BIOLOGY

Paper 0970/11
Multiple Choice (Core)

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

General comments

There was good understanding of: the characteristics of living things; the composition of a protein molecule and how the shape of the active site of an enzyme complements the substrate.

There was some uncertainty about: osmosis; the colour changes of hydrogencarbonate indicator solution; the importance of physical digestion and how to apply the magnification formula.

It is important for candidates to work methodically through information provided in questions, such as in **Questions 12** and **38**.

Comments on specific questions

Question 2

Many candidates appreciated that the genus was *Aquila*. Some candidates incorrectly opted for c*hrysaetos*.

Question 3

Many candidates correctly identified that two of the arthropods were insects.

Question 4

A minority of candidates incorrectly believed that root hair cells contain chloroplasts. Also, some candidates incorrectly believed that neither root hair cells nor palisade mesophyll cells contain cytoplasm.

Question 5

Many candidates were unable to calculate the actual size of the cell. To find the actual size, candidates needed to divide the image size by the magnification.

Question 6

While many candidates correctly identified the process as diffusion, some incorrectly opted for osmosis.

Question 7

Only a minority of candidates understood the changes that occur during osmosis. Some candidates incorrectly believed that there was a net movement of sucrose out of the dialysis tubing bag.

Question 8

Few candidates identified the correct description of the active transport of ions.

Question 10

Only a minority of candidates selected the correct option. Many candidates incorrectly believed that all enzymes are most effective at pH 7.

Question 12

The colour changes of hydrogencarbonate indicator solution were not well understood. The reduction in carbon dioxide in the indicator solution will turn it purple.

Question 15

Only a minority of candidates identified the correct statement about physical digestion, that is, it increases the surface area of food. Many candidates incorrectly chose option **C;** it takes place in the mouth only.

Question 16

There was some uncertainty about this question, with many candidates not appreciating that the food will contain less starch because of the action of amylase in the mouth.

Question 17

Many candidates did not understand the functions of xylem and phloem. The phloem transports amino acids and sucrose and the xylem transports mineral ions and water.

Question 19

Few candidates chose the correct option. Some candidates incorrectly believed that veins take blood away from the heart.

Question 24

While many candidates correctly identified the word equation for aerobic respiration, some incorrectly chose the word equation for photosynthesis, option **A**.

Question 25

Many candidates understood that the parts of the body that excrete urea, excess water and excess ions are the kidneys. Some candidates incorrectly believed that the part of the body that does this is the gall bladder.

Question 26

Many candidates correctly identified the ureter. Some candidates incorrectly chose the urethra.

Question 27

Many candidates understood that the name of the junction between two neurones is the synapse. Some candidates incorrectly chose option **B**, receptor.

Question 30

Many candidates were aware that antibiotics can be used to treat bacterial infections but are not effective against resistant bacteria. Some candidates incorrectly believed that antibiotics can be used to treat viral infections.

Question 33

Many candidates knew that a length of DNA that codes for a protein is a gene. Some candidates believed that this defined a chromosome.

Question 34

Few candidates understood that every time a couple has a child, there is a 50% chance of the child being a girl.

Question 35

Mutation, the term for a genetic change was known by many candidates, although some candidates incorrectly chose genotype.

Question 36

Most candidates selected the correct option, that is, heat energy is given off by plants and that chemical energy is transferred between animals. A common incorrect response was that light energy is lost by plants and kinetic energy is transferred between animals.

Question 37

Few candidates understood that the top of the pyramid represents carnivores. Some candidates incorrectly believed that the top of the pyramid represents decomposers.

Question 38

This was a challenging question for some candidates. It is important that candidates work methodically through the question to derive the correct answer.

Question 40

Most candidates understood that genetic modification produces a new combination of genes.

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Paper 0970/12
Multiple Choice (Core) 12

There were too few candidates for a meaningful report to be produced.

BIOLOGY

Paper 0970/21
Multiple Choice (Extended)

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

General comments

There was good understanding of: the characteristics of organisms; magnification; protein structure and anaerobic respiration.

There was some uncertainty about: osmosis; cholera; the colour changes of hydrogencarbonate indicator and the adaptations of xerophytes.

It is important for candidates to work methodically through information provided in questions, such as in **Questions 20**, **31** and **32**.

Comments on specific questions

Question 5

Most candidates were able to determine what happens to the level of the liquid in the glass tube (it goes up) and the reason, which is that the water potential of water is higher than the sugar solution.

Question 9

While many candidates responded correctly, some candidates incorrectly believed that all enzymes are most effective at pH 7.

Question 11

Few candidates could recall the colour changes of hydrogencarbonate indicator solution. The reduction in carbon dioxide in the indicator solution will turn the hydrogencarbonate indicator solution purple.

Question 14

Many candidates understood that physical digestion increases the surface area of food. Some candidates incorrectly thought that it only takes place in the mouth.

Question 19

Many candidates understood that dehydration is caused because chloride ions are secreted into the small intestine which causes water to move into the intestine by osmosis. Option C was the commonest incorrect response. In this option the water was moving in the opposite direction to the ions.

Question 23

Many candidates understood where glucose will be found in the body of a healthy human after eating a meal. Some candidates incorrectly believed that there would be no glucose in the glomerulus and nephron.

Question 26

While many candidates knew that auxin stimulates cell elongation, some incorrectly believed that auxin is more concentrated on the side of the shoot that receives the most light.

Question 31

While many candidates correctly selected option **A**, many did not. Candidates must work methodically through genetics questions to determine the correct answer.

Question 34

Few candidates were able to identify the adaptations that may be present in a xerophyte.

Question 36

Many candidates were able to identify when the reproduction rate was greater than the death rate. Some candidates incorrectly believed that the reproduction rate was greater than the death rate during the stationary phase.

Question 39

While most candidates correctly selected the plasmid, option **D**, many chose the loop of DNA, option **C**.

BIOLOGY

Paper 0970/22
Multiple Choice (Extended)

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

General comments

There was good understanding of: the processes that occur in both plants and animals; magnification; germination and photosynthesis.

There was some uncertainty about: the rate of transpiration; the site of maltose digestion and the transmission of impulses.

It is important for candidates to work methodically through information provided in questions, such as in **Questions 20**, **31** and **32**.

Comments on specific questions

Question 9

Although this question was generally answered correctly, some candidates incorrectly believed that maltose is digested in the stomach.

Question 12

Many candidates understood that between 15 °C and 20 °C the kinetic energy of molecules is increasing, resulting in more effective collisions. Some candidates incorrectly believed that chlorophyll can transfer more energy in chemicals to energy in light.

Question 15

While many candidates chose the correct option, some thought that high humidity raises the concentration gradient and high wind speed lowers the concentration gradient.

Question 18

Many candidates knew that veins have large lumens and thin walls. Some candidates incorrectly believed that arteries have large lumens.

Question 19

This was a demanding question, with most candidates choosing an incorrect option. The chloride ions move out of the blood into the intestine, and this is followed by water moving into the intestine by osmosis, resulting in diarrhoea.

Question 20

This was answered correctly by many candidates. The external intercostal muscles must relax before the rib cage moves downwards and inwards.

Question 24

Few candidates responded correctly. During the transmission of an electrical impulse along a reflex arc the receptor proteins of the relay neurone bind with neurotransmitter molecules.

Question 26

Many candidates knew that the distribution of auxin away from the light will cause the cells in that part of the shoot tip to elongate and therefore the shoot will grow towards the light. Some candidates incorrectly believed that auxin would concentrate on the illuminated side of the shoot and cause the shoot to bend towards the light.

Question 28

While many candidates understood that the arrow in the diagram represented self-pollination in an insect-pollinated flower, some candidates incorrectly believed that the arrow represented self-pollination in a wind-pollinated flower.

Question 33

Although many candidates responded correctly, some candidates incorrectly believed that variation caused by the environment can be inherited.

