BIOLOGY

Paper 9700/01

Multiple Choice

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

General comments

The mean score was 27.5 (68.75%) and there was a good spread of scores, the standard deviation being 6.5. Eleven questions were answered correctly by 80% or more of candidates – **Questions 3**, **4**, **5**, **9**, **17**, **24**, **27**, **28**, **33**, **37**, **and 39**. Only three questions were difficult; 40% or fewer candidates answered **Questions 1**, **26**, and **32** correctly.

Comments on specific questions

Question 1

Many candidates are unable to understand how a graticule and stage micrometer are used to measure cell organelles.

Question 2

Many candidates are unaware that in addition to being the site of protein synthesis, the rough endoplasmic reticulum also transports proteins throughout the cell.

Question 3

Weaker candidates were unable to identify structure **Y** as a starch grain and also thought that the vacuole contains air.

Question 6

Only **B** is true for cellulose, but not true for protein. Some better candidates as well as weaker candidates were under the impression that cellulose may be a structural component, but were unaware of the role of protein as a structural component.

Question 7

Many weaker candidates thought that Benedict's solution breaks glycosidic bonds.

Question 8

Some candidates poorly understand the difference between tertiary and quaternary structure.

Question 11

Only the more able candidates were able to determine the correct response. The mineral nutrients are dissolved in the water and as the frozen lake warms, water at 4°C sinks and cooler water rises. Therefore nutrients are brought to the surface.

Question 13

A surprising number of candidates selected option **B**, demonstrating a lack of understanding of the effects of competitive inhibitors.

Question 14

Multiple choice questions are designed to test understanding and therefore it is perfectly valid to have one option with two R's and a Q along with other options containing P, Q and R. Although cholesterol (R) is important for the mechanical stability of membranes, it does not perform this function by forming hydrogen bonds with water.

Question 15

Weaker candidates continue to have difficulty with the concept of more and less negative water potentials.

Question 19

Only the more able candidates realised that each chromosome contains one DNA molecule. During interphase the DNA replicates to produce 16 molecules of DNA.

Question 20

The less able candidates incorrectly thought that DNA polymerase was used to synthesise mRNA.

Question 21

Only the more able candidates knew that **C** was the correct response.

Question 22

A number of candidates thought that codons are found on tRNA.

Question 26

Many candidates do not realise that water evaporates from the mesophyll cell walls. It then diffuses down a water potential gradient from the air spaces through the stomata to the atmosphere.

Question 29

Many less able candidates poorly understand the concept of partial pressure and continue to believe that the proportion of oxygen in the air decreases at altitude.

Question 32

Although the data for number of smokers as a percentage of the 35–59 age group drops from approximately 80% to approximately 20%, this does not represent the **number** of men, as this is unknown.

Question 34

Although tetracycline is being used to treat drug resistant malaria, it is taken in combination with drugs such as mefloquine. Tetracycline tends to be slow acting as it mainly works by inhibiting action of the 30S ribosome of prokaryotes. Additionally, tetracycline cannot be taken by children under 8 years old or pregnant mothers. Therefore treatment of malaria by antibiotics alone would not be effective.

Question 35

The most able candidates knew that **C** was the correct response.

Question 38

A surprising number of candidates thought there were only four trophic levels present, not five.

Question 40

The role of nitrifying bacteria in converting ammonia to nitrogen compounds in the soil was poorly known.

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General comments

There were many encouraging responses to all 6 questions from the well prepared candidates, though disappointingly there were some low scores from some candidates, and even the most able candidates occasionally had some difficulty with **Questions 1(b), 2(d), 3(c)**, **4(c)** and **4(d)**, often where they were required to produce extended prose in answer to a question.

As in previous sessions, candidates continue to lose marks by not using their biological knowledge to answer the actual question set. For example, in **Question 2(b)**, candidates were asked to name three structures that are present in the cells in the cortex of the root of a legume that are not present in bacterial cells. Structural differences based on a comparison between eukaryotic and prokaryotic cells were required here, but many weaker candidates interpreted structures as tissues or did not read the question carefully and missed "in cells" and so referred to parenchyma, collenchyma and endodermis, with others, more inappropriately, referring to xylem and phloem.

Again, in answer to **Questions 3(c)** and **4(c)**, candidates were asked to "use information in the two graphs given" in **Fig. 3.3** and **Fig. 4.2** respectively. In analysing data and describing changes shown in graphical form, candidates are expected to be able to quote accurate figures read from the grids to support qualitative statements. Many candidates were not able to do this and often had difficulty with the term 'discuss' in **3(c)** and 'describe' in **4(c)**.

Other candidates were far too imprecise in their answers; for example, in **Question 6(b)**, where candidates were asked to complete the table to show what was happening to parts of the left side of the heart at each of the stages **H, J** and **K**, as shown in **Fig. 6.1**. Candidates often mentioned that a particular chamber – be it the left atrium or left ventricle – relaxed or contracted with no indication as to where blood is received from or forced into respectively.

Candidates should be aware of the significance of the use of bold type face in questions, for example, in **1(a)** in which candidates were instructed to use only the information given, and in **6(b)** where candidates were asked to complete the table to show what was happening to the left side of the heart.

Candidates should try and write within the lines of the paper and take note of the mark allocation. Many were using all the available blank pages and spaces at the sides and bottoms of pages to elaborate on their answers as, for example, in **4(d)**.

There were sufficient marking points to allow candidates to demonstrate their knowledge and understanding and differentiation was evident. Most candidates appeared to have had sufficient time. There were no common misinterpretations of the rubric, though **1(b)** and **2(d)** caused problems for several candidates. A good proportion of the lower scoring candidates could improve their performance if they prepared and revised in depth and used good scientific terminology.

