodenum, although there was some confusion with the ileum or large intestine.
- (d) In general this part was not well answered. Many of the candidates repeated the question and stated that the ducts were blocked but did not explain what effect this would have. The function of bile to emulsify fat was given and understood by most of the candidates. The importance of fat in particular was appreciated with regard to weight gain but fat digestion rarely went as far as the molecular level and the progress to absorption, assimilation and finally storage was usually lacking.

Question 4

- (a) Most of the candidates scored partial credit; some did not proceed after a poor start, or made no response. In most diagrams, the rays continued on a parallel course up to the cornea where convergence occurred. The lens did not always show convergence; the rays often passed through the ligaments and not the lens, or did not pass through the lens. The upper and lower rays sometimes behaved differently. The candidates knew that the rays should converge to produce a focussed image and most did so.
- (b) (i) Generally, this was well done, although many candidates answered 'contract' rather than 'constrict' and a few gave 'dilate'.
- (ii) The muscles responsible for the change were not often identified as the iris muscles and there was confusion with the ciliary muscles. However, most knew that the circular muscles contract to cause the change.
- (c) (i) Candidates usually scored credit for 'involuntary' or alternative wording. The speed of the reaction and that it was in response to a stimulus were also given by good candidates.
- (ii) This part question did not score well. Many candidates explained instead how reflex actions in general, were necessary and protective. Those who answered as required were often ambiguous about the effect, with damage being caused just to 'the eye' and not to the retina or light sensitive cells.

Question 5

- (a) There was an occasional confusion of names, especially labelling molars as premolars, otherwise this question was well answered.
- (b) (i) This was, again, competently answered although a few also included nitrogen in the list.
- (ii) Candidate responses were rather limited. There were not many who did not select person **E** as the one most at risk. There was little mention of the use of toothpaste; fluorine was given as a constituent but there were few references to its alkaline nature. It was well known that bacteria play a part in tooth decay but that they produce acid as a result of their action on carbohydrates (and the effect that this acid has on the teeth) was not always made clear.

Section B

Question 6

Candidates generally scored well in this question many gaining high credit in part (b).

- (a) Most candidates knew that the phloem transported manufactured food around the plant, however, that it was in solution received little mention. Some confused glucose with sucrose or sugar. There was the occasional confusion with the function of the xylem in weaker answers.
- (b) Candidates were all able to outline the route of the molecule of water from the soil to the atmosphere. Credit was lost by omission rather than error and most scored at least partial credit. The entry into the root hair by osmosis was usually given but there were not many references to cell membranes and in many cases the water molecule next appeared in the xylem without reference to its passage across the cortex. There were some candidates who believed that active transport is necessary to take up water from the soil. Transfer up the xylem was adequately described, with transpiration pull being the favoured option. In the leaf, water evaporated and exited via the stomata. However, the evaporation was sometimes described as occurring on the leaf surface rather than into the air spaces in the mesophyll, hence references to a water potential gradient and subsequent diffusion were not given.

Question 7

- (a) (i) The function of the urethra to carry urine was known and understood, and also that it transferred semen in the male. However, what happened in the female sometimes showed a lack of knowledge of the anatomy of the urino-genital system. The urethra was thought to function as the vagina and that menstrual blood flowed through it. There was some confusion of names, such as uterus/ureters and urine/urea.
- (ii) Most candidates gained high credit. If credit was lost it was due to a failure to provide a comparison, or give an adequate description.
- (b) Candidates were brief in their answers though most had a clear idea of what the surgical procedures involved (occasionally there was confusion with IUDs and Caesarean sections). The same idea was often put forward twice in a different way. The advantages usually scored minimal credit and the disadvantages scored slightly more credit. Almost all candidates stated that surgical methods resulted in a permanent solution, but only a few considered the possibility of reversal. There was little mention of the lack of protection against sexually transmitted diseases.

Section C

Question 8

This question was less popular than the alternative **Question 9** and the credit awarded was generally lower.