Question 34

Many candidates understood that being hairy is a leaf adaptation for living in a hot, dry desert. Some candidates incorrectly believed that having a thin waxy cuticle is an adaptation for living in a hot, dry desert.

Question 36

Although many gave the correct response, some candidates did not appear to know the difference in the appearances of pyramids of numbers and pyramids of biomass.

BIOLOGY

Paper 0970/31
Theory (Core) 31

Key messages

Candidates would benefit from reading questions carefully, as they often contain specific information that must be used in the answers. For example, when the question asks for five lines to be drawn, it is important that only five lines are drawn. Also, the question may ask for a definition rather than a discussion and that indicates the level of detail required in the answer.

If a label line is required, care should be taken to ensure that the line touches the structure being labelled.

General comments

Many candidates were well prepared for the exam and had obviously referred to past papers and mark schemes when preparing. This type of preparation allows candidates to express themselves clearly.

Command words such as 'describe', 'explain', 'suggest' and 'compare' require different responses from candidates. If a description is required, including a reference to a graph or table, then it will be expected that data will be used in the description given. Many candidates can do this effectively. An explanation requires more than just a description and candidates should be encouraged to practise the difference between 'explain' and 'describe'.

Comments on specific questions

Question 1

(a) Many candidates gained both marks for this question. Some candidates incorrectly referred to shared characteristics or a group of organisms living in the same area.

(b) (i) Many candidates showed a good understanding of binomial nomenclature and gained the mark. A common error was to state *forficatus* or the complete binomial name.

(ii) Some candidates confused the answers for the myriapods with those for the arthropods, but many gained a mark, usually for identifying the segmented body. Pairs of antennae or incorrect numbers of legs were frequent incorrect responses.

(iii) Spellings were often incorrect, especially for crustaceans, but were credited if they were phonetically correct. Incorrect responses included invertebrates and named vertebrate groups.

(iv) Most candidates gained both marks. Cell membrane and mitochondria were the most common incorrect responses.

(c) (i) Many candidates correctly gave shell as the answer, with fewer using the correct term, exoskeleton. Skin was the most common incorrect response.

(ii) Few candidates recognised the term kingdom in the question and simply referred to crustaceans.

Question 2

(a) The majority of candidates were able to answer this question well, with many gaining three or four marks. Those who gained only one mark usually connected **C** with the gum. The most common error was not identifying **D** as bone.

(b) The majority of candidates answered this question well and successfully described the role of teeth. The most common errors were stating that food was broken down into smaller molecules; giving the name of an enzyme e.g. amylase and not realising that enzymes are need for chemical digestion.

(c) The vast majority were able to identify two types of teeth. The most common incorrect responses were milk, adult, and wisdom.

Question 3

(a) Most candidates were able to correctly identify the red blood cell and describe their function. Candidates were less successful with the white blood cell. Many gave vague responses, such as fighting disease, which could not be credited.

(b) Many candidates were able to identify blood clotting. A smaller number were able to go on to state that pathogens are prevented from entering the blood.

(c) (i) Either carbon dioxide or urea were correctly identified by most of the candidates.

(ii) Oestrogen and testosterone were the most commonly identified hormones. The spelling of both hormones could be improved.

Question 4

(a) (i) Many candidates had little trouble giving at least one of the correct answers. Some incorrectly named insoluble substances such as cellulose, starch and glycogen. Glucose was also a common incorrect response.

(ii) Some candidates did not apply the information in the question carefully enough and labelled parts, usually the xylem, that were not in contact with the soil and therefore could not be correct. A few candidates did not extend the label line to touch the root hair.

(b) (i) Most candidates gave a correct description of the direction of movement, although weaker responses answered in terms of water and water potential gradient. Many candidates correctly stated that energy was needed. Only the strongest responses referred to a membrane.

(ii) Most candidates had the idea of support, although many candidates described an aspect of transport ignoring the instruction to describe a function other than transport.

(c) Most showed a good recall of the relevant variables.

Question 5

(a) The majority were awarded both marks for this question. Some listed the organisms in the wrong order, and some gave the arrows in the wrong direction. Others gave the number of organisms on the graph instead of the names of the organisms.

(b) Most candidates correctly stated the trophic level. Some incorrectly gave the answer as 3 or added up the number of organisms on the graph.

(c) Most candidates knew that the banana plant was a producer. The most common error was identifying the tree frog as a herbivore or a decomposer.

(d) Very few were able to describe the advantage of using a pyramid of biomass rather than a pyramid of numbers. The most common incorrect response was that pyramids of biomass are more accurate.

(e) The majority of candidates were awarded some marks on this question. Very few referred to light energy and simply referred to light. Some candidates misunderstood the term synthesise and described how plants use carbohydrates. Photosynthesis and chlorophyll had to be in the correct context to be credited.

Question 6

(a) (i) The strongest responses divided their answer into the main regions: before the untreated sewage release; immediately after the untreated sewage release and after **X**. The words used to describe the gradients were sometimes inappropriate and often too vague. Few candidates mentioned the final stage where oxygen concentrations return to normal. Weaker responses simply described the graph in terms of a drop and then rise in oxygen concentration with no reference to sewage release. Some candidates omitted to mention oxygen concentration.

(ii) Most candidates correctly predicted that the organisms would die or that the population would reduce, but few linked this to the need for oxygen for respiration. Some went into unnecessary details about eutrophication.

(b) Many missed that the question asked specifically about the effect on humans and therefore discussed the effect on the river or on marine organisms. Preventing the spread of disease was the commonest correct response.

(c) This question was answered well by most candidates. When predation was mentioned, few specified that it was the introduction of new predators that would result in extinction. Several candidates listed habitat destruction and deforestation which were the same point.

Question 7

(a) This question was answered well. A common error was incorrectly labelling the bladder as the gall bladder. Those who did not gain the mark for the function of the heart referred to transport instead of pumping. The kidney was often identified as the liver.

(b) This was correctly answered by most candidates. Some incorrectly identified ovum or ovules.

(c) Most were familiar with the characteristics of living organisms, although a few ticked more than two boxes and could not be awarded full marks.

Question 8

(a) (i) Candidates struggled to identify **X** as the spinal cord. A small number of candidates identified **X** as grey matter which was accepted. The most common error was to name **X** as a sensory or relay neurone.

(ii) Candidates either correctly identified the effector as a muscle or they incorrectly identified it as the hammer. Some gave a detailed description of a reflex action, which was unnecessary as the question simply asked for the effector to be named.

(iii) The majority of candidates correctly described the stimulus as the hammer hitting the knee. Many candidates gave detailed responses that did not answer the question.

(iv) Candidates were able to state that reflex actions were rapid and automatic. Some identified it as being a protective action. Weaker responses tended to give examples of reflex actions.

(b) Most candidates were awarded both marks. The most common error was to incorrectly convert the lengths to the same unit, or to not convert them at all.

(c) This question was answered well. A few gave synapsis as their answer which was not credited as it has a different biological meaning.

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Paper 0970/32
Theory (Core) 32

There were too few candidates for a meaningful report to be produced.

BIOLOGY

Paper 0970/41
Theory (Extended)

Key messages

Candidates should be advised to take time to read and assimilate the information provided in each question before starting to write an answer for the first item. Many answers showed that candidates had not read the material thoroughly and had not taken time to plan their answers before starting to write. This was particularly noticeable in **Question 1 (b)(i)** and **(ii)**.

Care needed to be taken over the analysis and interpretation of the data shown in Fig. 4.1. Candidates should try to approach data-handling questions, like those in **Question 4 (a)**, logically. They should start by looking carefully at what is shown on the *x*-axis and then on the *y*-axis, and in the case of Fig. 4.1, any annotations on the graph, such as temperatures and carbon dioxide concentrations that are limiting factors for photosynthesis. This analysis needs to be done by annotating the graph.