Comments on Individual Questions

Question 1

There were some high scoring answers to this question, though many candidates failed to gain more than a few marks.

(a)   The vast majority of candidates were able to match each organism with the most appropriate term from the list given stating **H, C, G** and **B**. Some confused **C** community with **B** population in matching "all the organisms in the mangrove swamp" and "all the hermit crabs in the swamp". Several candidates linked **D** niche with mangrove trees rather than **H** producer. A significant number of candidates gave multiple answers for each organism statement in the question or gave wildly inaccurate letters in the boxes suggesting this was guess work.

(b)   In explaining how the cells in the roots of mangrove trees obtain sufficient oxygen, many candidates used the term diffusion without reference to a concentration gradient. Many did not indicate that oxygen was absorbed from the air. Few mentioned the oxygen passing through the air spaces between the cells of the pneumatophores. Leaves and stomata were frequently mentioned. Oxygen was thought by many to come entirely from the trees own photosynthesis or from bacteria in the mud that could release oxygen. Whilst many mentioned osmosis from the soil in explaining the uptake of water, not all candidates referred to the existence of a water potential gradient due to the root cell vacuoles having salts to lower the water potential / solute potential. Where candidates referred to changes in solute potential, virtually all of them considered that increasing the concentration of solutes in the root cells produced a higher, rather than a lower, solute potential. Several candidates indicated that salty sea water had a lower water potential but water could still enter by osmosis. Weaker candidates had water being absorbed, by active transport from sea water or from rain water being caught by leaves. Several candidates stated that xeromorphic characteristics were important in water uptake. Some candidates bypassed the entry into the roots altogether and wrote at length about movement up the xylem to the rest of the tree. Only exceptionally was reference made to water from the soil entering root hairs / epidermal cells.

Question 2

There were some good answers to this question with parts **(c)** and **(d)** being the most difficult to answer correctly.

(a)   Able candidates in naming structures that are present in the cortex of the root that are not present in bacterial cells made reference to the nucleus, endoplasmic reticulum, golgi, mitochondria and a cellulose wall amongst other correct responses. Weaker candidates made unqualified reference to DNA, cell wall and ribosomes, i.e. no reference to linear, cellulose and larger / 80S respectively. Some candidates stated that chloroplasts would be present in the root cells of the cortex. As referred to earlier a significant number of candidates listed plant tissues.

(b)   In explaining the advantages of studying cell structure with an electron microscope rather than with a light microscope, excellent responses made reference to the higher resolution with more detail seen at the same magnification / can see two points that are close together. Others mentioned internal detail being seen of structures just visible with the light microscope, e.g. mitochondria, or the viewing of structures such as ribosomes and membranes not visible with the light microscope. Only occasionally did candidates link the higher resolution with a shorter wavelength. Weaker candidates gave vague answers relating to clarity and seeing more detail, whilst some candidates thought that resolution was the ability to distinguish between two objects without reference to their proximity.

(c)   In describing the role of *Rhizobium* in the root nodule, not all candidates appreciated the bacterium's role in nitrogen fixation with the conversion of nitrogen to ammonia and then to amino acids. Several candidates referred incorrectly to nitrification and denitrification. Good candidates made further reference to symbiosis / mutualism with the amino acids being exported to the cells of the legume in return for carbohydrate. Few made reference to *Rhizobium* helping legumes to survive in soils poor in nitrates. Weak candidates were not familiar with the bacterium *Rhizobium* and its role in the nitrogen cycle, often referring to nitrogen being converted directly to nitrates to be taken up by the roots from the soil. Only occasionally was mention made of the need by *Rhizobium* for ATP / H^+ / anaerobic conditions.

(d)   Even able candidates had some difficulty in suggesting why the base sequence in the gene that codes for the β polypeptide of mammalian haemoglobin is similar to that for leghaemoglobin. Only the better candidates made clear reference to both having the same function of combining with oxygen and therefore requiring the same structure, in terms of the primary sequence of amino acids or similar tertiary structure. Some candidates referred to the amino acid composition of the polypeptides rather than the amino acid sequence. Few candidates suggested a common ancestry, both legumes and mammals are eukaryotes and would share some of the same genes. There were several inappropriate references to bases, genes, genotypes and phenotypes.

Question 3

There were some good, clear and factually accurate answers to this question, though some candidates found **(c)** difficult.

(a)   The vast majority of candidates correctly used label lines and the letters **A** to **C** to identify cilia, nuclear membrane / envelope and the endoplasmic reticulum in **Fig. 3.1**. Marks were lost by a few candidates for imprecise label lines for **B** and **C**, which resulted in the labelling of the chromatin and cytosol. Several candidates ignored instructions using words rather than letters with their label lines. A few candidates labelled **Fig. 3.2**, usually in addition to **Fig. 3.1**. Occasionally candidates inaccurately labelled a basal body as **A** rather than a cilium or labelled the mitochondrion as **B**.

(b)   Candidates were required to explain why the lungs are at an increased risk of infection when the bronchial epithelium is damaged as shown in **Fig. 3.2**. The very best candidates made reference to the absence of cilia, with pathogens not carried away as the mucus cannot be moved, the pathogens remaining in the airways, reproducing and causing infection. Weaker candidates referred to excessive mucus damaging the cilia, cilia trapping bacteria, mentioned dust particles rather than pathogens in their answers or gave misplaced information on asthma and emphysema. Several candidates failed to mention mucus in their answer, and many had cilia moving bacteria directly. A significant number of candidates thought that goblet cells stopped producing mucus. A number used poor terminology, for example, 'germs'.