- (a) Candidates were able to score partial credit since most were aware of the need to be careful in the use of fertilisers, to prevent run off from fields into the water and somehow to prevent animal sewage or droppings from entering the water. However, it was not realistic to suggest that farms be sited well away from water. There were occasional references to the use of manure/compost in place of artificial fertilisers, to crop rotation and to biological pest control but the use of degradable pesticides, or genetically modified crops was not mentioned. There were some candidates who strayed from the theme and involved industrial wastes whilst others gave several examples of actions that farmers should avoid, e.g. not washing tools.
- (b) The requirement was for named examples to be linked to an explanation of the need to recycle them. Candidates were aware of which materials would cause pollution problems (paper, plastics, glass and metals) but it was the lack of a suitable explanation which often precluded the awarding of credit. The need to recycle paper in order to reduce the number of trees destroyed to make it was widely known, as was the non-biodegradability of plastic, but reduction in fossil fuel use and energy saving ideas were rare. Only a few candidates named a specific reuse of a product.

Question 9

Candidates gained high credit on this question; the topic was familiar.

- (a) The action of the diaphragm was usually correct, although sometimes candidates stated that the muscle contracted. The intercostal muscles were described to relax, in most cases, and the ribs or ribcage move down. The effect of these actions was not always accurately described, e.g. the 'lungs decreased in size' (rather than volume). Overall, the idea of decreasing the volume and thus increasing the pressure and therefore causing expiration of air was understood. If only one thing was missing, it was usually the reference to pressure.
- (b) Many candidates compared the change in the constituent gases of inhaled and exhaled air only in approximate terms, but those who chose to give figures did so with a high degree of accuracy. The main changes were always correct and any loss of credit was due to lack of an explanation for a change. The increased water vapour content in exhaled air was rarely linked to the saturated water vapour environment in the lungs, but to the water produced as a waste product of respiration. The higher temperature of exhaled air was rarely explained.

BIOLOGY

Paper 5090/22

Theory

Key Message

- Candidates are reminded that answers should be well structured and give precise answers to the questions.
- The whole paper should be read before questions are attempted to ensure that an answer to one question is not confused with another question elsewhere.
- Diagrams drawn by candidates usually gain credit only if they are annotated.

General comments

There was some work seen that was of an impressively high standard with the paper stretching the candidates across almost the entire range of credit. Only **Question 4(b)** proved to be beyond the scope of most candidates, but the very best were still able to produce relevant answers. Of the optional questions in **Section C, Question 8** was more popular than **Question 9** and only a very few candidates answered both **8** and **9**. However, those who answered **Question 9** did just as well, and often even better, than those who answered **Question 8**.

Comments on specific questions

Section A

Question 1

- (a) (i) This was well answered apart from the occasional confusion with conjunctiva and iris. Candidates appear to know the eye structure well.
- (ii) This was also well answered, especially if the answer was brief and did not try to explain how the pupil dilates.
- (iii) A significant minority of candidates omitted this part altogether. The **Z** was often placed on the optic nerve, the retina or the lens. As it is specifically the iris muscles that respond, a **Z** placed within the pupil was not accepted.
- (b) Candidates did not fully understand the impact of the detached retina on the optic nerve. Many suggested that 'images' were not transferred to the brain. Even when rods and cones were mentioned it was not in a relevant context. References to impulses not being able to pass along the optic nerve were comparatively few, and for many, it was thought that the person may simultaneously have blurred vision and also be unable to see at all. Often, answers were a description of how the eye works rather than a specific attempt to answer the question.
- (c) Responses were slightly better than for part (b) with many managing to identify the result as blurred vision. As often happens, lack of attention to precision lost credit. 'Cataracts stop light entering the eye' was a common inaccuracy.

Question 2

- (a) (i) Many candidates scored full credit here. A variety of fully acceptable mathematical routes were chosen, though there were several who found the calculation difficult.
- (ii) Candidates had a clear understanding that hard physical work required more energy and some went on to say how that energy would be achieved in the diet of the farmer.

- (b) Responses were generally excellent to this part.
- (c) (i) There was some confusion between rickets and scurvy. A wide range of adjectives were used to describe problems with the bones; most of them were appropriate apart from 'brittle'.
- (ii) Again, many candidates knew their material. Those that did not, attempted to compare the composition of the two cereals, often suggesting iron as the most likely significant component.

Question 3

- (a) This question tested knowledge of cell structure, but a significant number of candidates may not have read the question carefully enough. Where they are told that the outer line drawn on the diagram was the cell membrane, many then inaccurately drew their cell wall *inside* the membrane. Some excellent diagrams were seen.
- (b) This question was often very impressively answered, especially as it required candidates to use their knowledge coupled with logical deduction. Most candidates gained at least partial credit either for loss of contents and/or the lignification.
- (c) Responses to this question resulted in a good range of credit awarded, making the question a good discriminator. Some candidates lacked precision in their answers with no reference to the effect on leaf cells. Most did not acknowledge any xylem in the leaf. Many tried to link the lack of water with a failure to photosynthesise.

