T A S M A N I A N

C E R T I F I C A T E

O F E D U C A T I O N

Biology

Subject Code: BY826

2003 External Examination Report

Meetings

The Chief Examiners met with the marking team during the week after the exams. With a team of 15 markers the standards required for A, B and C ratings were determined for the externally assessed criteria. The Assessment Panel met in the first week of December to review the results, deal with interstate/overseas papers and reassess the borderline candidates on an individual basis.

General Comments

The feedback regarding the examination was generally very positive and was well received by teachers and candidates, with most finishing within the time.

The paper was even in its standard of difficulty throughout most sections, with most sections having similar cut offs. The only exception was section D on criterion 8, where candidates on the whole produced work of a very high standard. The markers as a group were satisfied that this was a result of how both candidates and teachers had taken on board the comments on this section over recent years, which has led to an increased standard on this criterion.

Once again there were significant differences between the state-wide results for externally assessed criteria and in the internal assessments for the same criteria. Also there continues to be higher grades given to non-externally assessed criteria on the whole. It was interesting to see the number of candidates who either performed much better in the exam than there internals and vice versa.

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)

Structure	Corresponding letter
Cell wall	E
Cell membrane	H
Golgi body/apparatus	G
Mitochondria	A
Rough Endoplasmic Reticulum	B
Plastid	C
Contractile vacuole	D
Nucleus	F

Each correct letter was worth $\frac{1}{2}$ mark.

(b) (i) C and I $\frac{1}{2}$ each

(ii) H and K $\frac{1}{2}$ each

(c) Here the answers needed to relate the structural feature with specialised function.

(i) F $\left(\frac{1}{2}\right)$ The function was to form a multilayered structure that forms an effective barrier against abrasions and pathogens in the mouth and structural features that could be used to relate to this include: flat, tightly packed, smooth, flexible, and form an effective barrier against pathogens.

(ii) A $\left(\frac{1}{2}\right)$ A red blood cell is a biconcave disc which provides a high surface area to volume ratio which maximises oxygen-carrying capacity, which is flexible and rounded to aid travel through capillaries.

(iii) G $\left(\frac{1}{2}\right)$ Ciliated epithelial cells lining the respiratory tract move particles trapped in mucus out of the lungs by wave like contractions of the cilia.

Comments

(a) Candidates who were familiar with cell structure gained an easy 4 marks for this part. A common error was to confuse the plastid with the contractile vacuole.

(b) This part was not well done by many candidates. Each correct answer was worth $\frac{1}{2}$ mark, but each incorrect answer given in addition cancelled out a correct response. Candidates who gave 4 or more answers in each part received no marks.

(c) Part 2 was generally well answered, with a majority of candidates gaining $1\frac{1}{2}$ out of the possible 2. Parts 1 and 3 consistently produced 1 mark out of the possible 2. The most common error in part 3 was for candidates to refer to cilia as "villi" or "microvilli" and describe increased surface area as a result of their presence. However, they could not explain how the increased surface area helped in the removal of unwanted particles. 'Villi which waved" and similar answers were given some credit.

Question 2

Substance W: ATP (½): the values in the table decrease (½). **W** is the energy releasing molecule (½) and will deplete as it is used in the reaction to produce the polysaccharide from glucose. ATP itself then forms ADP. (½) other marks award if they recognised it as ATP:

- 1 mark for saying as seen in the table it decreased from 35 to 0 units corresponding to X (ADP) that increases from 0 to 35 units
- 1 mark for saying W decreases and X increases in similar amounts/rates/proportions, indicating ATP converting to ADP
- 1 mark for saying ATP is the limiting factor for polysaccharide production as when this runs out no more is made as seen at time 15-20

If they recognised **W** as glucose (max 1 mark could be achieved) then ½ mark if they said the values decreased only. A further ½ mark for saying things like as it is being converted to polysaccharide; it is decreasing as the polysaccharide is increasing in similar proportions as many glucose molecules are used to make 1 polysaccharide or any similar answer given to the substance **Z** answer below.