(c)   Candidates were expected to use the information in **Fig. 3.3** to assess the student's conclusion that there was no link between cigarette consumption and deaths from COPD (chronic obstructive pulmonary disease). Many candidates indicated that the graph showed that there was no link between cigarette consumption and number of deaths but failed to support this with use of comparative figures. Where figures were given they were often incorrect – either by reading off the graph inaccurately or misinterpreting the x axis and multiplying by 100 000. Occasionally candidates indicated that other factors might contribute to developing COPD or that other factors involved in smoking may be more important than increased cigarette consumption, but did not always qualify such statements e.g. air pollution and number of years smoked respectively. Some candidates failed to discuss the student's conclusion using the information in **Fig. 3.3** and gave instead an account of health problems associated with smoking.

Question 4

A sound response by some candidates though **(c)** sometimes caused difficulty. This was however a low scoring question for many candidates.

(a)   A pleasing number of candidates were able to sequentially describe what happens to the chromosomes during mitosis between the stages **D** and **E** shown in **Fig. 4.1**. Many at **D** (metaphase) made reference to the orientation of the chromosomes on the equatorial plate, each chromosome of two (sister) chromatids attached to the spindle at the centromere. In **E** (anaphase) such candidates referred to the breaking of the centromeres with movement of chromatids to opposite poles by means of the microtubules (of the spindle), the centromeres leading the way. Weaker candidates still insist on referring to the centre / middle of the cell, centromeres splitting and chromosomes moving to the ends of the cell rather than referring to the equator, centromeres dividing / duplicating and opposite poles respectively. Some candidates described the two stages, **D** and **E**, shown in **Fig. 4.1**, but ignored what happens between these two stages. A significant number of candidates started their response with DNA replication in interphase and as a consequence had little space left for the relevant points once they began to answer the question set. Several failed to note that it was a plant cell from a root tip and wrote at length about centrioles forming spindles. Poor responses often involved the pairing of homologous chromosomes.

(b) In describing the events that occur within a cell after stage **E** to allow formation of two cells, able candidates gave detail of uncoiling chromosomes at the poles, the reformation of nuclear membranes, the formation of new cell membranes and cell wall from vesicles, leading to cytokinesis. Weaker responses referred to chromatids coiling and the cell membrane breaking, or inappropriately qualified cytokinesis by referring to the constriction of the cytoplasm, the cell in question being a plant cell in which a cell plate and cell wall would be laid down between the two nuclei.

(c) Candidates were asked to use the information in **Fig. 4.2** to describe how the mitotic index changes along the length of the root. Few stated that the mitotic index decreases from 0.11 to 0.016, as distance from the tip increases from 0.1 to 1.9 mm. The answers of many candidates merely listed the change in the mitotic index between two distances along the root tip, indicating if there had been a decrease or an increase in the index. Others just quoted the various distances from the root tip and gave the mitotic index at each point quoted. Few candidates gave comparative statements describing the changes in the mitotic index e.g. steep decrease from 0.6 to 0.7 mm with small decrease from 0.7 to 1.3 mm. There were numerous inappropriate references to 'rapid' or 'slow' increases and decreases. Many candidates made qualitative comments without using supportive figures and, as in **Question 3(c)** where data was also given, the figures, where quoted, were not always read accurately from the graph. In addition to the mitotic index of 0.016 at 1.9 mm being read as 0.16, there were numerous other errors, such as the mitotic index at 0.1 mm was sometimes given as 0.15 rather than 0.11. A significant number of candidates explained why the mitotic index changes along the length, referring to the meristem and zones of elongation and specialisation, rather than describe how it changes, which the question required.

(d) Candidates did not always explain clearly how the events in the mitotic cycle ensure that all cells in the root are genetically identical. The best candidates made reference to semi-conservative replication of DNA during interphase with base pairing to template strands and the formation of sister chromatids. Only the most able continued their explanation and mentioned sister chromatids moving to opposite poles. Few accurately referred to the resulting daughter cells having the same genes / DNA as well as the same number of chromosomes as the parent. Many candidates were unsure as to when DNA replicated and made references to "cells and chromosomes replicating semi-conservatively". A significant number of candidates made inappropriate reference to no crossing over and the lack of chiasmata rather than referring to events that actually occurred to ensure genetically identical cells. Several candidates gave full descriptions of the stages of mitosis previously given in **(a)** and **(b)**.

Question 5

There were many encouraging answers to this question, with part **(b)** causing some difficulty.

(a)(i) A pleasing number of candidates were able to calculate the percentage increase in the number of red blood cells in the person acclimatised to high altitude compared with the person at sea level, the correct answer being 13%. A significant number did not express their answer to the nearest whole number as requested. Several candidates in calculating the percentage increase divided the difference in the number of red blood cells by the figure for a healthy person acclimatised to high altitude (700 000 / 6 100 000) x 100 rather than 5 400 000, the figure for a healthy person at sea level (6 100 000 – 5 400 000 / 5 400 000) x 100 and in doing so arrived at the incorrect answer of 11%. Several candidates gave (6 100 000 / 5 400 000) x 100 = 113%.

(ii) In explaining the advantage of this increase in red blood cells to people who live at high altitude, good explanations referred to the increase in haemoglobin with more oxygen being carried (per unit volume of blood), the more red blood cells compensating for the lower saturation of haemoglobin at altitude due to the low partial pressure of oxygen at higher altitudes. Weaker responses made no reference to 'more haemoglobin' or thought that more red blood cells enabled the haemoglobin to have a greater affinity for oxygen.