Question 4

- (a) Generally, candidates used the information provided to formulate an excellent answer with the majority being awarded high credit. However, some candidates confused seed dispersal with pollination.
- (b) (i) It was rare to see an answer that appreciated the fact that chromosomes lying in threes cannot have their chromosome number halved during gamete formation, and/or its effect on fertility.
- (ii) This was a little better answered than part (i). Credit was occasionally scored for mentioning asexual reproduction, which is more commonly found in plants – or the fact that chromosomes in threes would not significantly affect mitosis. Many responses referred to the $3n$ condition in animals rather than in plants as was asked.
- (c) Some candidates described mutation in gamete formation and provided excellent answers, but a significant minority went down the heterozygous/carrier route complete with a genetic diagram. Imprecise use of terminology with reference to genes and chromosomes often ended up with a loss of credit.

Question 5

- (a) (i) This question was well answered by most, although some failed to gain credit by omitting the units.
- (ii) This question was extremely competently answered with the most popular enzymes being amylase and protease. However, amylase was sometimes thought to be present and active in the stomach.
- (b) The majority of candidates were able to relate the higher temperature to denaturation and to the stopping of enzyme action. Some went on to talk about active sites and substrates not fitting. Very few candidates referred to the lock and key hypothesis and none considered any possible change in the substrate molecule.

Section B

Question 6

- (a) Some candidates did not seem to have sufficient knowledge of seeds whilst others were able to give answers but often went on to provide detail concerning fertilization and seed development. Some of this additional detail would have been better given in part (b), though it often was not repeated there.

Credit was awarded for an understanding of the terms plumule, radicle, cotyledon and, for a few, micropyle. A description of the embryo was very rarely given. Confusion between hilum and micropyle was also noted.

- (b) The most common scoring points were water uptake and enzyme action with a few references to oxygen and respiration. Many responses went well past the limits of the question and described seedlings photosynthesising and roots taking up water.

Question 7

- (a) This question was a good discriminator with some very competent answers but others found it difficult to accurately describe. Those that had learned their material and were confident with the use of technical terms commonly scored at least half credit. Few realised the importance of explaining that the width of the bars denotes the number of organisms in each trophic level. Many thought that pyramids referred only to individual species. Centres are reminded that diagrams drawn by candidates as part of their response usually gain credit only if they are annotated.

- (b) Answers given were often inadequately structured by candidates. Some overlooked the origin of the energy and that it would not be returned there. However, confident and knowledgeable candidates had little difficulty in scoring full credit for this part. References to the uses of energy were not as common as might have been expected and the misconception that organisms use energy for or in respiration, rather than respiration releasing the energy for use, was quite common. Energy is generally a difficult concept to understand and describe, and candidates are to be complimented on many fine answers.

Section C

Question 8

- (a) (i) This question produced well-learned answers. There was some confusion over whether it was the water molecules or whether it was the solution that was more concentrated. Candidates who referred to water potential avoided this problem. References to the fact that energy is not required were made only by the better candidates.

- (ii) This was well answered by candidates, but many gave the opinion that water is moved by active transport – even when they have already accurately described osmosis. Many said that a membrane is not required, and, of those who did mention one, few said that it needed to be living. More precision was required when referring to a suitable example. Root hairs are not an example until there is a statement about how they are involved in the process.

- (b) This commonly scored the full credit available. All possible scoring points appeared relatively frequently – even the reference to the fact that there is a continuous supply of blood to the alveoli, though continual renewal of oxygen was less common.

Question 9

- (a) Of those that chose to answer this option, the scores were good but one of the important points, i.e. a reference to metabolic waste products, was usually missing. Several candidates gave an answer that described only one excretory route – usually via the kidneys, where they gave lengthy detail on the functioning of the kidney that scored only a limited amount of credit.

- (b) This was well answered and usually gained at least half credit – even including those candidates who, in **Question 4(a)** had described defecation as excretion.

BIOLOGY

Paper 5090/31
Practical Test

Key message

Candidates should be prepared to display not only their biological knowledge but also their knowledge and experience of practical work, together with the use and application of practical skills and techniques.