Several key concepts that appear in different parts of the syllabus need to be emphasised. The complementary shape of active sites of enzymes and substrates appeared in **Question 1 (d)** and the complementary shape of receptors on post-synaptic membranes and neurotransmitters was tested in **Question 5 (a)(iii)**. Water potential is another such key topic that was tested in **Question 2 (a)(ii)**.

General comments

Some candidates misread the questions and did not respond appropriately to the command words or phrases; for example they described instead of explaining or compared the wrong test-tubes or investigations.

Many candidates showed a good understanding of key biological knowledge and used biological terminology appropriately. There were some excellent performances on this paper, but many candidates found some of the questions requiring higher-order thinking skills a considerable challenge. This was the case for some of the questions that required explanations rather than simple descriptions, especially **Question 4 (a)**, which necessitated a careful and logical approach in order to analyse a large quantity of information in the graph.

Questions revealed candidates who did not read the question carefully enough. For example, in **Question 1 (b)(i)** many candidates wrote about test-tube **A** or simply described the results that are shown in the table without offering any explanations.

Few candidates scored well on all the parts of **Question 5**, with **(a)(ii)**, **(a)(iii)**, **(b)** and **(e)** being the least well answered items on the paper. This question tested parts of the syllabus that revealed many misconceptions.

In general, knowledge of technical terms is good, but many candidates had difficulty in expressing themselves clearly enough to gain all the marks available. For example, in **Question 2 (a)(ii)** many did not state clearly that the potato cube in 0.8 mol dm^{-3} sucrose solution lost more mass than that in 0.6 mol dm^{-3}. Some candidates also appeared not to have read, or understood, all the information provided in the question. For example, many did not appreciate that the micrograph in Fig. 3.1 shows cells in the trachea, or that they were asked for sources other than mutation in **Question 5 (e)**.

Comments on specific questions

Question 1

(a) Many gave three correct answers but did not seem to appreciate that they could give the same letter for more than one response. A small number of candidates wrote out the names of the parts of the

digestive system but did not gain any credit even if correct. The question tested the ability of candidates to locate the structures in the diagram.

(b) (i) Candidates often realised that this question was testing knowledge of the roles of lipase and bile in the digestion of fat. There were good explanations that used the information given above Table 1.1, stating that over time the reaction mixtures in test-tubes **B** and **C** became acidic. This was ascribed to the formation of fatty acids as lipase digests fat molecules in the milk. The emulsification of fat by bile was stated to be responsible for the faster rate of reaction in test-tube **C**. However, many candidates did not realise that the question was about fat digestion and referred to the digestion of milk instead, or simply described the results in the table without any attempt at an explanation. A few candidates wrote about the enzyme ligase. Many simply described the colour changes but did not relate these to the action of lipase and bile. Several thought that lipase and bile were acidic and some thought that bile also digested the fats in the milk to fatty acids.

(ii) The role of test-tube **A** in the investigation was stated by many as the control experiment or more usually the control. Some used the term control variable, which was not accepted. Few candidates stated that test-tube **A** was used to show that lipase, and not bile, was necessary for the colour and/or pH change in the other test-tubes.

(c) The sketch graphs were not completed very well. Many candidates drew bell-shaped curves rather than curves that increased gradually to a peak and then decreased steeply to meet the *x*-axis. Very few indicated that the point where the line meets the *x*-axis shows the temperature at which all the lipase is denatured. Many labelled the peak or the descending part of the curve as the point of complete denaturation. Some candidates drew a line showing an increase in activity and then a horizontal line showing the activity was constant. The horizontal line was labelled incorrectly as the point of complete denaturation.

(d) Many candidates realised that enzymes are specific to their substrate and wrote good answers explaining that the shape of the active site of lipase is complementary only to fat and not to protein. However, many candidates omitted to use the word ‘shape’ in their answers. There were many correct references to enzyme-substrate complexes. Some described protease as the enzyme to digest proteins but did not relate their answer to lipase as required by the question. Many answers described how lipase digests fats, but not why the enzyme cannot digest proteins.

Question 2

(a) (i) Most candidates performed the calculation correctly. The best answers wrote out the formula for calculating percentage change and then showed the working to derive the answer of –13.28%. An error seen on some scripts was to use 1.11 as the denominator to give –15.45% as the answer. The principle of error carried forward was applied to candidates who made such an error.

(ii) There were many good answers to this question which showed excellent understanding of water potential and the movement of water from the potato cubes used in the experiment. Some answers made all six points on the mark scheme. Other answers revealed several misunderstandings, such as water moving into the potato or sucrose solutions moving. Some candidates ignored the instruction in the question and wrote about the concentrations of sucrose and water instead of using water potential terminology. Three of the mark points required the use of the term water potential. Some candidates missed marks because it was unclear whether their comparisons were between the two solutions or between the potato cubes and the solutions. A significant number did state that there was a larger decrease in percentage mass in the 0.8 mol dm^{-3} sucrose solution.

(iii) A large proportion of the candidates did not seem to realise that this question asked about a cell in the potato cube that had been placed into distilled water. Instead, they either described a cell that would have come from the 0.8 mol dm^{-3} sucrose solution or about the effect of immersion in water on the cube of potato rather than its cells. Others used most of the answer space to describe how and why water would move into the cell, rather than its appearance. Good answers stated that the cells from the potato in distilled water would be enlarged and turgid. Many also stated that the vacuole would be enlarged so that the cell membrane or cytoplasm would be pushed against the cell wall.

(b) Many candidates explained that active transport requires energy, uses carrier proteins, and involves moving substances, such as ions, against a concentration gradient. All of these are different from the features of osmosis. Many wrote about osmosis as well, although this was not necessary to answer the question. The wording of the question clearly asked how active transport differs from

osmosis, not for a comparison between the two processes. There were many irrelevant comments about the need for a partially permeable membrane.

(c) Root hair cells or root hairs were the answers given by most candidates. Root cells and root were not accepted. Examples of incorrect answers included xylem and phloem.

(d) There were many good answers to this question on the effect of magnesium ion deficiency on the colour of plant leaves. Candidates often stated that the areas of the leaf between the veins would turn yellow because magnesium is required to make chlorophyll. The term chlorosis was seen on some scripts. Many candidates stated that magnesium ions are used to make chloroplasts, this answer was not accepted.

Question 3

(a) (i) Most candidates stated the role of the goblet cell shown in the photomicrograph in Fig. 3.1 as secreting mucus for trapping pathogens and/or dust. A common error was to fail to notice the information at the top of the question and state that the cell was in the digestive system secreting mucus for the lubrication of food.

(ii) Many candidates identified the cell labelled **X** as a ciliated epithelial cell or simply as a ciliated cell. The same candidates who made the common error in **(i)** stated that the cell has microvilli for absorption. Some candidates described cilia as hair-like, but many also simply called them small hairs, not mentioning cilia at all. Some described the cilia as moving bacteria, rather than moving the mucus containing the bacteria.

(iii) In this question, it was expected that candidates would identify another region of the breathing system such as the bronchi or bronchioles. In fact, these answers appeared rarely as the most common answers were the small intestine, stomach, and oesophagus. Ciliated cells are widely distributed in the mammalian body so almost anywhere other than the digestive system was accepted. Nose and oviduct were the most common correct answers. Nostrils and lungs were not accepted. Lung was too imprecise as the organ contains blood vessels and alveoli do not have cilia.

(b) Many candidates completed Table 3.1 showing the correct actions of the breathing system to achieve inspiration. Giving unsuitable answers for the external intercostal muscles and the ribs were common reasons for less than full marks. Candidates often stated that the external intercostal muscles relax, and the ribs expand during inspiration rather than saying that the muscles contract and the ribs move upwards and/or outwards. Candidates often stated that the pressure increased in the thorax. A few candidates tried to write lengthy descriptions within the table, so that their answers took up much more than the space provided.

(c) Almost all candidates named carbon dioxide as the gas excreted.