(b) In stating the roles of phagocytes and T-helper lymphocytes during an immune response to a bacterial infection, the most able candidates made mention of phagocytes engulfing / ingesting bacteria and T-helper cells secreting cytokines to activate B-lymphocytes to produce plasma cells / memory cells / antibodies. Weaker candidates had phagocytes 'eating' bacteria or ingesting antigens or foreign bodies rather than bacteria / pathogens and had difficulty in stating the role of T-helper lymphocytes, often incorrectly indicating they themselves produced antibodies.

(c)   In explaining the danger of the widespread use of antibiotics to treat disease, a few weaker candidates made inappropriate reference to people becoming resistant or bacteria gaining immunity. Whilst others wrongly referred to antigens, antibodies and antibiotics, even diseases, becoming resistant, the better candidates made clear reference to the development of bacterial resistance / multiple resistance with antibiotics becoming ineffective or cannot be used in treating infection.   Only exceptionally was reference made to the selection of resistant bacteria by widespread use of antibiotics. Several candidates gave inappropriate accounts of patients not completing prescribed doses of antibiotics or antibiotics killing 'helpful' bacteria.

Question 6

Overall a sound level of response. Part **(b)** was least well understood.

(a)(i)   Not all candidates were able to name the blood vessels labelled **F** and **G** as (inferior) vena cava and pulmonary artery respectively. Several referred to **F** as the superior vena cava and others wrongly identified **G** as the aorta or simply stated it was an artery or gave pulmonary vein.

(ii)   A surprising number of candidates were not able to state the heart rate in beats per minute given that **Fig. 6.1** indicated that one heart beat took 0.8 seconds. The examiners were looking for (60/0.8 =) 75. Weaker candidates multiplied 60 by 0.8 to give a heart rate of 48 beats per minute. Overall the answers ranged from 0.013 to 2880 beats per minute.

(iii)   Most candidates were able to explain why the walls of the atria have thinner muscles compared to the walls of the ventricles, with suitable reference to the ventricles having to pump blood further, to the whole body rather than atria pumping blood over a shorter distance to the ventricles. A significant number of candidates referred to blood being sent from the atria to the lungs. A few candidates referred correctly to the difference in the pressure generated in the chambers, with weaker responses referring to the ventricle wall being thicker to withstand greater pressure. Many candidates used the word force in explaining the relative thickness of the muscle walls.

(b)   Only the most able candidates were able to complete correctly the table shown in **Fig. 6.1** with reference to the left atrium, left ventricle and aortic valves. Although the majority were able to indicate that the aortic valve was open and closed at **J** and **K** respectively, many lost marks by not fully describing what was happening to the left atrium and left ventricle at **H, J** and **K** as required, failing to take the prompt from the completed boxes. Such candidates often referred appropriately to "relax" and "contract" without mentioning the cavity or blood vessels through which the blood was received or pumped out, for example, at **H** (left ventricle) – "relaxes, receives blood from left atrium". Many candidates incorrectly referred to the left atrium at **K** as contracting and forcing blood into the ventricle. Weaker candidates made reference to the right hand side of the heart and were unsure as to the nature and position of the aortic valve.

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General comments

The paper was accessible to the majority of candidates, who demonstrated good knowledge and understanding of those practical skills that were tested. The paper also discriminated well between weaker and more able candidates whilst at the same time allowing all candidates to demonstrate their ability in answering questions. The trend towards drawing less textbook diagrams continued and most candidates made a genuine attempt to draw what they saw and interpreted well what they saw through the microscope. This is to be applauded. There was no evidence that candidates ran out of time and almost every candidate completed every question.

Where candidates did make errors, it was mainly due to a failure in reading the question correctly. Candidates would be well advised to read all questions most carefully before attempting them, and to revisit the question when they have finished answering it to make sure that they covered specifically what the question was asking.

Comments on specific questions

Question 1

This question proved to be accessible to most candidates who performed well. Most candidates produced good diagrams and went on to explain both the conditions of the leaves and how to devise an experiment to investigate the effect of wind speed on similar leaves.

(a)   Most candidates scored three marks on this question. Weaker candidates failed to notice and take account of the word 'condition' in the stem of the question and simply described the leaves, often referring to size and colour. More able candidates described the three leaves comparatively and referred to the degree of dryness and wilting.

(b)   Most diagrams were well drawn. Credit was given for the use of clear single lines and correctly labelling stoma and guard cells. A few candidates lost marks for either producing poor quality drawings or failing to label them. Credit was given in the second part of the question for drawing the cells to the same scale. Although most candidates scored this mark it was clear that they had not made a serious attempt to do this and scored the mark by good fortune. This was another example of candidates failing to read the question carefully before attempting to answer it. Candidates would be well advised to spend some time in developing this skill.

(c)   Good answers to this section tended to be Centre specific, where candidates had studied not just the structure of a leaf but how this structure affected processes within the plant. Too many candidates failed to relate their explanations back to the leaves K3, K4 and K5, and some even referred to how this would affect gaseous exchange and rates of photosynthesis. Good answers described the effect of the petroleum jelly, the distribution of stomata on the leaves and how rates of transpiration were affected in each of the leaves.

(d)   This section was generally well answered. Most candidates described how they would use a photometer, but credit was given for a range of different ways by which the investigation could be carried out. Most candidates described in detail how they would set up the photometer and vary wind speeds. A few went on to say how they would control the variables such as light and temperature, however only a very few stated that they would repeat the experiment and determine the average. Due to the high number of marking points available for this section, most candidates managed to score four or five marks.