General comments

The questions tested candidates' abilities to follow instructions, make and record accurate observations using written and drawing skills, in addition to taking measurements and performing simple calculations. The use of techniques and apparatus in experiments and the ability to evaluate and apply data resulting from an investigation were also tested. Candidates appeared to have more than sufficient time to complete the paper.

Comments on specific questions

Question 1

- (a) This exercise was well executed with initial readings being similar and final readings generally showing an increase in height. The best answers also included positive (+) signs confirming the increase.
- (b)(i) The best answers showed that **S1**, unlike **S2**, increased in height with many bubbles occurring on the surface of **S1**. A number of candidates incorrectly described the opposite to these observations.
- (ii) The majority of candidates understood that aerobic / anaerobic respiration was involved with gases, such as carbon dioxide being released inside the dough, trapped, and causing the dough to rise. The appropriate equation was occasionally included.
- (c) Good answers suggested incubating the same amount of mixture over a range of at least three suitable temperatures, with the height of each being carefully measured before and after a 30 minute period. The best candidates appreciated the need to repeat the experiments in order to increase reliability and also to calculate mean values and undertake controls without yeast. Less specific and incorrect responses omitted taking height measurements and focused on the effect of varying temperatures on the denaturing or otherwise of enzyme action in yeast.

Question 2

- (a) The majority of candidates produced a large and well proportioned drawing of **S3** with clear outlines of least three leaflets, comprising the leaf blade / lamina with venation and a petiole or leaf stalk. Serrated margins on the leaflets, each with a distinct midrib and venation, were often neatly drawn. Labelling of the lamina / leaf blade, midrib / veins and petiole / leaf stalk was excellent whereas the bud / stipule at the base of the leaf was only occasionally included.

- (b) Responses were generally very good as the majority of candidates fully understood how **S3** was suited to its functions. The flat/thin lamina with a large surface area was linked with light absorption/penetration and gaseous exchange and the presence of chlorophyll was linked with light absorption and photosynthesis. Many candidates were also aware of the relationship between transport of water and nutrients and the attachment of leaflets to the stem. Weaker answers overlooked these functions by focusing, for example, on the serrated margins protecting the leaf from insects.
- (c) Most candidates made correct reference to the leaf closing around/over the insect or that the pointed/spine-like structures on leaf margins formed a trap. Weaker answers referred to these structures as 'stabbing' or 'squashing' the insect or that the leaf provided a platform for insects to obtain nectar.
- (d)(i)(ii) The best answers showed that nitrate(s) / nitrogen-containing compound(s) / phosphate(s) would be used in producing enzymes/named proteins/nucleic acids/DNA/cell membranes/new protoplasm for growth or chlorophyll. Weaker answers referred to the ion as calcium, carbon, magnesium, starch or cellulose with corresponding incorrect usages.

Question 3

- (a)(i)(ii) The best answers included the correct identification and drawing of the stamen/anther/pollen sac and also the stigma or stigmatic surface. Weaker responses confused the anther for the stigma, and vice versa, or the style for the stigma.
- (b)(i) Responses were generally excellent with relevant replies including preparing/cutting or grinding the tissue, adding Benedict's solution, heating in a water bath and the expected colour change given if positive.
- (ii) Many candidates gave the correct colour changes as yellow/orange/red, with the colour green indicating traces of reducing sugar. A substantial number of answers on the other hand recorded 'no change' or that the colour remained blue.
- (c)(i) The majority of candidates successfully measured and tabulated known lengths/mm of pollen tubes, grown from pollen grains, at 2 hourly intervals over 10 hours.
- (ii) The best answers showed the correct orientation of the x-axis (time in hours) and y-axis (length in mm) with clear plots (plus the zero included) neatly connected or drawn as a line of best fit. Weaker responses reversed the axes and did not link the plots correctly or include the zero on the axes.
- (iii) Most candidates correctly showed that rapid growth of the pollen tubes occurred within the first two hours, and then became slower and more constant over the 10 hour period. Weaker answers stated only that such growth increased with time.
- (d) Very few answers suggested that a chemical/hormone from the ovule sac was responsible for pollen tubes growing through the plant tissues towards the ovule. Weaker responses referred to the absorption of nutrients from the tissues to enhance growth.

BIOLOGY

Paper 5090/32
Practical Test

Key message

Candidates should be prepared to display not only their biological knowledge but also their knowledge and experience of practical work, together with the use and application of practical skills and techniques.

