

T A S M A N I A N

S E C O N D A R Y

A S S E S S M E N T

B O A R D

BY826

Biology

1999 External Examination Report



#### Membership

Co – Chief Examiners	Perviz Marker Robert Hopwood
Moderation Adviser	Perviz Marker
State Moderator	Anne Dean

#### Meetings

The Chief Examiners met with the marking team at Newstead College during the week after the exams. With a team of 16 markers the standards required for A, B and C ratings were determined for the externally assessed criteria. The Assessment Panel met in the second week of December to review the results and reassess the borderline candidates on an individual basis. The internal/external correlations for each school were compared with those for the state.

#### General Comments

The examination paper was deemed to be very fair and was well received by all. The content and range of questions were excellent. The questions ranged from straightforward short answer questions to some open ended questions, which allowed students to extend themselves.

Criticisms of the paper were more in the wording of some questions, which confused candidates, and in section E that did not have sufficient open-ended questions which inhibited students in extending themselves. This resulted in very high marks being obtained in this section and high standard being set for the A, B and C ratings.

As in previous years candidates lost marks by failing to read the questions carefully and not giving as full an answer as required. From the statewide figures there is some concern that a high number of students did not reach a C rating in the exam in criteria 4 and 5. These two sections were indicative of where students did not provide sufficient explanations to their answers and where application in thinking needs to be developed to a greater extent. It is also interesting to note that students were generally receiving A and B ratings much more frequently in their internal ratings of Criteria 3,4,5,8 and 9 than C ratings compared to the exam.

#### Written Examination

The following section specifically comments on candidate's performance in the exam. Marking examiners offer suggested answers to each question followed by specific comments on aspects such as how the question was assessed, where candidates gained and lost marks and where candidates misinterpreted questions. Comments on the open-ended questions may necessarily be limited to general comments rather than a suggested answer.

The suggested answers are by no means prescriptive and a number of them go into a greater detail than would be required to gain full marks. Candidates providing different but valid answers were rewarded accordingly.

## Section A

## Question 1

- (a) The cell is found in the leaf, outer part of a stem or green part of a plant. (Any one is acceptable.) The cell contains chloroplasts for photosynthesis and it contains a cell wall that are found in plant cells. (A vacuole is acceptable as one of the reasons, as is the starch grain in one of the chloroplasts)

(1 where cell found; 1 for each reason - one reason must be chloroplast; total of 3 marks)

'The fine structure of chloroplasts can be seen.' or 'The fine structure of mitochondria can be seen.' or 'The organelles can be seen clearly' or 'The scale for the diagram indicates the dimensions that can be seen with an electron microscope.' (Any of these reasons and the fine structure of other organelles is acceptable).

(b)

Biological Features Found in a Cell	Matching Everyday Terms
Cell membrane/wall	security fence
Ribosome	manufacturing assembly line unit
Chloroplast	solar panel
Golgi apparatus	pack and wrap department
Mitochondrion	power generator
Endoplasmic reticulum	transport canal system

- (c) The entrance of needed materials and the exit of wastes limit the maximum metabolic rate. The shape and size of a cell determines its surface area to volume ratio. The larger the surface to volume ratio, the more efficient is transport across the cell membrane as there is more surface area for the volume. Smaller cells have a larger surface area to volume ratio. A sphere has the smallest possible surface area to volume ratio for a certain volume and the materials have to diffuse further. Flatter shapes, with the addition of villi or similar, will have a larger surface area for uptake and release and no part of the cell will be far from the membrane. Small, flat cells with villi will maximise the metabolic rate.

## Examiners Comments

- (a) (i) The answer, cell wall and vacuole, is not sufficient to place a cell in the green part of a plant and did not receive full marks. Mitochondria and cell membrane are not acceptable reasons as they are present in plants and animals,  
(ii) The answer, chloroplasts can be seen, is not acceptable as they can be seen using a light microscope.
- (b) There was no flexibility in the marking of this part of the question,
- (c) This part of the question was the most difficult. Most answers were incomplete. For example, stating that the surface area to volume ratio affects transport in and out of a cell is general and not sufficient. It is important to include that smaller cells have a larger surface area to volume ratio. Many students forgot to include the shape after giving correct answers to the volume part.

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**Question 2**

- (a) Part A Photosynthesis  
Part B Cellular Respiration
- (b) (i) In strong sunlight photosynthesis is occurring, thus converting carbon dioxide and water to glucose and oxygen using chloroplasts. The rate of respiration (which uses oxygen) is constant so the rate of photosynthesis in strong sunlight is greater, thus giving a net gain of oxygen.  
(ii) At low levels or very high the rate of photosynthesis is reduced and the rate of photosynthesis becomes equal to the rate of respiration. (The oxygen being produced by photosynthesis is being used in respiration)  
(iii) Reduced (very high also)
- (c) (i) Enzyme activity decreases with a decrease in temperature. Enzymes have optimum temperature range and function is diminished outside of that range.  
(ii) Boiling water is 100 degrees. This temperature would be over the maximum suitable for the functioning of the enzyme. The enzyme would have been denatured which means it would have lost its three-dimensional shape, the active site would be destroyed thus preventing the enzyme from working on its substrate.  
(iii) Acid or base -enzymes are pH specific.  
(iv) Competitive or non-competitive inhibitor to take up the active site or change the structure of the enzyme.  
(v) Poisons destroy enzymes