Question 2

It was clear that Centres are spending more time teaching candidates the skills of how to determine the magnification of drawings. However overall the question proved to be quite difficult and discriminated well between weaker and stronger candidates.

(a) Most candidates made a good attempt at determining the magnification. Credit was given for dividing any number within the range of 15 mm to 20 mm by 220 and further credit for obtaining the correct answer. This should have been a straightforward question providing candidates with two easy marks. However all too often candidates made life much more difficult for themselves by converting the units into μm. Providing this was done correctly, candidates were credited, but all too often candidates made an error in an unnecessary conversion and lost marks. Sensible candidates gave an answer in the range of 0.073 mm to 0.091 mm. It was also noticeable that candidates were not using the skill of estimation to check their answer. Candidates should realise that if they calculated the diameter of an alveolus to be 0.7 of a metre, they had made an error in their calculation.

(b) Most candidates found this section quite difficult. Many went on to give answers about a diseased lung or that the lung was breathing in and would have different amounts of air in different alveoli. Candidates were told that this was a section through lung tissue and could not possibly be breathing in air. Creditable answers included reference to the section being taken through different parts of the alveoli at different levels or that some of the alveoli may have been squashed in preparation. Credit was also given to those candidates who stated that the alveoli may in fact be of different sizes or stages of growth.

(c) Most candidates scored at least one mark on this section. Credit was given for recognising that the terminal bronchiole was larger than the alveoli, had continuous epithelium, had alveoli branching off it or had fewer red blood cells in the epithelial tissue surrounding it.

(d) This section was also well answered by most candidates. Credit was given for identifying the presence of red blood cells and the idea of thin walls to facilitate the diffusion of oxygen and carbon dioxide.

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General comments

This paper proved to be difficult for candidates in the lower ability range whereas able candidates appeared to cope well. Several questions tested knowledge in parts of the syllabus that had not been assessed for some time. This may have been problematic for some candidates in resulted in a larger than usual number scoring below 20 marks out of 60.

The wording of **Question 2** may have caused problems with interpretation. Whilst the mark scheme was adjusted to take this into account there is evidence that some candidates spent far more time on this question than was justified by the mark allocation with a subsequent 'knock on' effect for the rest of the paper.

Questions 6 and **7** clearly showed that if a question asked for detailed recall it was well answered (as in the case of **Question 7**) whereas if a degree of application of knowledge was required then the responses were more varied (as in **Question 6**).

Section A

Question 1

Most candidates coped well with parts **(a)** and **(b)**. In part **(a)** lipids were recognised as having a greater amount of energy and better candidates went on to qualify the energy difference in terms of per gram or per mole. Many candidates referred to the greater amount of hydrogen in lipids. In part **(b)** the value for carbohydrate was usually correct whilst the value for lipids varied widely.

In part **(c)** many candidates were able to correctly describe the shape of the graph using figures. No credit was given for a general comment stating that RQ rose with temperature. Only able candidates were able to explain the change in RQ in terms of the type of substrate metabolised. Many incorrectly thought that it had something to do with the effect of temperature of enzyme-controlled reactions.

Surprisingly few candidates were able to indicate that an RQ value of over 1 would indicate that anaerobic respiration was taking place.

Question 2

Many candidates had difficulties with this question. They needed to recognise the hierarchy of the alleles in dog coat colour. The wording of the question did not always elicit the desired response. The mark scheme was adjusted to take account of this and candidates were not unduly penalised. A sizeable minority of candidates wrote genotypes instead of phenotypes in part **(a)**. In part **(b)** it was encouraging to note that candidates were familiar with a test or back cross with a homozygous recessive organism. Credit was given even if the recessive feature was the wrong one, provided the logic of the answer and context were accurate.

Question 3

In part **(a)** it was expected that candidates would be able to refer to the control or maintenance of water concentration or potential in the blood or the internal environment. Many candidates simply restated the question and used 'regulate' and 'osmotic potential' instead of answering the question.

It was, however, pleasing to note that many candidates were able to describe what was happening to the renal fluid as it passed through the loop of Henle. Better candidates explained the roles played by sodium and chloride ions in the movement of water by osmosis and the consequent changes in the water potential of the renal fluid. Good candidates were able to identify the hypothalamus as a receptor and the pituitary gland as an effector in part **(c)**.

Question 4

This question was very clear and straightforward and yet a large number of candidates did not know how to tackle it. It is disappointing that so many do not know the definition of a species. The diagram should have cued the candidates into allopatric speciation and yet parts **(b)** and **(c)** were often poorly answered. Many simply rewrote the information in the rubric. Natural selection was not very well described.

Question 5

It was pleasing to note that most candidates were able to calculate the size of the stoma and to use the correct units in part **(a)**. In part **(b)** it was expected that candidates would describe the chain of events that occur, due to ABA, when an <u>open</u> stoma <u>closes</u>, as requested. Many candidates mistakenly chose to describe how ABA would keep the stoma closed and so gained few marks.

The effect of wind speed on the rate of transpiration was well understood in part **(c)** and many candidates were able to score well. However it was noted that water molecules or just water itself was mentioned in many answers instead of the correct term water 'vapour'.

Section B

The overwhelming number of candidates opted for **Question 7** and weaker candidates tended to choose **Question 6**.

Question 6

(a)   This section was better answered than part **(b)**. Most candidates knew that there was a myelin sheath and that it insulated the neurone/axon. Very few went on to state that ions could not pass through it and that depolarisation only occurs at the nodes of Ranvier. Saltatory conduction was used because it had been learnt but quite a lot of candidates could not explain exactly what it meant. Large diameters and long axons/dendrons were only seen in answers from better candidates.