General comments

The objectives of this paper were to test biological knowledge and experience of practical work, together with the use and application of practical skills and techniques. The questions tested candidates' abilities to follow instructions, make and record accurate observations using written and drawing skills, in addition to taking measurements and performing simple calculations. The use of techniques and apparatus in experiments and the ability to evaluate and apply data resulting from an investigation were also tested. Candidates appeared to have more than sufficient time to complete the paper.

Comments on specific questions

Question 1

- (a) This exercise was well executed with initial readings being similar and final readings generally showing an increase in height. The best answers also included positive (+) signs confirming the increase.
- (b)(i) The best answers showed that **S1**, unlike **S2**, increased in height with many bubbles occurring on the surface of **S1**. A number of candidates incorrectly described the opposite to these observations.
- (ii) The majority of candidates understood that aerobic / anaerobic respiration was involved with gases, such as carbon dioxide being released inside the dough, trapped, and causing the dough to rise. The appropriate equation was occasionally included.
- (c) Good answers suggested incubating the same amount of mixture over a range of at least three suitable temperatures, with the height of each being carefully measured before and after a 30 minute period. The best candidates appreciated the need to repeat the experiments in order to increase reliability and also to calculate mean values and undertake controls without yeast. Less specific and incorrect responses omitted taking height measurements and focused on the effect of varying temperatures on the denaturing or otherwise of enzyme action in yeast.

Question 2

- (a) The majority of candidates produced a large and well proportioned drawing of **S3** with clear outlines of least three leaflets, comprising the leaf blade/lamina with venation and a petiole or leaf stalk. Serrated margins on the leaflets, each with a distinct midrib and venation, were often neatly drawn. Labelling of the lamina/leaf blade, midrib/veins and petiole/leaf stalk was excellent whereas the bud/stipule at the base of the leaf was only occasionally included.

- (b) Responses were generally very good as the majority of candidates fully understood how **S3** was suited to its functions. The flat/thin lamina with a large surface area was linked with light absorption/penetration and gaseous exchange and the presence of chlorophyll was linked with light absorption and photosynthesis. Many candidates were also aware of the relationship between transport of water and nutrients and the attachment of leaflets to the stem. Weaker answers overlooked these functions by focusing, for example, on the serrated margins protecting the leaf from insects.
- (c) Most candidates made correct reference to the leaf closing around/over the insect or that the pointed/spine-like structures on leaf margins formed a trap. Weaker answers referred to these structures as 'stabbing' or 'squashing' the insect or that the leaf provided a platform for insects to obtain nectar.
- (d)(i)(ii) The best answers showed that nitrate(s) / nitrogen-containing compound(s) / phosphate(s) would be used in producing enzymes/named proteins/nucleic acids/DNA/cell membranes/new protoplasm for growth or chlorophyll. Weaker answers referred to the ion as calcium, carbon, magnesium, starch or cellulose with corresponding incorrect usages.

Question 3

- (a)(i)(ii) The best answers included the correct identification and drawing of the stamen/anther/pollen sac and also the stigma or stigmatic surface. Weaker responses confused the anther for the stigma, and vice versa, or the style for the stigma.
- (b)(i) Responses were generally excellent with relevant replies including preparing/cutting or grinding the tissue, adding Benedict's solution, heating in a water bath and the expected colour change given if positive.
- (ii) Many candidates gave the correct colour changes as yellow/orange/red, with the colour green indicating traces of reducing sugar. A substantial number of answers on the other hand recorded 'no change' or that the colour remained blue.
- (c)(i) The majority of candidates successfully measured and tabulated known lengths/mm of pollen tubes, grown from pollen grains, at 2 hourly intervals over 10 hours.
- (ii) The best answers showed the correct orientation of the x-axis (time in hours) and y-axis (length in mm) with clear plots (plus the zero included) neatly connected or drawn as a line of best fit. Weaker responses reversed the axes and did not link the plots correctly or include the zero on the axes.
- (iii) Most candidates correctly showed that rapid growth of the pollen tubes occurred within the first two hours, and then became slower and more constant over the 10 hour period. Weaker answers stated only that such growth increased with time.
- (d) Very few answers suggested that a chemical/hormone from the ovule sac was responsible for pollen tubes growing through the plant tissues towards the ovule. Weaker responses referred to the absorption of nutrients from the tissues to enhance growth.