(d) There were many good answers to this question on features of gas exchange surfaces other than good ventilation. Most candidates gave a large surface area, some way in which the distance for diffusion of gases is short and having a good blood supply. Thin and one cell thick were common answers. Two answers that were not accepted were thin cell wall and thin cell membrane.

(e) Most candidates identified the gas exchange surface in humans as the alveoli. Several different spellings of the term were accepted if they were recognisable.

Question 4

(a) Fig. 4.1 showed the effect of three different variables on the rate of photosynthesis. In the investigation that generated these results, three groups of plants were exposed to different light intensities and kept in different environmental conditions as shown at the end of the lines on the graph. A logical approach to this question was to describe the shape of lines **B** and **C**, ignoring line **A**. An explanation of the shapes of these two lines then followed, with reference to limiting factors. Candidates who did this were often awarded high marks. Candidates often wrote that as light intensity increased the rate of photosynthesis increased until an intensity where the rate became constant or reached a plateau. These candidates noticed that at low light intensities the rates are the same, but line **B** becomes constant at a higher light intensity than **C** so that light intensity remains limiting to a higher value. Candidates explained that the rate became constant for **B** at a higher rate because the carbon dioxide concentration is higher. The use of light to provide energy and carbon

dioxide as a reactant in photosynthesis were sometimes mentioned. Temperature acts as a limiting factor for **B** at high light intensities since increasing the temperature from 15 °C to 25 °C shows that the rate increases even though the carbon dioxide concentration is the same.

Many candidates did not approach the question quite as logically as this. It was quite rare to see a clear description of the shapes of lines **B** and **C**. Many candidates were distracted by the carbon dioxide levels, apparently forgetting (or not understanding) that they also needed to think about the increasing light intensity. Only a small percentage of candidates referred to light providing energy or being a limiting factor over the first part of the graph. In addition, common errors were:

- Thinking that only one of the limiting factors applied to the whole graph.
- Stating that photosynthesis in each line (group of plants) stops when the line shows the rate becoming constant. Some stated that carbon dioxide was used up very quickly and photosynthesis came to an end.
- Thinking that the temperature increases as the light intensity increases, even though the annotations on the graph state that the temperatures were 15 °C and 25 °C.
- Not using the term limiting factor anywhere in the answer to explain the shapes of the lines.
- Interpreting the annotations on the line as meaning that the plants somehow reached those temperatures and carbon dioxide concentrations at the end of the experiment.
- Not relating their explanations to light intensity, the variable on the *x*-axis.
- Writing statements which applied to the whole of a line, instead of recognising that there were different limiting factors when each line was increasing and when each line reached a plateau.
- Misusing the word 'steep', which should be a description of the gradient of a line, to describe the difference in the rate of photosynthesis at which the lines levelled off.

(b) Almost all candidates gave O_2 as the answer. Many prefixed the formula with a 6 and some even wrote out the whole equation for photosynthesis. Both answers were credited. Some candidates ignored the question and simply wrote the name of the element without giving the formula. No mark was awarded for this answer.

(c) There were many good answers outlining the fate of the glucose made in photosynthesis. Some candidates gave all the examples listed in the mark scheme. The most common answers were: used to provide energy, stored as starch, converted to sucrose for transport, converted to cellulose to make cell walls, and used to make nectar to attract pollinators. Some candidates misread the question and wrote about how glucose is made in photosynthesis, mentioning at best only one of the uses of carbohydrates in plants. Some discussed many of the uses of energy in the plant rather than answer the question.

Question 5

(a) (i) Many candidates identified the three components shown in the diagram of protein synthesis. Weaker responses named **Y** correctly as mRNA but did not give a correct name for the other two.

(ii) Many gave the sequence of bases in DNA, mRNA or a gene as the feature that determines the sequence of amino acids in proteins. There were also many vague answers such as DNA, RNA, and gene, with no mention of the sequence or order of bases.

(iii) Many did not read the question carefully and wrote about receptor cells rather than receptor molecules. Correct answers were very few and far between, but some candidates correctly stated that the receptor molecule must have a shape complementary to the neurotransmitter to allow the neurotransmitter to bind to the receptor, and that it is the sequence of amino acids that determines the shape of the protein receptor.

(b) Candidates appeared not to have read the question carefully as they thought this was a question about what happens to stem cells, although they had not been mentioned earlier in the question. The link to protein synthesis was not made by many candidates. Few candidates realised that cells with different functions use only some of the genes in their nuclei. Good answers here referred to gene expression. The very best answers stated that the genes that are expressed are those that code for the proteins required by cells to fulfil their specialist roles in the body. They could have used as an example the goblet cells and the ciliated cells from **Question 3 (a)** which are specialised cells found in the same tissue. An exceptional answer would have been: goblet cells express genes that code

for the enzymes required to make mucus and ciliated cells express the genes that code for the proteins that form the components of cilia.

(c) Many candidates gave the definition of allele given in the syllabus. Some candidates did not make it clear that an allele is an alternative form of a gene. Many mentioned that an allele can be recessive or dominant but did not state the meaning of the term.

(d) Most candidates identified the role of humans in artificial selection. Other common answers were that artificial selection leads to less genetic variation, is faster and is of benefit to humans. Some gave examples of characteristics that are chosen such as disease resistance, drought resistance and higher yield. As with **Question 2 (b)** many wrote a great deal about natural selection when this was not required by the question.

(e) The main sources of genetic variation in populations listed in the syllabus, other than mutation, are meiosis, random mating, and random fertilisation. Some candidates gave other acceptable answers, including hybridisation or inter-specific breeding. Some went beyond the requirements of the syllabus, mentioning the events that occur during meiosis to give rise to genetic variation – crossing over and independent assortment. Some candidates did not read the question and incorrectly referred to causes of mutation, such as radiation. Many gave natural selection and artificial selection as their answers. Sexual reproduction was not accepted as this includes self-pollination that does not introduce any genetic variation.

Question 6

(a) Most candidates read the graph in Fig. 6.1 correctly to state that the pH in muscles during exercise decreases from 7.07 to 6.55. A common error was to give 7.7. Most identified oxygen as the missing term in the next two gaps, but many misread the time for the muscle pH to return to its initial level after exercise. The accepted answer was 31 or 32 minutes or anything in between, such as 31.5 minutes. Many stated that lactic acid is transported in the blood. Blood vessels or named blood vessels, such as veins, were not accepted as the lactic acid is dissolved in the blood plasma. Liver and heart were given by many as the last two answers. Many gave muscles instead of liver. Pulse was accepted as an alternative to heart.

(b) (i) The correct answer for the balanced equation for anaerobic respiration in yeast was given by many candidates. However, many did not write the formula for ethanol correctly or did not balance the equation. Some rewrote the question by adding $6O_2$ to glucose and completing the equation for aerobic respiration.

(ii) Almost all the candidates identified the cell wall as a cell component present in yeast cells but not in animal cells. Vacuole, sap vacuole and large vacuole were also given and accepted. Candidates should know that yeast cells do not have hyphae.

BIOLOGY

Paper 0970/42
Theory (Extended)

Key messages

Candidates should be advised to take time to read and assimilate the information provided in each question before beginning to answer the first item. Many answers showed that candidates had not read the material thoroughly and had not taken time to plan their answers before starting to write.

Care needed to be taken over the analysis and interpretation of the data shown in Fig. 3.1. Candidates should try to approach data-handling questions like those in **Question 3** logically. They should start by looking carefully at what is shown on the *x*-axis and then on the *y*-axis, or in the case of Fig. 3.1, both *y*-axes. This analysis is best done by annotating the graph.

Candidates are expected to know the meanings of the key terms given in the syllabus. These terms will not be explained in questions where they appear. Three examples from this paper that were not known by some candidates taking this paper are organ, gene, and decomposer.