**Examiners Comments**

- (a) Part A and B - most students were correct. Some students thought this was light dependent and light independent stage of photosynthesis
- (b) (i) Most students linked this with photosynthesis discussing oxygen as a product. Only a few mentioned the fact that the rate was greater than that of respiration.  
(ii) Generally answered quite well. A high proportion of students responded with regard to the respiration rate being equal to the photosynthesis rate and many mentioned compensation point.  
(iii) Almost all students gained this mark
- (c) (i) Must refer to enzymes. Simply discussing chemical reactions in general would not gain the whole two marks.  
(ii) The word 'denature' generally awarded 1 mark. For full marks must mention the changed structure and active site of the enzyme etc. Many students referred to the process as 'killing the enzyme' and were awarded no mark if this was their only answer.  
(iii) Quite well answered overall. Many students suggested lemon juice.

**Question 3**

- (a) (i) Osmosis  
(ii) The solutions of 0.5M and 1.0M were hypotonic to the worms. The net flow of water was therefore into the worms from the 0.5M/1.0M solution in order to dilute the cell contents so that they were equal to the external solution. This resulted in an increase in the worms' mass. The 1.5M solution

was isotonic to the worms' cells so that no net movement of water occurred and therefore no mass increase.

- (iii) 1.5M
- (iv) These approaches are osmoregulation (maintain their internal environment) and osmotolerant/conformation - sandworms (allow body fluid concentration to fluctuate with the external environment).
- (b) (i) III, IV, I, II
- (ii) Crossing over is occurring in IV. This is the exchange of genetic material between chromatids of maternal and paternal chromosomes. This leads to the formation of recombinant chromosomes which are different from either the maternal or paternal chromosomes. The increased genetic variation that results can be advantageous to the survival of the species as selective processes occur.

#### Examiners Comments

- (a) (i) and (iii) were basically very well answered - 1 mark was awarded for diffusion in (i) and no marks were subtracted for lack of units in (iii).
- (ii) Most students had some understanding of the required answer but the use of terms such as osmotic pressure, osmotic potential and hyper/hypo/isotonic was often incorrect. Many students explained what was happening without relating their answers to increased average mass as asked in the question.
- (iv) Students who did not know the terms osmoregulator and osmoconformer/tolerator found it difficult to answer this question clearly.
- (b) (i) A surprising number of students could not place these in order. Many misread the question and tried to name each stage.
- (ii) Many misconceptions about crossing over - students believed new genes were formed rather than the rearrangement of DNA to form recombinants. Most students had trouble expressing their ideas clearly and so very few received full marks.

#### Section B

##### Question 4

- (a) **Mechanical breakdown (2 marks total):** Identify adaptation (eg. teeth, bile, gizzard, churning of stomach (1 mark for 1 or more) and provide an explanation of how one of them operates (1/2 mark) and indicate the importance of mechanical breakdown in increasing the surface area available for later enzyme action (1/2 mark)

**Chemical Digestion (2 marks total):** Carried out by a series of enzymes (1 mark). These are secreted into the digestive tract from glands (eg. pancreas, salivary gland) OR mention adaptations of digestive tract (eg. folds in lining of stomach) which increase surface available for enzyme secretion OR provide a specific example of the sequential nature of enzyme action - eg. salivary amylase breaks down starch to disaccharides in mouth, then another amylase breaks it to monosaccharides in the small intestine (1 mark).

**Absorption (2 marks total):** Small intestine has adaptations which allow for maximum, rapid absorption.

- eg. Large surface area available (1 mark) due to length of small intestine OR presence of villi (1 mark)
- eg. Maintenance of a high concentration gradient (1 mark) as blood and materials in gut are continually moving (1 mark)
- eg. Movement of small molecules through intestinal wall is due to its semi-permeable nature (1 mark) and is facilitated by the thinness of the membrane and its proximity to capillary beds (1 mark).

A number of different answers were accepted. Mark allocation depended on clarity of answer and the extent to which it explained **why** it made digestive processes more efficient. Possible answers (each worth a maximum of 2 marks) include:

- A linear digestive system allows for step-wise/sequential processing.
- It allows an organism to eat continuously as ingestion, digestion and excretion can occur simultaneously.
- It enables establishment of environments within the gut, which have different conditions (pH etc.) which are optimal for the set of enzymes working in that area.
- It prevents the mixing of nutrient-poor wastes with nutrient-rich foods, thus increasing the efficiency of both enzymes and absorption.

Any **three** of the following, with some slight elaboration, received 1 mark each: large surface area; highly vascularised; thin membrane; semi-permeable membrane; moist membrane; maintenance of a concentration gradient.

#### Examiners Comments

- (a) Most students selected a human or another mammal as their organism. Where other organisms were used (eg. antelope, sheep, bird, koala) students often didn't gain as many marks as their answers tended to concentrate on the 'unusual' aspects of the chosen digestive system (eg. caeca, ruminant stomachs) and failed to mention the more 'normal' aspects, eg. absorption in small intestine. Overall, the question was generally well answered, although a large number of students did not mention enzymes at all, referring instead to 'digestive juices' and 'chemicals'. Many students gave a description of the passage of food from the mouth to the anus, outlining the processes involved, but not fully explaining *adaptations* of the digestive system which allow these process to occur.
- (b) Students often struggled to express themselves clearly, often only rephrasing the question. Good answers compared a two-opening digestive system to one with a single opening.
- (c) This section was extremely well answered by the majority of students, with good students comparing alveoli to villi.