Substance X: ADP (½): the values for **X** increase from time 0 to 35 units (½) indicating that ATP (**W** at 35 units) is being converted into ADP (**X**) and Phosphate with energy being released. (1)

- ½ for saying this is the only set of results that increases and therefore can only be ADP by elimination.

Substance Y: enzyme (½): The values for the concentration remain the same at 2 (½) as the enzyme a catalyst in the reaction and is not used up in the reaction (1)

- another reason it is only required in small amounts (1)

Substance Z: glucose (½): The concentration of glucose decreases (½) from 90-38 units (½) as small glucose molecules are being formed into larger polysaccharide molecules (½)

- ATP is the limiting factor (**W**) and no more glucose (**Z**) is synthesised into polysaccharide when this is all used up as seen at time 15 min (1 ½)
- As glucose concentration decreases polysaccharide values increase in similar proportions 15 glucose molecules for every one polysaccharide formed. (1 ½)
- This is an anabolic process using glucose molecules to make a larger complex carbohydrate as seen in the table (1 ½)

If they recognised it as being ATP then a max of 1 mark was awarded with similar reasons to substance **W**.

Comments

(i) Question was answered poorly.

(ii) Many misread the question and thought it was a respiration question (glucose being used to make ATP rather than ATP being used to help drive the anabolism of glucose to polysaccharide).

(iii) Common errors: The values in the table were decreasing as the factor was being lost, came up a lot rather than 'converted to' or 'assisted in'.

(iv) The difference in answers and ultimately marks came from reading the question correctly.

Question 3

(a) 1 and 3 **OR** 2 and 4 (½).

Essentially 1 ½ marks from the following

- 1 and 4 are the original strands (½)
- 1 and 4 are complementary (½)
- They unzip and are replicating (½).
- 2 is complementary to 1 and 3 complementary to 4 (½)
- if 2 is complementary to 1 and 4 is complementary to 1 then 2 and 4 must be the same(1)
- if 3 is complementary to 4 and 1 is complementary to 4 the 3 and 1 must be the same(1)
- if an example was used that they made up to show which were similar e.g.
- strand one GGG and strand 4 CCC as originals then stand 2 is CCC then 2 and 4 must be the same - full marks were given.

Some candidates interpreted that they had to identify 'pairs of bases' so if they explained this clearly they were awarded a max of 1 mark. e.g. 1 and 4 or 2 and 3 are the same. This is showing mitosis where exact copies need to be replicated for example in a skin cell so 2 is a copy of 1 and 3 is a copy of 4.

Only 2 or 3 were awarded marks for this, if they just wrote mitosis without explanation then no marks were awarded.

(b) (i) The process is **transcription**. In this the base sequence along a single strand of DNA that codes for a specific protein is copied onto a strand of messenger RNA (structure Y). This process allows the genetic information to be taken to the ribosomes, the site of protein synthesis in the cytoplasm, while leaving the original code unchanged in the nucleus.

(ii) The second process is **translation**. At the ribosome the coded information in the mRNA is used to synthesise a polypeptide chain (structure X) with the help of tRNA. The sequence of codons on the mRNA determines the order of the amino acids in the polypeptide chain, which is the basis for the final protein.

½ mark was given for the correct process, up to 1 ½ marks were given for a description of the process and the third mark was only given if candidates had addressed the significance involved.

Comments

Overall this question was fairly well done, with the bulk of the candidates gaining four or more marks.

(a) Many identified the correct pair (½) but gave vague or incorrect explanations.

(b) (i) Most identified the process and many were able to give quite some detail in regards to the process, but didn't always address the significance of the process. The best answers considered that the mRNA was a means of taking the coded information needed for protein synthesis from the DNA to the site of construction. Candidates also gained credit for recognising that the DNA couldn't or didn't leave the nucleus. A bit of flexibility was allowed in the marking to give candidates credit for their understanding of the process, but full marks could only be gained if there was recognition of its significance. Candidates did not have to describe the process to gain full marks as the question did not ask for a description.