General comments

There was a good understanding of the structure of a leaf in **Question 1 (b)**, protein synthesis in **Question 2 (c)(ii)** and food web construction in **Question 4 (a)(i)**. Candidates also demonstrated that they understood how to round to two significant figures, but many had difficulty in taking readings from a graph with two *y*-axes in **Question 3 (a)(i)**. Some questions highlighted common misconceptions about immunity and resistance in **Question 3 (a)(iv)** and between energy use and transfer in **Question 4 (a)(iii)** and **(c)**. Further misconceptions were seen with respect to diffusion, water potential, osmosis, and gas exchange; examples were water, instead of water vapour, diffusing through air spaces in **Question 1 (b)**, water entering stomata by osmosis, and stomata opening to allow a leaf to take in water in **Question 1 (d)**.

It was clear that many candidates had not read the information provided thoroughly enough. For example, there were some confused responses to some questions, such as **Question 3 (a)(ii)** which involved describing the data in Fig. 3.1. In **Question (4) (a)(iii)** and **4 (c)** some candidates wrote about the wrong aspects of energy flow through ecosystems and in **Question 6 (a)(iii)** some wrote about roots instead of shoots and described the effect of light rather than gravity on the growth of these organs.

Comments on specific questions

Question 1

(a) Many candidates explained why a leaf is an organ. Some candidates expanded their answers to include examples of specific functions of leaves.

(b) There were many detailed explanations about how the two layers in the diagram of the cross-section of the leaf are adapted for their functions. Almost all candidates focused their answers on the role of the layers in photosynthesis, with fewer referring to transpiration. Most candidates started their answers with correct identifications of layers **B** and **C**. All the mark points were regularly awarded to candidates apart from the evaporation of water from the surfaces of the spongy mesophyll cells.

(c) (i) Almost all candidates recognised the cells around the stomata in the sketches as guard cells.

(ii) Slightly fewer candidates stated the main function of the stomata. Some common misconceptions included allowing water vapour to be taken into the leaf or thinking that stomata were cells.

(iii) Many candidates correctly stated that closing the stomata would reduce water loss in the plant with a minority describing the prevention of wilting. Most candidates did not consider the context of the investigation and wrote absolute statements, such as preventing water loss with little consideration for water loss through the leaf cuticle or other areas in the plant. Nevertheless, these statements were accepted.

(d) Although most candidates correctly predicted that the stomata would open for longer, the explanations of the effect of high humidity on the stomata was less well known. Very few candidates made correct reference to the gradient of water vapour concentration or of guard cells and their role.

Question 2

(a) Almost all candidates drew a circle to correctly identify a pair of bases on the diagram of the DNA molecule. However, some drew their circle around two pairs of bases and occasionally around a single base.

(b) Many candidates correctly calculated the percentages of guanine bases in the species. Common wrong answers were 71, 79 and 29, suggesting that those candidates did not consider that there are two strands, four bases, or how the bases pair with each other.

(c) (i) Almost all candidates knew that gene is the term for a length of DNA coding for a protein. Some candidates also correctly stated that this could be an allele. Common incorrect answers included mRNA and amino acids.

(ii) Some very detailed descriptions of protein synthesis were seen. Almost all candidates knew of the involvement of ribosomes in protein synthesis, and many were also able to explain the role of mRNA. All the mark points were regularly awarded, except for the requirement for energy for the process. However, there were several common misconceptions and contradictions. These included:

- mRNA first moves into the nucleus and then later out of the nucleus
- mRNA leaves the cell
- mRNA is converted into amino acids at the ribosome
- ribosomes make amino acids.

(iii) The most common cell membrane proteins given were enzymes and protein pumps, although a few candidates also accurately recalled that receptors for neurotransmitters are also proteins found in membranes. However, many wrong answers were seen many of which were neither proteins nor structures found in membranes.

Question 3

(a) (i) Most candidates used the correct *y*-axis and read off the correct values from the graph to calculate the percentage change in bacterial infections resistant to erythromycin. These candidates also usually went on to do the correct calculation and round their answers to two significant figures. A small minority simply subtracted the two values, rather than calculate the percentage change. However, there was a significant minority of candidates who either read the value from the wrong *y*-axis or used the wrong two bars for 1993 and 1995. Often these candidates showed their working and were then able to gain some credit for the next steps in the calculation. Very few candidates rounded their answers incorrectly or gave their answers to the wrong number of significant figures.

(ii) Most candidates accurately described at least one of the sets of data shown in Fig. 3.1, with many giving a comprehensive account of both sets. It was common for candidates to notice that the number of bacterial infections resistant to erythromycin was first recorded in 1991, but a few candidates incorrectly described this observation as people resistant to erythromycin or bacterial infections without any reference to them being those infections resistant to the antibiotic. Many candidates used the years to describe the two peaks, but those candidates who chose to describe the number of daily doses or number of infections often did not include the correct units with their data values and hence could not be given credit. A common misunderstanding of the data was to describe that in 1991 there were similar numbers of doses and bacterial infections resistant to erythromycin, suggesting that those candidates had not understood that the data were plotted on different axes.

(iii) Many candidates correctly suggested that the decrease in the number of bacterial infections resistant to erythromycin was due to a decrease in use of the antibiotic. However, fewer candidates went on to give other suggestions, such as using new antibiotics or treatments, using vaccines, and taking the antibiotics as instructed or only when necessary. A significant minority of candidates did not answer the question, but rather discussed how the resistance had occurred, rather than how the number of resistant bacteria had decreased.

(iv) Most candidates knew that mutations were involved in the process whereby bacteria become resistant to antibiotics. Many of these candidates were also able to outline several of the other steps in the process of natural selection in this context. A significant number of candidates did not mention a gene or allele providing resistance at any point in their response, with many referring to passing on traits or characteristics. Few candidates mentioned variation in the population and even fewer related this to the degree of antibiotic resistance. However, some candidates confused immunity and resistance, attributing mutations to components of an immune system, such as memory cells. Others incorrectly stated that the mutations were caused by the antibiotics, rather than occurring randomly.

(b) (i) The most common correct features of all prokaryotes that were stated included circular DNA, cell wall and cell membrane. A few candidates did not read that the feature should be of all prokaryotes, and listed plasmids and capsules among their answers. Other candidates mentioned features that prokaryotes do not have, such as a nucleus, but did not go on to mention that they do have DNA.

(ii) Almost all candidates knew that the function of a flagellum is movement.

Question 4

(a) (i) Most candidates drew a food web from the student's notes. The most common errors were either the omission of arrowheads or the arrowheads pointing in the wrong direction. There was evidence that several candidates needed to redraw their food webs after an initial attempt. Very few candidates drew the food webs as individual food chains, but some did include incorrect connections between organisms or did not draw each organism at a separate place in the food web.

(ii) Most candidates identified a primary consumer and a secondary consumer from the food web. Some of these candidates named the next trophic level as tertiary consumer and identified an example from the food web. However, far fewer candidates knew that the last trophic level in this food web is called the quaternary consumer. Even though many candidates did know that the example was the heron, this was only part of the answer. A common misconception was that decomposer was the highest level in the food chain.

(iii) Most candidates correctly stated that energy from the primary consumers was transferred to the secondary consumers. This was often described in the context of the inefficient transfer along a food chain, suggesting that most candidates had not read the question carefully and were expecting to describe the inefficiency in the transfer, rather than how the energy is used to produce biomass. Those candidates who did understand the question went on to write comprehensive answers covering the full range of mark points.

(iv) There were many excellent predictions on the impact of the overharvesting of salmon on the food web. Those candidates who used the names of the organisms in the food web often gained full credit, but a few chose to use the terms primary consumer and secondary consumer not realising that the same trend was not true of all the organisms at each trophic level. Some candidates who followed the impact through the food web very carefully wrote some excellent explanations as to why it was not possible to predict the impact on the aquatic plants because of two different interactions from the midges and from the mayflies and shrimps. A minority of candidates did not understand the impact of overharvesting salmon and described the reverse impact. However, the error carried forward rule ensured that these candidates gained some credit for this mistake.