#### Question 5 - (a) and (b)

- (a) (i) C & D (1/2 mark each)
- (ii) Blood pressure in the main artery of the arm would decrease. (1 mark)  
Blood pressure in vessel D would increase because blood is banked up in the left side of the heart. (1 mark)
- (iii) The increase in blood pressure in D causes an increase in pressure in the capillaries of the lungs. (1 mark)  
This forces fluid out of the capillaries into the alveoli. (1 mark)

- (b) (i) high blood pressure (1/2 mark) and pores in the capillary wall (1/2 mark) or semipermeable membrane (1/2 mark)
- (ii) Osmosis or diffusion or concentration gradient or ADH (1 mark)
- (iii) Urea must be removed by the kidney as it is toxic (1 mark) when it builds up. Excess salt(1 mark)is removed so that its concentration is kept constant in the blood.(1 mark)  
Or If the concentration of the salt in the blood is too low more is reabsorbed (1 mark) to maintain homeostasis. (1 mark)
- (iv) Any of the following was awarded 1 mark: enormous surface area, wastes removed more rapidly, filtration faster, more reabsorption, kidney can still function if some nephrons are damaged.

#### Examiners Comments

- (a) (i) A disappointing number of students did not get both C & D.  
(ii) The first part was well answered.  
(iii) Very few students could relate the increase in blood pressure in D to an increase in pressure in the capillaries of the lungs, which would then force fluid out of the capillaries into the alveoli. Many incorrectly stated that osmosis would occur.
- (b) (i) Most students realised that high blood pressure was important. Very few mentioned the pores in the capillary wall or the semipermeable membrane.  
(ii) Satisfactorily answered. A disappointing number of students stated 'active transport' caused water to return to the capillaries.  
(iii) This part of the question was very poorly answered because the students had not read the question carefully. It asked for the importance of the difference in salt and urea in the blood entering and the blood leaving the kidney.  
(iv) Well answered. However, many students stated that substances were 'absorbed' rather than 'reabsorbed'.

#### Question 5 – (c) and (d)

- (c) (i) The process is transpiration (1/2) and structure IV is a stoma (1/2).  
(ii) It is only possible for water to move out of the leaf when the stoma is open (1). The movement occurs because of the concentration gradient between the inside of the leaf and the surrounding air (1).  
(iii) Two of (1 each)
  - waxy cuticle which reflects light and heat
  - stoma on the underside of the leaf to reduce transpiration
  - stoma in pits to increase water saturation
  - hairs on the leaf to hold moisture.

(iv) One of (1 each)
  - leaf on edge to sun to minimise heat contact
  - small leaves to reduce evaporative surface area
  - succulents have fleshy leaves to retain water
  - stoma able to close in high temperatures to reduce transpiration loss of water etc.

(d) (i) In summer there are more hours of sunlight and the temperature is higher (1/2). Transpiration occurs between the hours of 5 - 10 am and 4 - 6 pm (1/2). This allows the plant to photosynthesise sufficiently, and also to conserve water in the hottest part of the day (1/2), by closing its stoma between 10 am and 4 pm (1/2). In winter transpiration occurs from 8 am to 5 pm, making best use of

- the available sunlight hours for photosynthesis (1/2). Water conservation is not important, and enough carbon dioxide is obtained for photosynthesis from the open stoma (1/2).
- (ii) Stoma need to be open to allow for the entry of carbon dioxide for photosynthesis (1), but water loss (transpiration) will occur (1).
  - (iii) The area (1) under the carbon dioxide uptake graph (1) is a measure of growth since this is when photosynthesis occurs.

#### Examiners Comments

- (c)
  - (i) The answer 'diffusion' was allowed also, and most students gained 1 mark.
  - (ii) Students easily gained one mark for the obvious part of the answer. The additional explanation relating to the concentration gradient was usually missing. The wording of this question, asking 'why', made it difficult for students.
- (iii) and (iv) Most students were able to give enough examples and explanations for 3 marks. Incidentally leaves have a high SA/Volume ratio to allow for maximum light absorption.
- (d)
  - (i) The quality of answers for this question varied greatly. Most mentioned temperature differences, but some answers which related these well to transpiration differences forgot to mention the (probably thought to be obvious) need for water conservation in high temperatures. A few answers referred only to light differences, and could be given only 1 mark in the context of the question.
  - (ii) Generally well answered by students.
  - (iii) While most answers correctly identified carbon dioxide uptake, it was not related to the specific information which could be read from the graphs.

#### Question 6

- (a) The concentration of any substance in the blood will determine the concentration of that substance in the tissue fluid that bathes the cells. Substances will move between the blood and the tissue fluid by diffusion and osmosis according to prevailing concentration gradients.

The same substances will move between the tissue fluid and the cells, also due to concentration gradients. The dissolved substances will also pass between adjacent cells.

Thus if the concentration of dissolved substances in the blood is controlled then the concentration of the substances in any other medium (cytoplasm, tissue fluid, cell sap) will be affected accordingly.

- (b)
  - (i) Recessive, Reason: Parents who do not express the trait have children that do express it (eg: 1 & 2 and 18 & 19). Occurs in the second generation and not the first.
  - (ii) The trait could be either sex-linked or autosomal. There is not enough information to be certain about which it is. 1 marks were given if students who said one or the other and substantiated their answer with a reasonable statement.