(b)   A considerable number of candidates wrote at length about the transmission of an impulse along a neurone or across a synapse. They had clearly not understood what was required by this part of the question. Many answers were vague and inaccurate.

Most candidates used either the skin or the eyes as receptors to answer the question, if they named a receptor at all.

Although marks were scored for the opening of sodium channels and the entry of sodium ions resulting in depolarisation many candidates were unsure of how to explain the idea of threshold and most had no idea of the terms receptor potential or receptor potential.

Question 7

(a)   It was encouraging to see so many candidates who had learnt this topic and who scored well. Many used Z diagrams as well as prose to explain how light energy is converted into chemical energy in the form of ATP.

(b)   Once a candidate realised that oxidative phosphorylation could occur in most cells then the answer given was clear and full. Unfortunately some candidates thought that this part of the question followed on from the first and so they gave accounts of the Calvin cycle. Others described the Krebs cycle in full and latterly explained what happened to reduced NAD and reduced FAD.

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Paper 9700/05
Practical 2
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General comments

The paper was accessible to the majority of candidates, who demonstrated good knowledge and understanding of those practical skills that were tested. The paper also discriminated well between weaker and more able candidates whilst at the same time allowing all candidates to demonstrate their ability in answering questions. The trend towards drawing less textbook diagrams continued and most candidates made a genuine attempt to draw what they saw and interpreted well what they saw through the microscope. This is to be applauded. There was no evidence that candidates ran out of time and almost every candidate completed every question.

Where candidates did make errors, it was mainly due to a failure in reading the question correctly. Candidates would be well advised to read all questions most carefully before attempting them, and to revisit the question when they have finished answering it to make sure that they covered specifically what the question was asking.

Comments on specific questions

Question 1

This question proved to be accessible to most candidates who performed quite well. Most candidates correctly identified the solutions and went on to explain how they identified them.

(a) Most candidates scored three marks on this question. Weaker candidates failed to notice the instructions about recording results and identifications in the table and wrote their identifications separately. This lost the mark allocated for a correct table. Other errors that lost this mark included failing to record results of the starch and enzyme test. Most candidates correctly identified the four solutions and scored the three marks allocated.

(b) Only the most able candidates scored full marks from the seven marking points allocated to this section. Many candidates went straight into explaining the Benedict's test, but credit was given to those candidates who stated that all solutions were tested for protein and two of them, S1 and S3 gave a positive result. Candidates who had made an error in part **(a)** had the error carried forward so that they would not be penalised twice for the same error. Credit was then given for adding starch to S1 and S3, waiting for the hydrolysis of the starch to occur and then testing with Benedict's reagent. Credit was also given for providing details of how the test was carried out i.e. heating to above 80°C and describing a positive result.

(c) As in the previous section, only the most able candidates scored full marks. A common error was to produce a range of different urine solutions from different diabetic patients. More able candidates stated that they would produce a range of glucose solutions with different concentrations of glucose. These would then be tested with Benedict's reagent to produce a range of colours against which the tested urine from the diabetic could be compared. Good answers also included an explanation about how this could be carried out, such as using a colorimeter or filtering and weighing the precipitate. Credit was also given for explaining that this was a semi-quantitative test and some degree of interpolation would be necessary.

Question 2

It was clear that Centres are spending more time teaching candidates the skills of how to produce good biological drawings. However these skills were very centre specific and even though candidates have been advised in previous reports to practice these skills, there are still a few cases where it is clear that they do not possess the appropriate skills to make good biological drawings.

(a)   Candidates were requested to make large, labelled, low power, plan diagram. Although most candidates carried out this request, a few produced a plan showing cellular details or repeated what they had seen in a textbook. Credit was given for producing a clear single lined drawing of a whole kidney section with two correct labels.

(b) (i)   Most candidates managed to score at least one mark from this section. Good answers included a description of the shape of the glomerulus, a statement that the glomerulus was surrounded by a capsular space and that the more frequent nuclei were more densely stained. Weaker candidates failed to realise that the question asked for visible features, and gave an answer more related to a text book description of a glomerulus.

(b) (ii) Most candidates performed better on this section as drawing a large labelled high power diagram was a skill they were more familiar with. Textbook diagrams were limited to a maximum of three marks. Drawings that had details of a brush border were treated as text book diagrams as individual cilia could not be seen in the slides provided. Credit was given for following instructions and drawing a single renal capsule and for drawing the tubule to the correct scale. Credit was also given for correctly labelling the tubule, tubular nuclei, the glomerulus and the renal capsule.

(b) (iii) One mark was credited to those candidates who divided any measurement by 0.07. Further credit was then given for correctly calculating the magnification of the tubule. Several candidates lost this mark as they measured the diameter of the glomerulus and not the tubule even though the calculation was correct. Some candidates went on to lose the second mark by attempting to convert the measurement that they had made into μm. Candidates should be aware that if they attempt to make the question more difficult than intended they are in jeopardy of losing the mark due to their own error.

(b) (iv) Most candidates managed to score one of the two marks for this section. Credit was given for any reference to anomalies produced by the preparation of the slide and for the idea that some of the tubules would be cut at an angle to the slide.

BIOLOGY

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Paper 9700/06
Options
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General comments

Option 3, Growth, Development and Reproduction once again proved to be the most popular choice with candidates. Option1 Mammalian Physiology was more frequently chosen than in previous sessions. The least attempted was Option 2, Microbiology and Biotechnology.

The paper differentiated well between candidates throughout the mark range with each option offering a range of both straightforward and more challenging questions. It was evident that many of the candidates had been well prepared for the examination, with able candidates achieving maximum marks in many sections of the paper. Candidates usually attempted every section. Some individuals once again appeared to answer an option for which they had not been prepared.