(b) Although most candidates knew that decomposers feed on dead organic material, only very few added that they receive their energy from this material.

(c) There were some comprehensive answers to this question on why it is more energy efficient for humans to eat crop plants than livestock. Most candidates described how energy transfers are inefficient and gave examples of how energy is lost along a food chain. Some candidates found it challenging to apply their understanding of energy transfer in food chains to the number of trophic levels in the chain. A common misconception, which linked with the misreading of **Question 2 (b)(iii)**,

was that energy is lost to growth and reproduction. Another misconception seen frequently was that plants contained more energy than livestock, when discussing the organism rather than the trophic level; some even went on to say that when consumers eat crop plants, they get 100% of the energy.

Question 5

(a) Many candidates identified the cell structure in the photomicrograph as a mitochondrion and correctly stated its function. A small minority of candidate incorrectly stated that it produces energy, rather than releases energy. A number of candidates thought that the label was pointing to cytoplasm, and this was credited as was an appropriate function of the cytoplasm. Many of those candidates who misidentified the cell structure, were able to gain a mark for correctly stating the function of their stated cell structure.

(b) Most candidates knew that the magnification is required to calculate the actual length of the cell structure, but were often too vague about the measurement required, i.e. the image length, often stating image size which is ambiguous.

(c) Almost all candidates converted the length in millimetres to micrometres, with only a small minority giving answers that were out by factors of 10 or 1000.

Question 6

(a) (i) Many candidates stated that the bean shoots in the Petri dish that was supported in a fixed vertical position grew upwards and that the roots grew down. However, a sizeable minority misread the question and only described the response in either root or shoots, but not both.

(ii) Many candidates also knew that the growth response is gravitropism. Many candidates did not realise that the investigation was carried out in the dark and stated that the growth response was phototropism. Others gave the answer tropism or simply wrote gravity.

(iii) Those candidates who had not noticed that this investigation was carried out in the dark invariably explained the effect of auxin in terms of phototropism. Nevertheless, these candidates were able to access many of the mark points if they knew where auxin was produced, how it moves, and that it causes cell elongation. Most candidates described gravitropism and wrote some very detailed and accurate answers. Common omissions were to describe elongation more generally, rather than to be specific in stating that the cells elongate, or to describe the shoots as bending, rather than the idea that they are growing or elongating. Two misconceptions were seen. Some candidates stated that auxin is produced in the area in which the effect occurs, and others stated that auxin moves against gravity in roots. Those candidates had often misread the question and attempted to explain the phenomena in roots, rather than shoots.

(b) (i) Almost all candidates stated an environmental condition that affects germination, with temperature being the most common. A few candidates suggested humidity and moisture, which implied they had not read the stem of the question before writing their answer.

(ii) There was a good range of correct suggestions for why oxygen and water are required for germination, with many candidates giving very detailed accounts of the use of water in activating enzymes and allowing solutes to dissolve. However, there were also many candidates who mentioned respiration without being explicit that oxygen would be required for aerobic respiration. Others mentioned photosynthesis in their answers, even though seeds do not contain chlorophyll and have no requirement for photosynthesis to germinate.

Question 7

Many candidates correctly completed each sentence in the passage about enzymes. The exception being the first marking point, when many candidates did not give small soluble molecules as being the products of chemical digestion. Common incorrect answers included liver as the site of trypsin production, low rather than high pH needed and digestion as the role of bile rather than emulsification.

BIOLOGY

Paper 0970/51
Practical Test 51

Key Messages

Candidates should manage their time so that they are able to complete the practical activity but also have enough time to complete all the questions.

Candidates should ensure that they read the questions carefully before starting to answer. This is particularly important for any planning exercise that is required. Identification of the dependent and independent variables is vital before a plan is completed. Controlled variables must also be considered and included in a plan.

Candidates should also try to match the answers they give with the number of marks available for each part of a question. A three-mark question will require three separate points to be made if full credit is to be awarded.

General Comments

Candidates performed very well on this paper with some clear and thoughtful answers. Most candidates appeared to perform well on the practical itself with some excellent results that were clearly presented. Time management appears to be good.

The planning exercise was done well overall with some good responses. Similarly, the drawing of the carrot section was done well with some good drawings of adequate size and quality.

The plotting of the points on the graph was very good considering the complexity of the data provided in the table.

It is important that candidates check their work thoroughly before moving on to the next question. This is particularly true for the graph and the calculation where several unnecessary errors were seen on some of the papers.

Comments on Specific Questions

Question 1

(a) (i) Most candidates were able to produce a suitable table which included data consistent with the practical carried out. Some candidates forgot to include the units in the table heading or put the units in the body of the table.

(ii) Most candidates gave a very good conclusion which related the temperature to the rate of respiration. The most common error was to describe the results in terms of the number of bubbles instead of the rate of respiration.

(iii) The calculation of rate of bubble production was done well but some candidates showed inconsistent rounding of the two answers.

(iv) Almost all the candidates could identify the independent variable as water temperature.

(v) This question asked for one variable that was kept constant. Some good responses were seen but a few candidates gave answers that lacked detail, such as simply stating time.

(vi) This question asked candidates to explain the two-minute wait before bubbles were counted. There were some confused answers, but a significant number were able to equate the wait to equilibration time.

(vii) For this question candidates were asked why counting bubbles was not an accurate method for determining the rate of respiration. As a result of the candidates actually doing the practical and seeing the bubbles being produced, the answers to this question were particularly good.

(b) Candidates were asked to complete the apparatus to measure the volume of gas produced by the reaction. Many candidates found this a real challenge with a significant number either leaving it blank or using inappropriate apparatus, such as a test-tube. A few candidates included a gas syringe even though the stem of the question told them to use a different method.

(c) Nearly all students could name Benedict's solution, but a significant number forgot to refer to the heating of the solution.

(d) The planning activity asked candidates to plan an investigation to find out how the mass of salt added when making bread affected the size of the dough ball formed. Many found the context challenging, even though standard experimental procedures could have been followed. For many candidates the identification of control variables, suitable repeats, and the use of at least two masses of salt gave at least 4 or 5 marks. The more challenging aspect of describing methods for measuring the volume of a solid, such as dough, was only obtained by a few candidates.

Question 2

(a) (i) The drawing of the carrot root section was reasonably well attempted by most candidates but there were a number of errors when drawing the relatively straight forward outline of the section. The detail at the centre of the root could be improved, with many not drawing the exact shape of the tissue layers. The drawing of any biological specimen should not include shading or stippling.

(ii) Most candidates scored well on the calculation of actual size, but care must be taken when measuring and the use of centimetres when measuring should be avoided. It is also important that candidates are aware of the difference between significant figures and decimal places.

(b) (i) The majority of candidates could identify the dependent variable in the investigation, although several referred to size rather than mass.

(ii) This question asked candidates to identify two variables that were kept constant during the investigation. Many candidates stated that the size or mass was constant, where in fact this was the dependent variable. Even the initial mass was not constant as this was different for each cube.

(iii) Many candidates gave very good answers as to why the carrot cubes were dried before measuring their masses. A few candidates were confused with the idea of measuring dry mass of the carrot cubes and missed the point of the surface water adding extra mass to the measurements.

(iv) The graph question was very well done, with some fairly difficult data to plot. A common error was to make the plotting points too large or to try to join points without the use of a ruler. Candidates need to think carefully about the scale they will use to ensure that the plotted points fill at least half of the graph grid.

(v) When asked to show an estimated value from a graph using interpolation between points, it is important that the lines drawn from the *x*-axis and *y*-axis are clear and visible. In this case, a clear indication of the point at which the line crossed the *x*-axis needed to be visible.

(vi) The calculation of percentage change was done well by many, but a few candidates found this challenging and used incorrect figures or an incorrect calculation.

(vii) Many candidates correctly referred to the identification of anomalous data points when answering this question. Care should be taken with the wording however, as repeating an investigation does not prevent anomalies, it merely allows them to be identified.