Example: Sex linked – only occurs in males. Autosomal – as it would seem that fathers pass the trait to their sons and this is not possible in sex-linked crosses.

- (c) Male parent: bbss (both traits described in the question were recessive so therefore this is the only possible genotype for the male parent.

Female parent: Could be BBSS, BbSS, BBSs, BbSs. She must carry at least one recessive colour gene (b) as there are offspring who are white. Therefore she is either BbSS or BbSs

It is likely that she carries two genes for short hair (SS) as there are no long-haired offspring. This is not necessary though, the possibility that she is Ss cannot be ruled out. 9 offspring is not a very big sample and the 10<sup>th</sup> could still be long-haired. Therefore: Male Parent: bbss. Female parent: BbSS (most likely) or BbSs

#### Examiners Comments

- (a) This was the discriminator in question six with very few students achieving full marks or even 3/4 on it. Students could not make the link between blood & tissue fluid & cells and concentration gradients and osmosis and diffusion.

Many students achieved two marks for saying that blood flows all around the body and thus affects all parts of the body including the concentration of substances. Some were awarded one mark for stating the question in the answer and expanding on the statement slightly.

The word control caused many students to discuss homeostasis in some way. Credit was given for this where the answer was well thought out. Full marks were never awarded for this discussion.

This was a very difficult question to mark as most students just filled the space with waffle. A good answer was very obvious when it was read.

- (b) Part (i.) was well answered with only a few students saying the trait was dominant. Some students were only awarded 1 or 1 marks as the reasons for why it was recessive were not clear.

Part (ii.) Most students therefore got one mark automatically. The only ones not to were those who wrote that the trait was sex-linked autosomal. 2 marks were only awarded if the student gave evidence that both modes of inheritance were possible.

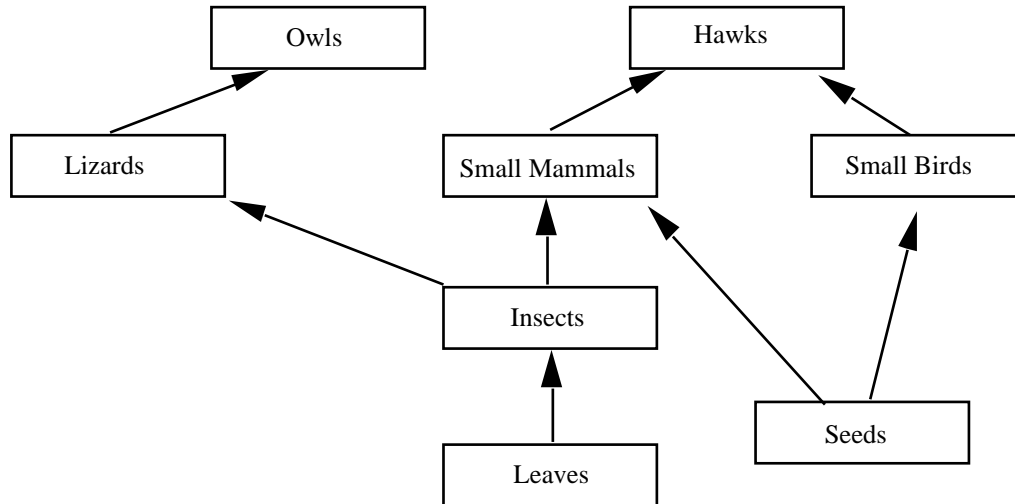
Awarding of the second mark was done very carefully to try and discriminate fairly between students.

- (c) Students were able to do this question quite easily. The best students identified that the female parent could be two different genotypes. Most just gave one or the other and depending on the working/reasoning given 3 or 4 marks were awarded.

## Section C

## Question 7

(a)



- (b) Feeding niche of owls are small mammals and lizards. (1 mark)  
 Feeding niche of insects is the leaves and they are also the prey of lizards, small mammals and small birds. (1 mark)

Also accepted: (Question only says 'Name')

Owls are top carnivores. (1 mark)

Owls are 2<sup>nd</sup> or 3<sup>rd</sup> order consumers (when eating mammals). (1 mark)

Owls are 3<sup>rd</sup> order consumers (when eating lizards). (1 mark)

Insects are herbivores. (1 mark)

Insects are 1<sup>st</sup> order consumers. (1 mark)

- (c) (1 mark given for any of the following possible answers)

- (i) Owls and hawks are in competition for food (small mammals), territory and nesting sites.
- (ii) Small mammals and small birds are in competition for food (seeds and insects).
- (iii) Lizards and small mammals compete for insects.
- (iv) Lizards and small birds compete for insects.