(ii) This part had a similar response to part i). Many candidates managed to name the process and make a connection with the formation of the polypeptide chain.

Question 4

(a) Solution D was the most concentrated (½ mark). This solution results in the greatest loss of water and hence mass as shown by the table with a loss of 14.7 g (1 mark) through the process of osmosis (or exosmosis) (½ mark). Solution D is hypertonic to the celery (½ mark) so through the process of osmosis water is taken from the low osmotic/solute concentrations inside the celery to high osmotic /solute concentrations outside (1 mark) across the semipermeable cell membranes of the celery (½ mark) to try to achieve an equilibrium (½ mark). This results in the cells of the celery losing water from their cytoplasm in the process of plasmolysis (½ mark).

(b) Solution A (½ mark), as the solution resulted in the least change of mass. This solution is closest in solute/osmotic concentration to the celery, it is nearly isotonic (or only slightly hypotonic) in relation to the cells of the celery or it has the least concentration gradient (1 mark) and so there would be little change due to osmosis (or diffusion) (½ mark), also identified ½ mark given for referring to the figures regarding weight loss.

Comments

This question sorted the candidates out very well between those who recognised that osmosis was the key process and those who could not. A lot of candidates did very well, with the two most popular scores being 5 and 6 out of 6. A number of candidates still managed to get 2 or 3 by answering part b fairly well and showing some understanding of diffusion in part a.

(a) Candidates needed to be clear about the type of concentrations they were referring too and the better answers referred to osmotic or solute concentrations. Osmosis is the key process here as even if sucrose could diffusion across the membrane the change in mass would be negligible compared to the changes due to osmosis. However candidates who argued for solution C and showed a good understanding of diffusion gained 1 mark. Candidates who argued for C on the basis that it gained the most weight due to osmosis gained (with an explanation) gained 1 ½ marks and those who gave the right arguments based on water loss by osmosis but opted for solution B gained up to 3 marks.

(b) Very well done. Most candidates opted for the correct solution with at least an explanation based on the least change of weight. The better candidates explained it further in terms of the relative concentrations and/or the least changes due to osmosis.

Section B

Question 5

(a) A: glomerulus
B: Bowman's capsule
C: collecting duct
(1 mark for **one** correct answer, ½ mark for each extra correct answer)

(b) **Protein molecules** are too large to pass throughs the walls of the capillaries in the glomerulus so none enters the Bowman's capsule resulting in the drop in concentration from 80 to 0.0 g L^{-1}. (1 mark)

Glucose passes freely from the glomerulus to the Bowman's capsule (1.2 g L^{-1}), but is fully reabsorbed into the bloodstream from the tubule resulting in none being present in the collecting duct. (1 mark)

Urea, which passes freely into the Bowman's capsule is not reabsorbed (½ mark), but other substances, especially water, are reabsorbed, (½ mark) resulting in an increased concentration of urea in the collecting duct.

Comments

(a) Most candidates were able to correctly identify the collecting duct, although many confused the glomerulus and the Bowman's capsule. A few candidates failed to read the question carefully and gave answers other the three structures listed in the question.

(b) Many candidates were able to correctly state that the size of the protein molecules was responsible for their absence in the Bowman's capsule (and collecting duct). While many candidates were aware that it was important for the body to retain glucose, many were imprecise in their description of the process of reabsorption. Explanations of the reasons why urea became more concentrated in the collecting duct were often very vague, and did not show any understanding of the relevance of water reabsorption in the increase in concentration of the water.

Most candidates were able to score some marks on this question, but surprisingly few were able to score full marks on what should have been an easy question. Some understanding of the mechanism which resulted in the concentration of the urea was expected.

Question 6

(a) Any two of the following accepted.