BIOLOGY

Paper 5090/61
Alternative to Practical

Key Messages

This paper tests experience of practical work and the ability to use practical skills such as observation, drawing, data handling, interpretation of results and experimental design. Candidates should be familiar with biological tests such as food tests.

It is important that all the information provided with each question is read thoroughly, including introductory material, such as the details of how an investigation has been carried out. That information will be necessary for answering the questions that follow.

The questions themselves and any tables provided should also be read carefully so that, e.g. the correct units are used for measurements.

General comments

The amount of credit awarded overall covered the whole range available.

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

It appears that candidates had sufficient time to complete the paper.

In general, candidates were more confident in making responses involving knowledge than in application of that knowledge to unfamiliar practical situations.

Comments on specific questions

Question 1

- (a) This question required candidates to read a selection of measurements from two measuring cylinders. The vast majority correctly identified the initial measurement as 20 cm³, although a number misread the final volumes. The changes were generally calculated correctly, resulting in the majority of candidates scoring high credit on this question.
- (b)(i) The credit available indicated that two observations were expected. The majority of candidates recognised that the volume of **A** had risen more than **B** with most supporting this observation with figures from the diagram. Fewer candidates noted the difference in quantity or spacing of the bubbles.

Possible explanations for the causes of these differences were not asked for here.

- (ii) This part required an explanation for the observations previously noted. Better candidates answered this well with many gaining full credit for stating that aerobic/anaerobic respiration in yeast produces carbon dioxide. The majority of candidates correctly identified the gas produced as carbon dioxide, although few related the production of this gas to the rise seen in Dough **A**.

Some wrote in general terms about enzyme activity and a few candidates attributed the respiration to the wrong organism, e.g. bacteria.

Some candidates restated observations given in **(b)(i)** but did not suggest explanations for those observations and therefore gained no credit.

Some candidates omitted this question entirely.

- (c)** This was a more demanding question that the better candidates answered well.

These candidates took dough **A** and divided it into several equal portions. The question required designing an experiment that would investigate the effect of temperature on the activity of the yeast in the dough and many candidates suggested using different temperatures. Better answers included some suggestions of suitable temperatures to be used within a sensible range. Some candidates tried to subject the dough to a constantly changing temperature, for which no credit was gained.

The concept of a fair test is clearly understood by many candidates and most suggested leaving the dough for 30 minutes (as stated in the information provided about the original experiment), before measuring the change in volume.

Some candidates did not correctly address the question and wrote generally about, e.g. how temperature affects enzyme activity. A few chose to omit this question.

Question 2

- (a)** Despite being informed that Fig. 2.1 showed the upper surface of **one** green leaf, when asked to draw the leaf, a significant number of candidates only drew 1 leaflet. The best drawings showed all 5 leaflets in proportion and were drawn with clean lines and to a good size.

This question also tested observation skills and the better drawings showed leaflets with clearly serrated margins and a realistically drawn midrib with veins, on at least one of the leaflets.

The question asked for a labelled drawing, though some candidates did not attempt to label their drawing. Of those that did, most labelled the midrib and veins and better candidates included the blade/lamina. Few candidates labelled the petiole.

There were a few candidates who drew objects not shown in Fig. 2.1, e.g. cross section of a leaf as viewed under a microscope.

- (b)** The majority of candidates identified photosynthesis as a function of the leaf. Better candidates went on to identify one or more features of the leaf and related these features to its specific function, e.g. the presence of chlorophyll for the absorption of light energy.

- (c) (i)** Many candidates were able to suggest that the leaf was curved and that the spiky edges were designed to trap the insect when the leaf closed up. Some suggested that the leaf contained a sticky substance that prevented the insect from escaping, but since there was no evidence in Fig. 2.2 to support this idea, no credit could be given.

- (ii)** A significant number of candidates incorrectly suggested the element nitrogen as an example of such an ion. Most of the candidates giving creditworthy answers named 'nitrate', with a very small minority suggesting 'phosphate'.

- (iii)** Many candidates scored on this question with a general answer, i.e. that the ions could be used by the plant for growth. The other more specific suggestion 'to make protein' was also commonly seen. This question was well answered.

Question 3

(a) (i) Most candidates were able to identify and label the anther on Fig. 3.1.

(ii) Many candidates successfully labelled the stigma.

(b) Many candidates had obvious experience of the test for reducing sugar and were able to describe the test and state the expected results correctly. A few misinterpreted the question and incorrectly used the pollen grains as the tissue being tested. The majority of candidates were able to name Benedict's solution as the reagent used. Some candidates did not score full credit as they failed to suggest heating the Benedict's solution during the test.