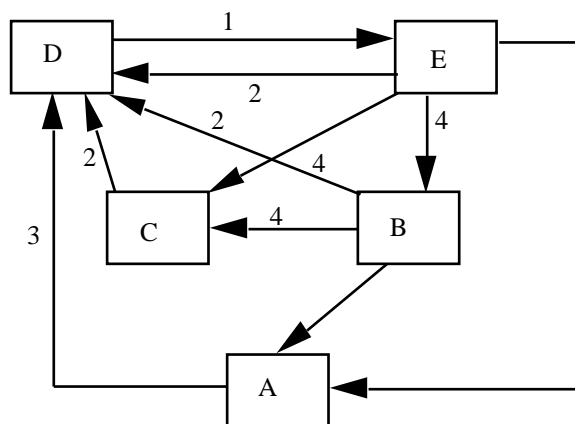
- (d) The fungicide used in the orchard was probably a persistent toxic chemical and **not biodegradable** (eg. contained mercury). (1 mark) Some of the fungicide **entered the food chain** of the forest ecosystem when insects eat the leaves or fruit in the orchard (or if some of the spray drifted from the orchard into the forest and contaminated leaves and seeds). (1 mark) The fungicide would probably be **stored** in fat (or it was not water-soluble and could not be excreted) and so it **accumulated** (was amplified or magnified) as it passed along the various food chains. (1 mark) While the fungicide might not be very harmful in low concentrations ('recommended levels of application'), a single owl (or hawk) will eat numerous lizards or small mammals (or small birds) and so in a tertiary consumer the **concentration of the fungicide may reach lethal levels**. (1 mark)

## Examiners Comments

- (a) This question was very well answered. Most candidates began with the producers (leaves and seeds) and had no difficulty constructing this simple food web. Furthermore, no marks were deducted for arrangement (vertical or horizontal) or neatness. However, a single mark was deducted for each of the following: incorrect feeding relationships; missed feeding relationships; arrows not used in the diagram; and incorrect direction of arrows.
- (b) This question asked students to simply 'name' the niches of the owls and the insects. Consequently marks were given for stating the trophic levels of these two groups of animals although this did not show any understanding of the niche concept. About half stated the feeding niches, ('Eats small mammals and lizards' and 'Eats leaves') and these answers were given full marks. A surprising number only stated 'mammals and lizards' and 'leaves' and, because the question asked students to 'name' the niches, these answers were given part marks.
- (c) Most students were able to state two animals who were in competition for resources (half mark) and only a few of these neglected to give a reason why they compete.
- (d) Most candidates appeared to be familiar with biological accumulation ('bio-magnification') but only a small number of students were able to get full marks for this part of the question. Consequently, this part of the question was able to discriminate between the 'B' and 'A' rating students. Many ('B') students simply stated that the fungicide was passed from one trophic level to the next and accumulated to such an extent that it killed the owls and hawks. As indicated in the suggested answer, marks were given for stating, suggesting or describing the following main points:
- how the fungicide entered the various food chains;
  - the fungicide was probably not bio-degradable;
  - the fungicide was stored by the organism;
  - bio-accumulation, magnification or amplification occurred;
  - the increase in fungicide concentration became lethal.

## Question 8

(a)



2 marks for placing the components correctly and 2 marks for the processes.

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- (b) (i) Energy is stored in carbon compounds (starting with the conversion of the sun's energy during photosynthesis), so that movement of carbon compounds in the carbon cycle is also a movement of energy. (1 mark)
- (ii) Carbon is recycled. It changes form but is never lost. (1 mark) Energy flows through the ecosystem, starting with the sun and gradually being lost as heat as it flows through the trophic levels. (1 mark)
- (c) With a small population there will be a limited gene pool since the only source of variation will be mutation (which occurs infrequently) (1 mark)

The population will have to breed with others in this gene pool, so that genetic defects will be more likely. This occurs because the chance of offspring being homozygous for deleterious genes increases. (1 mark)

The bicycle means that the population can breed with people from differing gene pools. This increases genetic diversity and gives improved genetic health. (1 mark)

Greater variation means an increased likelihood that some individuals will survive any change such as differing climate or the introduction of a new disease and so the species as a whole will adapt by the process of natural selection. (1 mark)

#### Examiners Comments

This question was poorly done with only 10 full marks and 171 students getting 2 marks or less out of 11.

- (a) was difficult and many students placed some of the components incorrectly, then got stuck trying to place the processes and then they either made up their own processes or gave up altogether.
- (b) was well done.
- (c) was done very badly. Many students did not understand the term GENETIC HEALTH and so they went off at a tangent and got few if any marks. The most common errors involved Lamarck: either supporting Lamarck and saying that riding a bike made you fit and healthy which would then be passed onto your offspring or going against Lamarck and saying that riding a bike could make you healthy but could not be passed onto your offspring.

The students who recognised that the question was about genetic diversity generally scored well.

#### Question 9

- (a) Interaction between members of the same population contributes to homeostasis through
- competition for food resources
  - competition for mates
  - animals defending territories

Interaction with members of other species contributes to homeostasis through

- predator/prey relationships
- disease organisms

Non-living factors which contribute to homeostasis are

- elements of climate such as water availability, optimum temperatures and light intensities

- soil nutrient and pH requirements of plants

(1 mark for each of the above factors)

- (b) (i) The frequency has increased.  
(ii) Genetic variation in the population of the moth arose through mutation, meiosis and sexual reproduction, the variation including the Bt-resistant allele. Moths with the Bt-resistant allele are selected for by the Bt toxin, other moths are selected against. Surviving moths pass on the Bt-resistant allele to their offspring and resistant moths are again selected by the Bt toxin. Further generations of moth have an increasing frequency of Bt-resistance due to selection by the Bt toxin.

(1 mark for each point)

#### Examiners Comments

- (a) Problems with answers included discussion of only one example of control for each factor; a belief that reproduction was the answer to the first factor; not specifically addressing the factors, but writing an account of density dependent and density independent controls; missing the point of the question and writing about the pros and cons of inbreeding and breeding with other species!
- (b) (i) Most students could see there was an increased frequency, but many inferred this in a roundabout way. Some believed the allele became dominant (instead of recessive?)  
(ii) This question was generally well answered, but in most cases without mention of selection- just moths that die or survive. Some students took a Lamarckian approach- ie. each dose of toxin made the moths 'more resistant' or 'stronger'.