- Large surface area. (1 mark). Exchange of nutrients/gas/wastes occurs across surfaces, so the larger the surface area, the more rapidly exchange will occur. (1 mark).
- Rich blood supply in capillaries. (1 mark). The large number of capillaries maintains blood flow close to either the gut or air sac thus maintaining a high concentration gradient. This results in high levels of exchange of molecules into and out of the blood. (1 mark).
- Thin membranes. (1 mark). This reduces the distance molecules must travel to reach or leave the blood, increasing efficiency of exchange. (1 mark).
- Moist surfaces. (1 mark). Transported of molecules is facilitated when they are in solution. (1 mark).

(b) (i) Increase in CO_2 levels in the blood (which results in a fall in pH). (1 Mark)

(ii) Normal (resting) inspiration and expiration (in Section I) is mainly achieved by the contraction and relaxation of the diaphragm (which alters the volume of the thorax) (1 Mark). During more forceful inspiration, the thoracic volume is increased by the contraction of both the diaphragm and the external intercostal muscles (1 Mark). During more forceful expiration, the relaxation of the inspiratory muscles is accompanied by contraction of the internal intercostal and abdominal muscles (1 Mark). In Section II, breathing is quicker and deeper plus the ribcage moves up and out further during inspiration and down further during expiration (1 Mark). Air moves into and out of the lungs due to changes in pressure associated with changes in thoracic volume caused by the above respiratory movements (1 Mark)

(c) (i) This narrowing of the aorta would have an adverse effect on circulation to the trunk and lower limbs (since it was after the branching leading to the head and upper limbs). There would be a decrease in

blood pressure in these areas and a lack of oxygen to the extremities (toes etc). This could cause cell death. There would be a decrease in the metabolic rate. Lack of blood pressure and low oxygen would also affect organs and functions such as filtration in the kidney. 3 marks were allocated for any 3 points.

(ii) If the blood vessels are joined to the opposite sides of the heart then the systemic circulation is completely separate from the pulmonary circulation. This means that the deoxygenated blood is being recirculated around the body and the oxygenated blood is going back to the lungs. This would cause death. The left ventricle would be more powerful than needed to pump to the lungs and the right ventricle would be ineffective to pump all the way around the body. Once again 3 marks for 3 points.

Comments

(a) Most candidates were able to correctly identify two features common to both that increased efficiency of exchange and thus gain two marks. Explanations were often not sufficiently clear to gain full marks. Many candidates repeated the wording of the question that the features they stated increased efficiency of uptake/exchange of nutrients/wastes without any indication why or how. The same "explanation" was often given for both features.

(b) (i) Less than a quarter of the candidates knew that carbon dioxide was the most important stimulus for changing the respiration rate and tidal volume. A large proportion of candidates said that increased physical activity/exercise was the most significant stimulus and half a mark was awarded for this basic understanding of bodily function. Changes in blood gas levels (O_2 down & CO_2 up) or simply stating 'increased metabolic activity' were also given half a mark.

(ii) Very few candidates were able to give a good description of the physical mechanisms involved in inspiration and expiration.

(c) Part c) was answered reasonably well by most candidates with the most common marks being 3 or 4 out of 6.

Question 7

The **stimulus** is the rise or fall in calcium levels in the blood. The **receptors** are the thyroid gland and the parathyroid gland. They send a hormonal message of either calcitonin or PTH to the **effectors**, which are the bones. These either transfer calcium into the bones or back into the bloodstream which is the **response**. This causes the calcium levels to either fall or rise. This is the **negative feedback** where the response to a stimulus reverses the stimulus.

1 mark was given for identifying the stimulus, receptor, effector and response and 1 mark for identifying the negative feedback.

Comments

This question resulted in a wide spread in candidates' marks. Many candidates made no attempt to answer it. Another large group rewrote the information in the diagram but made no attempt to link it to the question. They were given 1 mark. If they mentioned negative feedback too, they scored 2 marks. The remainder of candidates understood what was required by the question and made a good attempt at identifying the key features of a feedback model and so scored 4 or 5 marks.