One of the commonest problems encountered seemed to be the misunderstanding of the question. Candidates frequently *described* when they should have *explained*, repeated a method when asked for one *other* method, failed to give *visible* or *structural* features when requested for these. It needs to be emphasised that reading the question carefully and noting the salient aspects of it is essential to ensure success. Many candidates were competent in handling data, such as the calculation of percentage difference.

Comments on specific questions

OPTION 1 MAMMALIAN PHYSIOLOGY

Question 1

(a)(i) Most candidates were able to correctly name the structures. B produced the most incorrect responses, being called a muscle fibre instead of the correct terminology 'myofibril'.

   (ii) There was a general appreciation that D would be longer or the Z lines further apart. Problems arose when candidates made statements about the paler areas without specifying to which areas they referred. Other candidates incorrectly described changes that were not visible.

(b) Well prepared candidates were able to score maximum marks. Unfortunately some were unable to draw a correct diagram illustrating sex linkage. A number only showed X and Y chromosomes, while some attached allele symbols to Y chromosomes. It was disappointing that few responses clearly explained the meaning of the symbols used. The most common error was the use of two different letters instead of upper and lower case for the alleles of the gene.

(c) This was a more testing question. Many responses only repeated the information in the question stem. Most did not appreciate that cross-bridges would still form but that the pull would not be transmitted to the rest of the muscle fibre, so the muscle would not contract.

(d) Many good descriptions were seen, scoring maximum marks.

Question 2

(a) Most appreciated that a change in the cholesterol level would provoke a negative feedback response, but few described that this would bring the level back to a set point i.e. a normal level. This is a vital part of any explanation of negative feedback.

(b)(i) This was well understood.

(ii) The most common mistake was to divide the decrease in number by the number of deaths when taking statins but many calculated this correctly.

(iii) It was appreciated that the data supported the hypothesis to some extent. Candidates should be encouraged to be more critical of data, such as the fact that no *direct* link is shown between cholesterol levels and statins or that the only link shown is between statins and deaths.

(c) Some candidates realised that normal feedback mechanisms would operate if diet cholesterol was reduced so more would be made or that statins would inhibit the enzyme synthesising cholesterol regardless of the level of cholesterol in the blood. However it was rare for both to be described.

Question 3

(a) Many candidates were able to score maximum marks. A few gave very detailed responses referring to solubility and hydrolysis by enzymes.

(b)(i) The idea that this enabled a wide opening and vertical movement was quite well known. Less frequently mentioned was the creation of a great force or the action of canines to pierce or grip the prey.

(ii) Some responses seemed more appropriate for a herbivore with many incorrect references to flesh being torn, chewed or ground up by these teeth. Although the crushing of bones was often mentioned, few appreciated the slicing or cutting action due to the teeth's sharp edges.

Question 4

(a)(i) and (ii) Most candidates correctly identified the parts.

(b)(i) Many gained maximum marks here. A few candidates confused the point at which the rotation stopped with the period immediately after the peak number of impulses.

(ii) In general this was well understood, with the idea of the inertia of the endolymph resulting in movement of the cupula clearly described. Candidates did not always describe the subsequent change in permeability of the cell membrane leading to depolarisation and an impulse.

OPTION 2 MICROBIOLOGY AND BIOTECHNOLOGY

Question 1

(ii) Only the strongest candidates mentioned mutation and selective pressure. Most did not recognise this as natural selection, describing rather than explaining the relationship.

(iii) Candidates failed to realise that human pathogens can be present in meat or eggs and could become resistant to these antibiotics. This would stop the antibiotics being effective as a treatment for human disease.

(b)(i) and (ii) The majority of candidates were able to answer these correctly. Most calculated the percentage as 60%, the commonest error being the use of A minus D.

(c) A number of good candidates gained full marks. It was rare to find detail such as enzyme inhibition preventing the formation of bonds in the cell walls.

Question 2

(a) Weaker responses thought **B** was either DNA or RNA. Many candidates failed to identify **C** and **D** as the sheath and fibres or pins of the tail respectively.

(b) Differences in outer coverings or nucleic acids were expected but candidates concentrated on internal structures such as the lack of organelles, cytoplasm or cell membranes in the bacteriophage. A few responses gave non-structural differences.

(c) Some very good answers were seen describing binary fission. Some confusion with mitosis was seen.

(d) Most steps were correctly described but few candidates noted the initial attachment to a binding site on the bacterium.

Question 3

(a)(i) The idea of sterilisation was well known.

(ii) The role of colchicine to double the chromosome number was not understood.

(b) It was not appreciated that cells from two different anther calluses would be needed. Details such as fusion techniques and the idea that colchicine would no longer be needed were lacking.

(c) Well prepared candidates scored maximum marks, most giving details of carbon and nitrogen sources. Some candidates, however, seemed ill prepared.

Question 4

(a)(i) Candidates generally did not appreciate the potential dangers to humans, such as inhalation, allergies or skin damage. Most realised that the enzymes would be more thermostable.

(ii) Only a few candidates recognised that the reaction rate would be slower.

(b)(i) Well answered.

(ii) The majority realised that this would damage the immobilising system.

(c) Reuse of the enzymes and the enzyme not having to be separated from the product were commonly given as reasons. An alternative was the reduced cost of emptying and sterilising as it runs for a long time.

OPTION 3 GROWTH, DEVELOPMENT AND REPRODUCTION

Question 1

(a) Surprisingly this was very poor. A bacterium was often not named for the Prokaryotae. In the first two kingdoms binary fission was often confused with mitosis, while examples of artificial cloning were given for Animalia.