#### Section D

##### Question 10

- (a) A camel's ability to thermoregulate is affected by its level of hydration.
- (b) Deserts have been a barrier to migration of European starlings within Australia.
- (c) Randomly assign 100 broad bean seeds to 5 groups (sample size = 20). Plant all seeds and grow under glasshouse conditions so the following can be kept constant for all plants: soil, fertiliser, watering regime, temperature, humidity, light intensity and length of daily exposure to light. The control group (A) would have no onion root extract added. The remaining groups would each have a set amount of onion root extract added at regular intervals, increasing in concentration from B to E. (independent variable = concentration of onion root extract). As the plants mature, the bean pods should be picked and weighed (yield = dependent variable). Average total yield per plant should be tabulated and graphed against onion root extract concentration. The hypothesis would be supported if group A showed greater total average yield than some or all of the other groups. The experiment should be repeated.

A maximum of three marks were given to answers that clearly showed an understanding of the elements of good experimental design, but used the wrong independent and/or dependent variable.

Answers that gained five or six marks were those that showed understanding of how the various elements of experimental design should be applied to this question rather than simply giving a 'formula' answer.

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A clear method was given, elements of experimental design (sample size, control etc) were clearly identified and answers showed understanding of what was meant by yield.

#### Examiners Comments

- (a) This part of the question was well done with higher marks given to answers that showed an understanding that the experimenter would have been studying core body temperature, with rectal temperature used as a means of measuring this.
- (b) This part was not so well answered. Many answers implied that Western Australia has no areas of significant rainfall, moderate temperatures or even human habitation. Many answers also failed to recognize that starlings had successfully spread throughout eastern Australia over significant distances and into a variety of climatic conditions. A significant number of answers were not written as hypotheses and often gave a number of suggestions. Other answers were too vague (ie. the conditions don't suite them). Some good answers gave presence of predators, absence of suitable food source, and an inability to compete with existing birds as the underlying reasons.
- (c) When answering an experimental design question it is important for students to outline a method and not simply list a series of experimental design features (independent variable, sample size etc.). A significant number of students were able to correctly identify that the independent variable related to onion root extract, and that the dependent variable was yield, but then described a method which was not appropriate. Many students suggested planting broad beans alone, and broad beans alongside onions, without reference to the onion root extract. As the information supplied gave no indication of the amount of extract which was thought to affect the broad bean yield, better answers used a range of concentrations. It was obvious that many students had little idea of what was meant by 'onion root extract' and a surprising number of answers suggested planting the extract, and even harvesting it!

A clear description of the data which should be collected is important. Many students indicated that the height of the plants or the total weight of the bean plant should be measured. Some suggested collecting a range of data, such as height of plant, colour of leaves and 'yield'. Sample sizes ranged from one to twenty thousand! Students should recognize that it is easier to control variables under laboratory (glasshouse) conditions. Very precise details of how to control variables (water each plant with 50mL of water at 2:00 pm each day, or, allow all the plants to grow for three weeks) are unnecessary and may be quite inappropriate. Field experiments were acceptable, but students need to indicate that it can be difficult to control environmental variables under field conditions and explain how they would attempt to do so.

Despite being an easy question, very good answers were not common. The relatively low mark allocation and small number of lines given for this answer may have resulted in important information being left out of some answers, but some of the best answers were concise and covered all important details.

#### Question 11

- (a) (i) protein concentration in the feed  
(ii) total vitamin level in the feed

This part of the question was very well done with only a few students putting the answers back to front or saying it was the cost of feed per chicken.

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- (b) (i) total vitamin level  
(ii) time during which the eggs were collected in 24hrs  
or 100 hens  
or amount of feed

The majority of the students gave the right answer to this question with only a few students not giving the correct variables, instead they gave other variables that needed to be controlled.

- (c) Any of the following; breed of bird, temperature, light, age and health of the birds, water, amount of feed given, exercise, time of the year etc. Most of the students were able to come up with two variables easily but a few just repeated their answers from part b so no marks were given.
- (d) The effect of vitamin levels on the egg production relative to the feed cost. Most students only received one mark for this question because they didn't mention about the cost.
- (e) The answer could either have a line graph or another column added to the table, both of which had to represent the data as cost per egg versus production. Most students received only 1 or 2 marks because they didn't show the farmer exactly what he wanted to know. Most students gave the cost per 100 hens not cost per egg, which gave the student 2 marks. The other common answer was vitamin and protein level versus egg production which only gave the student 1 mark.
- (f) Many answers could be given for other tests; repeat test, how the size and quality of the eggs are affected and the effect on the bird, laying time, type of chicken, time of the year, use a combination of protein and vitamin regime, different temperatures, and having the birds in different environments ie battery or free range.

Many students only received one mark because they gave retest to increase sample size rather than looking of other ways to investigate the problem or improve the procedure already give.

Generally this question was very well done with the majority of student's scoring about 8 as the first five marks were fairly straight forward. The last 3 questions were the discriminators.