The question asked for a description of how the test might be safely carried out. A number of candidates did not suggest any relevant safety feature, e.g. using a water bath to heat the Benedict's solution or using tongs/gloves.

(c) (i) This was well answered by most candidates showing the ability to read and follow instructions, measure accurately and record data appropriately in a table.

There were some candidates who did not notice that the measurements were required in millimetres and used centimetres instead. Some candidates did not read the instructions carefully, nor appreciate the significance of the first entry in Table 3.1 that had already been completed as an example. As a result some went on to include the pollen grain in their measurements, instead of just the pollen tube as instructed.

(ii) The ability to take the results of an investigation and to present them in a different way was tested by asking for the construction of a graph from the figures in Table 3.1.

Most candidates constructed a graph; only a small number attempted to draw a bar chart instead of a graph. Most correctly chose the x -axis for the known quantity, time, and the y -axis for the quantity being measured, length. Not all candidates fully labelled the axes, usually omitting units of measurement.

A few candidates produced a non-linear scale on the y -axis, using the lengths recorded in Table 3.1. These could not be credited.

Most candidates were able to plot the points accurately and clearly, although some chose to omit the first plot (0, 0).

If candidates are using a dot (.) rather than a cross (x) for a plotting point, they should ensure that it is still clearly visible when the points are joined up.

Most candidates joined their plots with straight lines or a line of best fit.

(iii) This question was not well answered by candidates.

Most candidates described the length of the pollen tube as increasing proportionally with time, but omitted to note that growth was faster at the beginning. Very few candidates stated that the growth rate changed in any way.

(d) A significant number of candidates did not attempt this question.

Some misinterpreted the question and answered in terms of enzymes digesting through the style, which, while not incorrect, did not answer the question. Others restated the question by saying that the pollen tube grows down the style towards the ovule in the ovary.

Better candidates suggested that there might be a connection to gravity or towards a chemical in the ovule. A few candidates suggested that light might be a factor, but incorrectly stated that the pollen tube grows towards the light.

BIOLOGY

Paper 5090/62
Alternative to Practical

Key messages

This paper tests experience of practical work and the ability to use practical skills such as observation, drawing, data handling, interpretation of results and experimental design.

Candidates should also be familiar with biological tests such as food tests.

It is important that all the information provided with each question is read, including introductory material, such as the details of how an investigation has been carried out. That information may well be necessary for answering the questions that follow.

The questions themselves and any tables provided should be read carefully so that, e.g. the right units are used for measurements and observations are recorded in appropriate places.

The meanings of terms such as accuracy and reliability should be understood.

The correct spelling of meiosis is required to ensure that it has not been confused with mitosis.

General comments

The amount of credit awarded overall covered the whole range available.

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

It appears that candidates had sufficient time to complete the paper.

In general, candidates were more confident in making responses involving knowledge than in application of that knowledge to unfamiliar practical situations.

Comments on specific questions

Question 1

This question related to some leaves grown in sunlight and some grown in shade. A few candidates equated 'shade' with 'total darkness' which led to incorrect answers in terms of photosynthesis not being able to take place.

(a) This was well answered by almost all candidates showing ability to read and follow instructions, measure accurately and record data appropriately in a table.

There were candidates who did not notice that the measurements were required in millimetres and used centimetres instead.

A small number of candidates recorded their measurements in the wrong columns.

(b) (i) The vast majority of candidates knew what a mean was and were able to calculate the two means correctly.

- (ii) The available credit indicated that two suggestions were expected.

Many candidates correctly suggested in some way that light seems to slow down the growth of the leaves.

Fewer candidates commented on the differences in the colours of the leaves – those in sunlight being lighter than those in shade.

Possible explanations for the causes of these differences were not asked for here.

- (iii) This was a more demanding question which the better candidates answered well.

Having thought through the original investigation, they were able to suggest that the investigation could be extended by repeating it using a larger sample of leaves, or using leaves from other species of plant, or using a variety of different light intensities.

Others suggested extending it by measuring and/or comparing another aspect of the leaves' growth, e.g. thickness, petiole length, mass, surface area, chlorophyll or starch content. All these suggestions were based on the original method.