(b)(i) Most correctly identified lag and log.

(ii) Good responses included a shortage of nutrients and oxygen or the build up of waste materials. The reproduction rate being equal to the death rate was also frequently mentioned, although some candidates thought cell division would have stopped altogether. The use of the word food instead of nutrients was considered inappropriate at this level, especially as this is a photosynthetic organism that manufactures its own food.

(c) Very few candidates considered the effects of a small rise above optimum causing an increase in respiration, heat release and enzyme activity. Most successfully described denaturation and a reduction in cell activity or death as a consequence.

(d) The majority of answers used turbimetry as the method but most were surprisingly lacking in detail, not even mentioning the passing of light through a sample of the culture and measuring the amount of absorbance. When dry mass was used, this was usually well described. It was common for a method that involved counting cells to be described; candidates must read the question carefully.

Question 2

(a)(i)   Most calculated this correctly. Some errors were seen in the measurement of X-Y. A few candidates converted from one unit to another, achieving wildly inaccurate answers. Candidates should be encouraged to roughly estimate the size of the answer from the diagram.

(ii)   Generally well known.

(b)(i) and (ii)   Some did not appear to know this was mitosis.

(iii)   The majority of responses correctly described the process of meiosis and the resulting products. It was pleasing to see how many were also aware of the time delays involved.

Question 3

(a)(i)   Frequently responses were too vague. The best answers referred to germination being linked to a suitable season, time of rainfall or after fires. A few references to allowing time for dispersal or maturation were also seen.

(ii)   This was not well known. The candidates who mentioned abscisic acid rarely gave further detail. References to ABA being needed in high concentrations or that gibberellin concentrations must be low were expected. Responses describing how gibberellin stimulates germination did not answer the question.

(iii)   Most could gain both marks by using the data provided, although a significant number referred to simply 'high temperatures' rather than fire.

(b)   Many candidates were able to score maximum marks here by describing the stimulation of enzyme formation and action. It was pleasing to see details such as a named enzyme and its role in the hydrolysis of named substrates. Some responses described the use of the subsequent product in germination. Disappointingly few references were made to genes being switched on.

Question 4

(a)(i)   **A**, **B** and **D** were usually recognised but many thought **C** was the ovary rather than the ovule.

(ii)   The majority of candidates did not recognise this as an example of protandry. Most incorrectly described the relative positions of the stigma and anther.

(b)(i)   Rarely did candidates appreciate that the majority (90%) of seed production took place regardless of whether insects visited or not. As a result relatively few described the increase with insect visits as insignificant. Some realised that self-pollination accounted for the seed production when insects were not present but sadly most did not use Fig. 4.1, giving wind pollination as the cause.

(ii)   Many candidates realised that insect pollination was a form of cross pollination and would result in greater variation. It was rarely noted that this was only if the insect transfers pollen to a different plant. Many vague responses indicated there would be variation but made no comparison with the 'no visit' situation.

OPTION 4 APPLICATIONS OF GENETICS

Question 1

(a)(i)   Apart from some well prepared candidates, answers tended to lack detail. Most knew an appropriate piece of tissue but rarely mentioned that it was only surface sterilised rather than just sterilised. Responses often lacked a clear reference to plant growth substances stimulating mitosis in the formation of callus, likewise the use of plant growth substances to stimulate differentiation of the callus. When a nutrient medium was mentioned, it was rare to see any named nutrients or that the medium should be sterile.

(ii)   This was generally well known, describing the problems of three sets of chromosomes in meiosis. Some responses confused this with trisomy.

(iii) Candidates who stated that these were genetically identical usually also understood their common susceptibility to pathogens or climatic factors.

(b) Suitable parents proved a problem for many with the hybrid often being selected, despite being told this was sterile. No one suggested a way of dealing with this sterility. However many other marks were readily accessible. The selection of offspring with desirable characteristics over several generations, detail of the crossing process, backcrossing to parents or reference to background genes were all points well known to many candidates.

(c) Most did not recognise this as due to selective breeding by man, appearing to ignore the references to 'ornamental' and 'garden' plants. As a result the many descriptions of natural selection usually only gained one mark for mutation as the initial source of variation. The idea that people have selected different traits for different conditions or fashions was not appreciated.

Question 2

(a)(i) Many errors were made and answers poorly expressed. It was rare to see a clear understanding that this was 100 000 base pairs long.

(ii) It was common for vertical transmission to be erroneously included here. Good answers did describe horizontal transmission, with some also aware of transformation and transduction.

(b)(i) Some candidates realised that the increase was 10^{-2} - 10^{-4} but did not appreciate that this gave an increase of 10^2 or X100.

(ii) The general increase in transfer of the antibiotic was noted, together with the greater effect on *E. coli*. It was not often noticed that the antibiotics have the same effect in each of the donors. Few attempted to quote data to support their statements.

(iii) Relatively few candidates understood that there would be an increase in the number of resistant bacteria or the frequency of resistant alleles.

Question 3

(a) This was answered well.

(b)(i) The relationship was usually correctly described but it was rare to see any reference to Fig. 3.1. A reference to the varying distances moved by the fragments of family members was expected.

(ii) Many candidates *described* the positions without *explaining* them. The idea of the stutter becoming longer with each generation was often noted but few referred to the homozygous recessive condition of **C** or the heterozygous condition of the alleles in **A**, **B** and **D**.

Question 4

(i) Both storage conditions and periodic germination tests were well known.

(ii) General reasons for maintaining a seed bank were readily provided. The fact that these plants are unique and so should be preserved was not appreciated.