Question 8

(a) (i) Recessive ($\frac{1}{2}$ mark). The definitive proof is that the trait does not appear in either parent #3 or parent #4 (which must be heterozygous) but it appears in one of their offspring (#11) (1 $\frac{1}{2}$ marks). In other words, the trait could not 'skip a generation' if it was controlled by a dominant allele (1 mark).

(ii) The trait is **not** sex-linked (ie. it is autosomal.) ($\frac{1}{2}$ mark). The two definitive proofs in this pedigree diagram are that, if the trait was sex-linked, then: **either** male #4 should have received the trait from his homozygous recessive mother (#1) but he did not (1 $\frac{1}{2}$ marks); **or** male #2 should have expressed the trait in order for him to produce a homozygous recessive daughter (#8) with the trait (1 $\frac{1}{2}$ marks).

(b) **B -** = black coat & **bb** = brown coat;
T - = unspotted coat & **tt** = white-spotted coat

F1 Parental Genotypes: **B - tt** x **bb T -**
F1 (Progeny) Genotypes: **All BbTt** (2 Marks)

2nd Generation Parental Phenotypes: F1 Black Unspotted x Brown Unspotted
2nd Generation Parental Genotypes: **Bb Tt** x **bb Tt** (1 Mark)
Using Independent Probabilities (2 Marks)

P(**bb**) = $^1/_2$ and P(**tt**) = $^1/_4$
Therefore P(**bbtt**) = $^1/_2$ x $^1/_4$ = $^1/_8$

Using A Punnett Square *(Alternative Method)* (2 Marks)

Parental Gametes	**BT**	**B t**	**bT**	**b t**
bT	**BbTT**	**BbTt**	**bbTT**	**bbTt**
b t	**BbTt**	**Bb tt**	**bbTt**	**bb tt**

Therefore, the chance of getting a brown, white-spotted mouse (**bb tt**) is $^1/_8$.

Comments

(a) (i) This part of the question was answered correctly by most candidates with about 70% receiving full marks. Candidates who incorrectly stated that the trait was dominant and made a reasonable attempt to justify this answer (eg. it appeared in more than half of the individuals and did not appear to skip a generation) were given half a mark.

(ii) The majority of candidates stated that the trait was **not** sex-linked but only a small proportion of these were able to justify their answer. Many candidates received some credit ($\frac{1}{2}$ mark) for stating that it could not be sex-linked because it appeared in both sexes and so many females (three out of nine) expressed the trait. Some credit ($\frac{1}{2}$ mark) was also given to candidates who stated that females #3

and #10 must be either 'carriers' (of a sex-linked trait) or heterozygous for an autosomal recessive trait. Many candidates (more than half) did not even attempt to justify their answers for this part of the question (as instructed) by using evidence from specific crosses.

(b) This question was answered quite well with about half the candidates showing that they understood the question and were able to use appropriate strategies to determine the expected progeny from a di-hybrid cross. As indicated in the above answer, 2 marks were given for correctly determining the F1 genotype, 1 mark was given for stating the genotype of the brown coated 2nd generation parent mouse (which was heterozygous unspotted), and the remaining 2 marks were given for determining the probability of getting a brown mouse with white spots. Candidates were not penalised very severely if they showed the right method but made a simple error. Generally only one mark was deducted for each error. On the other hand, a small number of candidates who failed to show adequate working (as instructed) were only given part marks (as indicated by the above marking scheme). Furthermore, a significant number of candidates only gave their answers as a ratio (ie. 1 : 7) but did not give their answer as a probability (ie. $^1/_8$, 0.125 or 12.5%).

Section C

Question 9

(a) Benthic diatoms, Macroalgae, Phytoplankton (1 mark)

(b) Benthic diatoms, (1 mark) mention of Phytoplankton or Macroalgae ($^1/_2$ mark)

(c) The bacteria and protozoans act as food sources for the grazing invertebrates and sedentary invertebrates (barnacles and mussels) and they also act as decomposers on the remains of the invertebrates. (2 marks)

Credit was also given for answers which indicated that protozoans and bacteria could have been parasites.