#### Question 12

- (a) (i) Unethical, differences in males ages, weight etc different, control group not free of previous exposure, a long an expensive process, everyone has different lifestyles, sperm counts naturally vary.  
(ii) Survey men in industrial areas compared to men in unpolluted areas and count the sperm count of a large number of males of similar age. If a correlation is found that more men in industrial areas have a low sperm count test on an animal i.e. a rat the experiment needs to be controlled and all variables kept constant. Half of the rats would be given chemicals the other half not. Test sperm counts before and after experiment, and compare results. For it to be meaningful a large number of surveys need to be carried out and the experiment on animals needs to be carried out to confirm a correlation.

(Students needed to include a survey/investigation and experiment to get full marks).

Other students gained some marks if they talked about sampling sperm of different males for chemicals.

- (b) (i) Capture, mark, recapture technique (2)  
(ii) Some sort of counting (half) monitoring (half) In a set area (half)

- (iii) Quadrats (half) randomly (half) placed in 1m<sup>2</sup> area and count (half) grass stalks for a number of sites and average (half) results of number/m<sup>2</sup>.

#### Examiners Comments

- (a) (i) Generally well done  
(ii) Many students did not read the question and were testing the viability of sperm not the *production* of sperm. The tests needed to be carried out the animal not the sperm out of the animal.
- (b) (i) Well done most students were able to gain half marks here for counting rats.  
(ii) Well done

#### Section E

#### Question 13

- (a) (i) rat tailed maggot and sludge worm  
(ii) As pollution level increased, dissolved oxygen level decreases  
(iii) As water temperature increases, level of dissolved oxygen decreases.  
(iv) 7 ppm or '6.5 to 7' were given the full mark. Any other answer between 6 and 7.25 was given mark.  
(v) Water must be free of pollution, and at a relatively low temperature to maintain the levels of dissolved oxygen that trout appear to require, in order to survive and be productive.
- (b) A variety of answers were accepted, but full marks were given only to those that related to sampling of animals, as the question required.

#### Any 2 of:

- Animals may only be present at certain times of year (ie. Mayfly nymphs metamorphose and leave the water.)
- Animals may only be present in certain microhabitats, and the animals listed have a variety of microhabitats, therefore many samples needed.
- Individuals within a species vary in their tolerance of pollutants, or may develop resistance to pollutants, therefore may tolerate levels outside their normal range.
- Animals may just be moving through the area, and not normally live at the pollution levels present.
- Animals such as trout are difficult to observe and capture, so the method becomes inconvenient.
- Sampling may affect the organisms adversely.
- Samples representative of the animals present may not be caught.
- Different types of pollutants may affect different animals in different ways, therefore water may be more polluted than the results suggest, depending on the type of contaminant present.
- Does a single animal of a species (ie trout) indicate a particular pollution level, or must a significant population be present?
- Animals may live in different levels of pollution, therefore the method does not give an accurate indication of pollutant levels.

- (c) (i) Over time, chlorine levels in the atmosphere have been steadily increasing. Levels of ozone above Antarctica fluctuate, but show an overall decrease. The rate of change of both substances appears to be related, from which a cause - effect relationship may be inferred, but further studies would be required to confirm this.
- (ii) A range of answers were accepted as extrapolation of the line was necessary approximately 3.8 to 4.4.
- (iii) Ozone levels fluctuate, therefore a short term study could be very misleading ie. 1960 to 64 data suggests a sharp increase (1).

Long term studies allow overall trends to be established and more reliable predictions of future levels. (or more reliable extrapolation of data.) (1)

Fluctuations may be due to a variety of uncontrolled variables such as weather patterns, long term studies allow such effects to be 'averaged out' and overall trends to be more reliably established. (1)

The rate of increase in chlorine levels changes. A study which terminated in 1974 would suggest much higher levels by 1990 than actually occurred as the rate of increase levelled off somewhat. Long term studies allow for changing slopes, therefore making extrapolation more reliable. (2)

#### Examiners Comments

Question 13 was answered very well by the majority of students, with a great many students scoring between 9 and 11 out of thirteen. Where possible, efforts were made to discriminate in favour of more precise and sophisticated answers. Answers to (a)(v), (b), (c)(i), and (c)(iii) in particular were marked with discernment.

Parts (a)(i) to (a)(iii) were answered correctly by almost every student.

Many answered 6.5 ppm for (a)(iv), but as 10<sup>0</sup> C is actually closer to 5 than to 20, this answer was only given point.

To score full points for (a)(v), no pollution, oxygen levels and temperature all had to be mentioned, plus some attempt at reasoning, ie. 'explain'. Some students mentioned that mayfly and stonefly nymphs should be present in the water source, and this also earned a mark as it was considered a reasonable interpretation of the information.

A wide variety of answers were given for (b) with any clear, logical problem related to sampling being given 1 point. Many students misread this question and criticised the experiment design. However, as information on the design of the experiment was not given, such answers were penalised. If the problems given by these students were well described and convincing, they were given mark, up to 1 mark for 2 such problems.

Question (c)(i) did cause considerable difficulty as many students answered based on previous knowledge of the relationships between chlorine in the atmosphere and depletion of the ozone layer. However, this data does not justify the conclusion that 'chlorine causes the depletion of the ozone layer', and this answer was given no credit. Nor was any credit given for explanations of the chemistry behind breakdown of ozone, as this is in no way indicated by the data. However, students who stated that chlorine levels have been steadily increasing while ozone levels have decreased were given credit for this statement, even if it was followed by something like 'which proves that chlorine breaks down ozone', though mark was deducted for the unjustified statement of cause effect. However, if they stated something to the effect that there may be a causal relationship, they were given credit for this.