Suggestions not based on discovering more of the effect of light on the growth of leaves did not gain credit, e.g. those involving changing temperature or carbon dioxide availability; neither did suggestions not involving leaves, e.g. growth of seeds.

Some candidates misinterpreted the question and wrote generally about, e.g. how to test for starch which was not relevant to the question.

- (c) (i) This question tested knowledge and observation of the different types of cell that may be found in a leaf and was well answered by many candidates. A few candidates recorded differences that were not observable in Fig. 1.2; only observable features were asked for.

The majority of candidates were able to identify palisade cells but not all recognised that the leaf grown in sunlight had two layers of these. Some candidates correctly observed that the shape of the palisade cells was more varied in the leaf grown in shade than in the leaf grown in sunlight. Care must be taken not to give the impression that these plant cells are able to change their shape as some animal cells are.

A few candidates misunderstood the word 'thickness' and compared the width of the leaves instead. Some compared the thickness of the cuticle rather than the leaf as asked.

Some candidates recorded that the leaf in sunlight had more chloroplasts. In fact, there were more in the leaf in shade, where they were more densely packed in the cells. A few candidates identified chloroplasts in epidermal cells rather than guard cells which is incorrect.

Not all candidates were sure what air spaces were but many observed that there were more in the leaf grown in sunlight than in the one grown in shade.

- (ii) This question was not well answered. Many candidates did not show the fundamental relationship between light and photosynthesis. Some answered in terms of transpiration. However, the better candidates were able, e.g. to relate the higher numbers of chloroplasts in the leaf grown in shade to the necessity for absorbing all available light for photosynthesis and the higher number of air spaces to increased gaseous exchange in the leaf grown in sunlight.

Question 2

- (a) (i) Most candidates were able to complete Table 2.1 satisfactorily. A few miscalculated, or did not know how to calculate, the missing values.

- (ii) The difference between 'accuracy' and 'reliability' was often misunderstood. Ten readings were taken to ensure the reliability of the measuring process. Any anomalous readings would have been shown up and could have been checked. The 10 readings could also be used to calculate a mean value.

- (iii) Although the majority of candidates were able to complete this part, there were those who misread the information even though they had completed the table correctly or who had not read the introduction to the question carefully in order to understand the aim of the investigation.
- (iv) Correct answers were given either in terms of the comparative numbers of sensory receptors present in the two areas or related to the differing functions of those areas. Many candidates did not appreciate that the skin contains sensory receptors and answered in terms of neurones and nerves, or of thickness of the skin.

Question 3

- (a) (i) Half credit was awarded for a clear continuous outer line showing the shape of the granule and of good size. The remaining credit was awarded for indicating that the granule was composed of layers.

There were a few candidates who drew objects not shown in Fig. 3.1.

- (ii) Many candidates were able to follow instructions and calculate the magnification of their drawing correctly thereby scoring full credit.

Some failed either to draw a line as instructed to indicate where they had measured, measured inaccurately or failed to include units in their measurements.

Others used an incorrect formula to calculate their magnification.

Most frequently, the fact that the granule in the Fig. 3.1 was already at a magnification of $\times 500$ was not taken into account.

A few candidates included mm or cm in their final magnification.

- (b) (i) Many candidates had obvious experience of the solutions used to test for food materials and were able to state their colours correctly. A few lost credit because they recorded the colours that would be expected for positive results, i.e. at the end of the test instead of before being used in the test.

The biuret reagent was the least familiar solution to candidates.

- (ii) Nearly all candidates identified the presence of starch correctly although a few wrote that iodine was present.

Most identified the presence of reducing sugar; some stated only sugar and therefore were not awarded credit.

Most identified the presence of protein or peptides.

A good number of candidates recognised that the green colour of the Benedict's test and/or the pale purple colour of the biuret test indicated that small quantities of either reducing sugar or protein were present.

Question 4

- (a) (i) Most candidates were able to identify a chromosome on Fig. 4.1.

- (ii) Many candidates successfully labelled cytoplasm.

- (b) (i) Meiosis or reduction division was correctly stated by many candidates. The spelling of meiosis must be correct to ensure that there is no confusion with mitosis.

- (ii) Many candidates knew the term haploid and that such nuclei/cells have only half of the full number of chromosomes present in diploid cells. Some wrote of chromosomes being halved instead of the number of chromosomes being halved. A number of incorrect spellings were seen, e.g. hyploid and daploid.

- (c) Most candidates were able to correctly identify a part of a plant where meiosis occurs.