BIOLOGY

Paper 0970/61
Alternative to Practical 61

Key messages

When drawing conclusions from an investigation, candidates should reread the aim of the investigation. They should then give a conclusion linking the independent variable to the dependent variable.

Candidates are expected to be able to draw, complete and label diagrams of apparatus. Candidates should be familiar with the names of common laboratory equipment and should practise drawing apparatus.

When drawing graphs, candidates should be careful when choosing a scale so that their data fills at least half of the grid in both directions.

General comments

Many candidates demonstrated good skills throughout the paper, including table construction, graph drawing and biological specimen drawing.

Comments on specific questions

Question 1

(a) (i) The majority of candidates constructed a table with at least two columns and a header line. Some candidates could not be awarded the first marking point as their headings were floating. Candidates often included units in the body of the table, usually ºC, or did not put units for temperature in their headings or gave bubbles rather than number of bubbles for their heading. Some candidates misread the thermometers in Fig. 1.2, often as 41ºC and 19 ºC. Occasionally, candidates gave the temperature as hot water and cold water but did not give values.

(ii) A conclusion should relate the independent variable to the dependent variable. Sometimes candidates will have to look back to the start of the investigation to find the dependent variable. In this question, the investigation was into the effect of temperature on the rate of respiration in yeast cells. Therefore, the conclusion was that the higher the temperature the higher the rate of respiration. The dependent variable was measured by counting bubbles and many concluded that the higher the temperature the higher the number of bubbles produced but did not relate this to the rate of respiration. Some referred to rates of reaction, but this was insufficient. Almost all candidates were able to make a comparative statement in their responses, and most avoided the error of simply restating results.

(iii) Most candidates gave correct answers by dividing 54 by 3 and 12 by 3. Some divided the number of bubbles by 2 minutes or 60 seconds. Others divided 18 by 3 (the temperature) rather than 12 (number of bubbles).

(iv) Temperature was correctly identified as the independent variable by most candidates. Some incorrectly gave constant variables such as time or volume of yeast and a significant minority provided number of bubbles, the dependent variable, as their response. Some candidates wrote both the independent and dependent variable together, rather than selecting just the independent variable.

(v) The most common correct response related to the volume of yeast in each syringe. A significant number of candidates stated that water or time was kept constant. Step 3 of the investigation stated that the water level in the measuring cylinder was above the syringe nozzle but did not say that the volume of water was always constant. An answer of time was not enough for the mark. Candidates either needed to give the time for equilibration or the time for counting bubbles as their answer.

(vi) A variety of responses were given for this question. Some candidates understood the idea of equilibration; that the yeast had to be left to reach the temperature of the surrounding water. However, many candidates thought that this time was needed so that the yeast could start respiring or producing bubbles. Yeast will always be respiring so this is not a correct answer. Responses also referred to the water heating up or cooling down, rather than the yeast, suggesting that the method had not been clearly read.

(vii) A range of responses were seen, but most related to the idea that it is easy to miscount the bubbles or that the bubbles are different sizes. Some candidates referred to human error or subjectivity but did not link this to errors in counting and so did not gain credit for their response.

(b) Candidates had to draw and label two pieces of apparatus used to measure volume of gas, apart from the use of a gas syringe. It was expected that candidates would draw a delivery tube leading into an inverted measuring cylinder with graduations, in the container of water, which was already drawn. Most candidates found this question difficult. Many drew a gas syringe or a thermometer in the container of water. Some did draw a tube, but most did not correctly draw a second piece of equipment to measure the volume. Some candidates drew the correct apparatus but did not label it. Delivery tubes were often incorrectly identified as pipes and they were often drawn in the wrong location in relation to the measuring cylinder.

(c) The Benedict's test was well known and most also knew that Benedict's reagent should be heated with the sample. This question asked candidates to describe the method for testing for reducing sugars. Candidates were not expected to give the results of the test, although a large number did.

(d) Candidates were asked to plan an investigation to determine the effect of the mass of sodium chloride on the volume of dough.

Most candidates described an investigation where dough was made containing different masses of sodium chloride and left for a set time. Many accurately gave three constant variables such as using a constant mass of yeast and flour in the dough and the same volume of water. Many described keeping the temperature constant. Precision should be given when describing the constant variables. For example, saying that the experiment is left for about half an hour is not enough.

Few candidates gave a valid dependent variable. Some described the need to measure how much the dough has risen but did not state that this could be done by measuring the volume of dough before and after. Some thought the volume of carbon dioxide produced needed to be measured using a gas syringe. Mass and volume were often confused as concepts.

Candidates should give more detail in their methods. For instance, marks were given for describing the use of a balance to measure the mass of the dough ingredients and describing a method to measure the volume of dough, e.g. using a measuring cylinder. Few candidates were awarded the mark for giving an appropriate number of repetitions. In many cases this was because a single repeat of the experiment was given, rather than two further repeats i.e. three trials in total. A number of candidates did not mention repetition of the experiment at all. Some candidates did mention suitable apparatus for their experiment, but simply listed it and did not then describe its use, so could not gain credit. Candidates should be aware that simply stating the name of the independent variable but then giving no indication as to how this variable will be changed in an experiment will not be given credit.

Question 2

(a) (i) Many high-quality drawings of the carrot root cross-section were seen, giving appropriate detail to get full marks. Those that included too much detail, e.g. by drawing cells, could not be awarded marking point one. Most drawings were an appropriate size, although a few were too big and crossed into the text at the top or bottom of the question. Most drawings had a clear, continuous outline, with no errors. Those that included shading or hatching could not be awarded marking point one. Most drawings had at least three layers drawn with a bump shown on the left-hand side of the cambium layer.

(ii) Generally, this question was very well answered. The line **PQ** was nearly always measured accurately, and the actual diameter of the carrot root cross-section usually calculated correctly. The most common error was to not give the answer to one decimal place. Candidates must ensure they read all instructions carefully. A few multiplied by 6 rather than dividing by 6. Some had difficulties converting cm to mm.

(b) (i) The dependent variable in this investigation was the mass of the carrot cube. Most candidates answered this question correctly, but some gave answers such as mass, which is not enough, or concentration of salt solutions which was the independent variable.

(ii) The most common correct answer was the time that the carrot cubes were left in the salt solution. Many candidates incorrectly gave size or volume of the carrot cubes. As this changed over the course of the investigation this was not a constant variable. A correct answer would have been the initial volume of the carrot cubes, which was kept constant. The initial mass was not constant. Time, unqualified, was not enough for a mark. Again, sufficient detail for a mark is provided in the description of an experimental method, and candidates should be encouraged to read the method and make sure their description of a variable is sufficiently detailed to be unambiguous and thus gain credit.

(iii) Candidates answered this question in a variety of ways, but most had the idea that the carrot cubes should be dried as the extra solution would add to the mass of the carrots. Those that said it was done to improve reliability or accuracy did not get a mark. Some said that it was done to remove the excess salt solution but did not explain that this extra solution would add to the mass.

(iv) Most candidates labelled the axes correctly giving suitable labels including units. The scale mark was the most commonly missed mark for this question. Often the scale for the *y*-axis was too small, so the data points did not cover at least have the available space. Another common error was to give values on the *y*-axis, which were out by a factor of 10. For example, giving 0.4 rather than 0.04. Some gave a non-linear scale, and some put the axes the wrong way round. The independent variable should be on the *x*-axis. Plotting was generally accurate, and a line was drawn point to point with no extrapolation. Some candidates found the negative plots confusing and produced non-linear scales with values distributed in very unusual places. As osmosis experiments do involve mass loss and negative values, more practice constructing and plotting graphs of this nature would be useful. Almost all candidates avoided the error of plotting a bar graph instead of a line graph.