This was a difficult question to mark, and there may be need for clarification of what constitutes a justifiable conclusion from data among teachers.

Question (c)(ii) was marked quite leniently due to the different extrapolations of the curve made by students. Most gave reasonable answers.

Question (c) (iii) was marked in a discerning manner to give credit to those students who explained clearly the benefits of long term studies. Three relevant points were required for full marks.

Overall, the question allowed students to score some points with little difficulty, but still provided a reasonable spread of marks.

#### Question 14

- (a) (i) Negates hypothesis, calcium deposited is the same for both (0.26  $\mu\text{g}$ )  
Supports hypothesis, around twice the amount of calcium deposited (1.63 Vs 0.81  $\mu\text{g}$ )  
Negates hypothesis, results suggest significant effect with more calcium with algae (0.81 Vs 0.26  $\mu\text{g}$ )  
mark given for whether negates or supports and the other for the evidence given in each case.
- (ii) Even though you cannot expect growth of algae at depths where light fails to penetrate (1/2), some growth would be expected as calcium deposition occurs in the dark without algae (1 mark) at a slower rate (0.26  $\mu\text{g/hr}$ ) (mark).
- (iii) Increases turbidity from pollution etc or increased cloud cover etc (1 mark for good reason mark for indirect or lessor reason).
- (b) *T. confusum* is favoured when the humidity is low at any of the temperatures tested and also at the lowest temperature (24°C) at either humidity. The most favoured conditions being 24°C and 30% humidity where it wins 100% of the time. *T. castaneum* is favoured when both the temperature and humidity is high, its ideal conditions being at 34°C and 70% humidity it wins 100% of the time. The change in humidity is more significant as *T. confusum* still wins 90% of the time at the highest temperature tested. 2 marks given if ideal conditions were stated with respective survival rates, another mark if they distinguished the success of *T. confusum* at 24°C at any humidity, and another if they could identify the importance of humidity especially at higher temperatures.

#### Examiners Comments

- (a) This section of the question was generally very well answered with few candidates scoring less than 5/11.
- (i) Better answers considered whether the results supported or negated the hypotheses given. Candidates needed to give the right reasons to get the full mark for each part.
- (ii) Answers needed to relate to the data given to show that some growth would have occurred, but at a slower rate, which most answers covered. The best answers considered that algae could not survive at depths where light could not reach.
- (iii) Answers needed to relate to a factor that directly affected light intensity, answers such as weather were too general to gain full marks.
- (b) Around half the candidates gave a basic answer that simply gave the ideal conditions for each species and quoting the respective survival rates. A lot of candidates took a lot of space to say only that. Some failed to really address the question, simply restating the information in the table without any interpretation. The best answers recognized the importance of humidity at higher temperatures and that *T. confusum* survived better at any humidity at 24°C.

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**Question 15**

- (a) No. The experiment was not controlled and too many assumptions were made. Even in a 'perfectly' controlled experiment such claims cannot be made. The soot cannot be claimed to be the cause of the effect (a dark colour mutation). Scientific experiments are limited in that they can only either support or negate such statements (3)
- (b) Two major faults needed to be stated **AND** discussed
- There was no control group (larvae fed leaves without soot), as a result there was nothing with which to compare the experimental results, and no conclusions should have been drawn (2)
  - Too few larvae were used and could have been unrepresentative of the entire moth population (2)
  - The genetic history of the original female moth was unknown. Likewise nothing was known about the original male. The original male could have been black or the female could have been a carrier of a recessive black gene (2)
  - The experiment was not repeated to lessen the affects of one off chance influences and uncontrolled variables (2)
  - Any other major fault that was discussed (2)
- (c) Three **OTHER** improvements needed to be suggested
- Run the experiment for several more generations (1)
  - Isolate pure breeding moths and feed their larvae soot/ no soot (1)
  - Collect moths from a wider area (1)
  - Control all extraneous variables (1)
  - Any other sensible improvement (1)

**Examiners Comments**

- (a) Many students misunderstood the question and assumed, from previous knowledge, that the question was about natural selection and the selective advantage of being dark coloured in a sooty environment. Other students assumed that the dark colour was an acquired characteristic and as a result could not be passed on to the moths' offspring. Some students said it was impossible for soot to cause a mutation, or for any environmental influence except for radiation to cause a mutation; – this is wrong. Other students did not know that a mutation would interfere with the organism's genetic code. To receive full marks the students had to mention the limitations of scientific experiments in general and the limitations of this particular experiment.
- (b) A significant number of students named many of the faults of the experiment but did not discuss their significance. As a result, those students received half marks.
- (c) A large number of students merely restated their answers to section (b) with one or two additional answers. Marks were only given for answers that were different to any answers in section (b).

This question produced a good spread of answers and acted as a useful discriminator.

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**Statistical Summary****Award Summary**

Outstanding Achievement (OA)	154
High Achievement (HA)	289
Satisfactory Achievement (SA)	302
Reassessed into neighbour	82
Total	827

**Gender Breakdown**

Males	262
Females	565

**Summary of external ratings**

	A	B	C	D
Criterion 3	186	224	315	79
Criterion 4	158	200	341	101
Criterion 5	147	197	350	107
Criterion 8	146	251	317	87
Criterion 9	133	238	385	44

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