(d) Consequences

- Both the benthic diatoms and the macroalgae would increase as these producers were the main food sources of the grazing invertebrates.
- There would be more protozoa and bacteria available from the presumably dying grazing invertebrates, which may provide more of a food source for the barnacles and mussels.
- The numbers of fish, crabs and shrimps may decrease as the grazing invertebrates are one of the main food sources.
  - alternatively, the fish, crabs and shrimps may rely more heavily on the phytoplankton whose numbers may subsequently decrease.
- muricid whelks could decrease due to their main food source of grazing invertebrates decreasing..

(Any 3 well explained consequences 3marks)

Comments

Generally this question was answered quite well. However many candidates did confuse bacteria and protozoans as producers.

Question 10

(a) (i) Trophic level X has the highest living mass (1 mark) indicating that the other trophic levels Y and Z feed upon it. Trophic level X is found in the top 2m of the lake ($\frac{1}{2}$ mark) where it receives the greatest light intensity for photosynthesis ($\frac{1}{2}$ mark).

(ii) Decomposers breakdown (1 mark) complex organic substances to simple organic substances which can be reused or recycled (1 mark) through the community.

(iii) The decomposers are able to break down the remains of all other trophic levels and therefore have more nutrients available to them (1 mark).

(b) D (1 mark). Photosynthesis (1 mark) converts radiant energy into chemical energy in organic molecules like glucose (1 mark).

Comments

(a) (i) Most candidates could come up with the first point. Some could say that it was because they were at the top of the lake but most who realised this did mention the need for sunlight.

(ii) This question was done well by about half of the candidates.

Common mistakes were statements like decomposers "eat" dead organisms. Decomposers actually secrete digestive enzymes and then absorb the breakdown products. Detritivores eat dead material and candidates mistakenly mentioned detritivores or alluded to their role in the community. Decomposition does not yield oxygen. Many candidates considered the role of decomposers to be recycling energy.

In this case the more thorough answers were better but the brief answers may still have gained full marks if they mentioned "breakdown" and "recycled"..

(iii) There were only about 1/3 of candidates who answered this correctly.

The problem candidates encountered with this question was in dealing with the term living mass. Common answers were that there must be very numerous because bacteria are very small. The most common error was that there needed to be a great number of decomposers because they have to decompose all the matter from all the other trophic levels.

Good candidates mentioned that the living mass of decomposers would be less than the total living mass of X, Y and Z (assuming there is no major input of dead organic material into the ecosystem). Some candidates could even state that the decomposers even decomposed themselves.

(b) This question was poorly answered. While many candidates chose the wrong option there were candidates chose the correct option but could not justify their choice.

Good answers to this question even criticised the other three options as well as giving a correct justification. Some candidates mentioned other ways in which energy might enter the community such as direct heat.

Question 11

(a) Mutualism (1 mark). The mistletoe bird gains food. The mistletoe has its seeds dispersed (½ mark each).

(b) Parasitism (1 mark). The mistletoe gains water and other inorganic compounds. The tree suffers harm and the branch eventually dies (½ mark each).

Comments

This question was answered very well by the majority of candidates.

Problems occurred with some candidates not realising the relationships were named above and described the relationship. The names of the relationships were poorly spelled considering they could copy these words from the table above. Some candidates only stated which organism benefited, disadvantaged or was unaffected.

Many candidates did not realise the bird gained food so they stated it was unaffected. Many candidates did not understand the concept of dispersal. Many candidates did not state that the mistletoe gained water and other substances. Most said that it gave the mistletoe a place to live. Many others stated that the tree was unaffected.