(v) There was some misunderstanding with this question. A significant number of candidates thought they had to give the concentration where the mass of carrot cubes became constant, i.e. at 1.1 mol per dm^3, rather than where their line crossed their *x*-axis at zero change in mass. Those that misunderstood were still able to get one mark for showing an intercept. Candidates should be reminded that accuracy of plot points and readings from a graph are usually applied to within plus or minus one half of a small square; hence care needs to be taken when reading their values. Some candidates did not indicate on their graph where they read their value from.

(vi) The majority of candidates gave a correct answer of –6.25%. Those that gave an incorrect answer often divided 0.06 by 0.9 rather than 0.96. Some also mistakenly divided 0.96 by 0.9.

(vii) Collecting several sets of results allows candidates to identify anomalous results. Answers that did not gain credit included to prevent anomalies, to increase reliability and so that an average can be calculated. Use of correct vocabulary in describing anomalies or outliers is important; abnormal results, errors, mistakes etc. were all seen in responses that showed the right understanding but could not gain credit because the wrong term had been used.

BIOLOGY

Paper 0970/62
Alternative to Practical 62

Key messages

When drawing conclusions from an investigation, candidates should reread the aim of the investigation. They should then give a conclusion linking the independent variable to the dependent variable.

Candidates are expected to be able to draw, complete and label diagrams of apparatus. Candidates should be familiar with the names of common laboratory equipment and should practise drawing apparatus.

When drawing graphs, candidates should be careful when choosing a scale so that their data fills at least half of the grid in both directions.

General comments

Many candidates demonstrated good skills throughout the paper, including table construction, graph drawing and biological specimen drawing.

Comments on specific questions

Question 1

(a) (i) This question was answered correctly by most candidates. Some candidates did not appreciate that a precision greater than 0.5 °C could not be given based on the scale given in Fig. 1.2. Therefore, an answer of 68.3 °C, for example, was not appropriate.

(ii) This question required the tabulation of three sets of data. Good responses gave a clear table with four columns and correct headings and units. Common errors included not providing suitable headings, entering units in the body of the table, missing units, or using incorrect units, e.g. using 'm' which is the unit for metres not minutes. A few candidates did not format the table correctly and combined three separate tables or simply restated Fig. 1.5.

(iii) Most candidates recognised that a line graph was appropriate for the data, and they also gave an appropriate key for the three sets of data. Good responses ensured the graph was of suitable size with correctly labelled axes, including units. Inappropriate scales often resulted in three lines clustered at the top of the grid with points from the different lines too close together. The height from the highest plotted value (73 °C) to the lowest plotted value (55 °C) should cover at least 50% of the height of the grid. It does not mean that just the scale values on the axis cover at least 50%. Some candidates chose a scale for temperature that made it difficult for them to plot the data, e.g. increasing by 15. Candidates should try not to draw lines that are too thick or have a wavy line that occupies too much vertical space. Some candidates extrapolated lines past the last data point, and some extrapolated their lines towards 0, even though there were no results for time = 0.

(iv) Some candidates were able to correctly describe the relationship between heat loss and tube number, but some found it difficult to give two different conclusions and merely gave the reverse of their first answer. Some also recognised that as time passes, the temperature in the tubes decreases. Weaker responses restated the results of each of the tube groups but did not comment on the relationship. Some also described temperature dropping more slowly as an increase in temperature or as maintaining the temperature. Few candidates related the results to the aim of the investigation and did not refer to huddling and the consequence on heat loss in animals.

(v) Many candidates found this question challenging. Good responses recognised that time intervals were kept constant or that the test-tubes were the same size or type. Several candidates made incorrect assumptions that related to the starting temperature of the tubes, the volume of water and the environmental conditions. These were features that had not been specified in the experiment or could be shown to be incorrect.

(vi) Good responses clearly stated errors and understood the importance of stating the actual problem, e.g. volume of water was not measured accurately, rather than just stating volume of water. Some candidates described improvements rather than errors, or suggested aspects of human error, which was not appropriate for this question. Those who suggested that thermometers should have been placed in all the test-tubes in the group had misunderstood the point of the investigation.

(vii) There were some excellent answers with candidates identifying a variety of different improvements that could be made. These were often ideas about starting all tubes at the same starting temperature or using the same volume of water in each tube. Some candidates only stated how water should be measured, e.g. using a measuring cylinder, and did not specify that the same volume should be put in all the tubes. Repeating the investigation was another common answer but some did not specify that it should be repeated at least twice more.

(viii) This question was generally very well answered with most candidates able to recognise the hazard posed by hot water or hot test-tubes. Weaker responses concentrated solely on the precaution without referring to the hazard at all. It was clear that the term hazard had not been understood by some.

(b) Many candidates answered this question well and scored full marks. Most candidates described using at least three different temperatures. They understood the need to control variables such as the volume and concentration of starch and/or amylase, but many referred simply to the amount rather than a specified volume or concentration. Some candidates referred to controlling the pH, but few described the use of a buffer to control it. Several candidates described the use of thermostatically controlled water-baths. Few candidates equilibrated both the solutions separately before mixing and only placed one of the solutions in the water-bath to equilibrate.

Most candidates chose the Benedict's test as a method for determining when the starch had been broken down. However, many added it to the starch and amylase mixture at the start rather than the correct method of adding it after a specific incubation time and recording a colour change or removing a sample to test at regular time intervals. For those who chose iodine solution, some took samples and used a spotting tile, but others incorrectly thought that they could add it to the starch and amylase mixture, and measure how long it took for the iodine solution to turn from blue-black back to brown as the starch disappeared.

Candidates have clearly been well trained in stating that an experiment should be repeated at least twice, and that gloves and goggles should be worn. A few misunderstood the question and wrote theoretical answers about enzymes and respiration or continued the theme of heat loss from part **(a)**.

Question 2

(a) (i) The best responses referred to avoiding bias or being able to identify anomalous results. Weaker responses incorrectly described preventing anomalous results. Many candidates discussed improving accuracy or did not qualify reliability in terms of improving or increasing it. Some also referred to calculating an average without appreciating that this value would be more representative of the population if a large sample was used. Some answered in terms of there not being many leaves in winter and so needing a large number.

(ii) Most candidates gained full marks, although some did not indicate on the graph how their value had been estimated. Some candidates did not appreciate that precision could not be applied to decimal places based on the scale given and gave answers such as 3.25 instead of 3.2 or 3.3.

(iii) Although most candidates were able to correctly select the right data from the graph, a significant number did not correctly calculate the percentage increase and used 2.2 as the denominator instead of 1.4. Many candidates did not give the answer to two significant figures, and some misread the question and gave their answer to two decimal places.

(b) A wide range of correct responses were seen. The area was mostly calculated within the acceptable range, although several did not include units or gave the wrong unit (cm or cm^3).

(c) Most candidates correctly identified the Benedict's test as the test for reducing sugar and correctly stated the colour(s) for a positive test. Some candidates did not refer to the need to heat the sample. A few candidates incorrectly referred to using Biuret reagent, DCPIP or iodine solution.

(d) Nearly all drawings were large enough, although some extended into the text. Outlines were mainly good, but some lines were sketchy, discontinuous, or very thick. Some of the veins were drawn inaccurately so that their line crossed over the outline. Nearly all were drawn with the required five lobes, but a few did not feature one main vein in each lobe.

(e) Most candidates correctly referred to the presence of veins or the five sections of the leaves when asked for a similarity. Some incorrectly referred to parallel veins or five leaves or petals. Most candidates could correctly describe a difference. However, candidates need to be aware that referring to the absence of a feature, e.g. the fig leaf had rounded leaves, but the grapevine leaf does not, will not gain credit. Differences need to be comparative, but many answers were not, either referring to just one of the leaves, e.g. the fig leaf has a smooth edge, or not linking the feature to the leaf type, e.g. one has a stalk, the other does not. Some candidates incorrectly referred to the petiole or stalk as a stem or confused the identity of the leaves in their answer. Candidates should also be aware that, with no indication of a scale on Fig. 2.3, any reference to a size difference is not appropriate.