Question 12

(a) Among the original blow-fly population there was genetic variation, (½) including a very few individuals who carried a mutant gene (½) which conferred resistance to the dieldrin (½) (produced an enzyme which allowed them to detoxify the poison (1). When the sheep were first bathed in the chemical, most flies were killed, but the few with the resistant gene survived.(½) These reproduced, and passed the gene for resistance to dieldrin on to some of their offspring (1). Because of decreased competition, many of their offspring survived to adulthood. (½) On repeated spraying, a larger proportion of the flies carried the protective gene and survived, (½) and this proportion increased with each generation because the dieldrin had become a major selection pressure in their environment(1), determining which individuals would survive and pass their genes on to the next generation. (½) Eventually the dieldrin would become useless as virtually the whole fly population carried the protective gene.(½).

Any combinations of points totalling 5 marks was given full credit, as long as it made sense (ie seemed like a complete story).

(b) (i) There is only one species of snake (1) because although A and C cannot produce fertile offspring, each of these populations can produce viable offspring with population B.(1)

Candidates who said that there were 2 species because populations A and C could not interbreed to produce viable offspring were given 1 mark for their reason.

Candidates who said there were three or more species were given no marks.

(ii) Variation between the populations already exists (½). If the populations were to become geographically isolated (½) for example by [various possibilities – deeper rivers, mountain ranges, gorges etc…(½)], gene flow between the populations would no longer be possible (1). Environmental conditions in the different habitats would be different (½)[different predators, prey,

vegetation etc (½)] **, OR** different selection pressures would act (½). Over many generations, the populations would become very different in their genetic makeup. (½) Different mutations in each population would add genetic variation (1). Because of the small population, genetic drift and the founder effect would add to the genetic variation.(1) Eventually, the populations would become so different that if they were to come into contact again, they would be reproductively isolated (1), for example, would not recognize each other's mating behavior, gametes would be incompatible, etc. (½ mark for each example, up to 1 ½ marks).

Introduction of new species by humans, or snakes migrating into the area was allowed up to 1 mark.

This question was answered in quite a variety of ways. To gain full marks, candidates had to write a complete explanation, not just list examples of geographical and reproductive isolation.

Comments

(a) The blow-fly question was quite well answered by most candidates. In many cases there was evidence of answering from a 'recipe', and some candidates failed to tie the recipe in to the question, failing to mention any specific details of the example. These rarely scored more than 2 ½. Many incorrect answers were based on Lamarck's theory, where exposure to the dieldrin caused the flies to become resistant. Others referred to biological magnification, where a build up of dieldrin in the flies' bodies somehow conferred protection.

(b) (i) The most common answer gave 2 as the number of species because A and C could not produce viable offspring. A few candidates chose the one species option, and quite a few of these showed good reasoning, but some reasons were poor e.g. 'They are all snakes', or 'all of them can interbreed'.

(ii) This question was answered with admirable imagination in a wide variety of ways. Probably around 1/3 of candidates had something resembling the right idea, that is that geographic isolation and a long period of time with different selection pressures acting on the three populations resulted in reproductive isolation, producing new species. The amount of detail in the answer determined the marks given

Section D

Question 13

(a) The 15 plants in one part of the garden bed that are not growing as tall as the rest of the plants (1 mark for dependent variable) is due to less water (1 mark for independent variable) available in that part of the bed (1 mark for linking the two variables in a valid hypothesis).

Other possibilities included:
- less nutrients (N, P or K may be specified) available in that part of the bed
- less sunlight due to shading in that part of the bed
- soil contamination by a pathogen/herbicide etc. in that part of the bed
- waterlogging in that part of the bed.

(b) (i) The rate of photosynthesis (½ mark for dependent variable) depends on the wavelength of light (½ mark for independent variable and 1 mark for linking the two variables in a valid hypothesis.

(ii) Wavelength of light (1 mark)

(iii) Light intensity (1 mark)

Water temperature (1 mark)

Other possibilities included:
- water transparency
- water quality (nutrients etc.)
- level of background light
- same leaf area
- amount of carbon dioxide in the water etc.

(iv) There is a built in control ($\frac{1}{2}$ mark) in that each test tube has a plant exposed to a particular wavelength of light (1 mark) and therefore each plant acts as a control for the others (or the shortest wavelength acts as a control to compare the others to etc.) (1 $\frac{1}{2}$ marks)

or

There is no control ($\frac{1}{2}$ mark) to compare the results to and a suitable control is to have a plant in normal daylight. (1 mark) Daylight is the typical light situation to compare with the particular wavelengths. (1 $\frac{1}{2}$ marks)

(v) Any two of the following were accepted. (There were some others that were also accepted): (1 mark each)
- measuring the volume of oxygen collected
- measuring the time interval for illumination
- variations in the light intensity due to filters used, power source etc.
- variations in water temperature – heat from light source
- oxygen content of the water
- nutrient level of the water
- adhesion of small oxygen bubbles to the plant stems, leaves and glassware or
- not all of the evolved oxygen bubbles collected
- glassware cleanliness
- water transparency
- variations in carbon dioxide level in the water
- plant may have been unhealthy or atypical
- size of plant material used

Comments

This question was done very well.

(a) The candidates were generally quite able to write correctly constructed hypotheses for part a). The few difficulties experienced included imprecision in hypothesis construction through alternatives, only giving the independent variable "too much shade" is not a full answer if not linked to the dependent variable, and describing/explaining the situation rather than giving a testable hypothesis. Broad hypotheses, such as "soil conditions", which could be many things, rather than stating "lack of nitrogen" were not awarded full marks. Simply restating the information in the stem of the question resulted in zero marks.

(b) The hypothesis in (b) (i) was straightforward. The independent variable in (b) (ii) was correctly identified in most cases.

The main problem arising from (b) (iii) was from the confusion of factors that must be kept constant and experimental errors that were covered in (b) (v). Some factors, however, such as water temperature and carbon dioxide content of the water, were acceptable as an answer to either part.

The issue in (b) (iv) was either identifying an inbuilt control and explaining how it could be used as a control, or stating that no suitable control was present, giving one and then explaining how it was appropriate. There were other controls that were accepted and credit was given for suggesting total darkness. Also, credit was given to those who stated that a control was present effectively argued that 700nm wavelength could be used as the control group. There were other possible answers and the function of a control was well understood by most candidates.

Part (b) (v) was answered very well. Simply repeating the same "two factors that must be kept constant" and "two experimental errors" did not necessarily gain full marks for this part of the question.

Question 14

(a) There are a number of valid designs possible; the following table highlights the main points which were considered necessary and the marks awarded. To gain full marks any 10 of the possible 12 marks were necessary.

1 mark	Large sample size	100 rabbits
2 marks	Describe treatment of groups	Prepare 2 paddocks. The soil in one of the paddocks should be broken ($\frac{1}{2}$ **mark**); in the other it should be unbroken ($\frac{1}{2}$ **mark).** Release 50 rabbits into each paddock ($\frac{1}{2}$ **mark)** for 1 week or more ($\frac{1}{2}$ **mark**).
1 mark	Identify control	The paddock containing unbroken soil is the control. The number of burrows made in this paddock will be compared to the number made in the paddock containing broken soil (experimental group).
1 mark	Identify independent variable	The brokenness of the soil.
1 mark	Identify dependent variable	The number of burrows.
2 marks	Identify the main controlled (fixed) variables	In order for the results to be valid, many variables that would affect the dependent variable need to be controlled. Size of paddocks, soil type, moisture content of soil, vegetation in the paddock, the rabbits' age, sex, species, size and diet should be the same for both groups. ($\frac{1}{2}$ **mark** for each controlled variable; for **2 marks** reference to both soil and rabbits was necessary.)
1 mark	Describe how the dependent variable will be measured	At the end of the 'week' count the number of burrows. A **bonus** $\frac{1}{2}$ **mark** was given for also measuring the depth/length of the burrows.

1 mark	Treatment of results	Record the results in a table and/or draw a bar graph for both groups. Compare to see if there is a significant difference in the number of burrows in each paddock.
1 mark	Replication/Follow up investigation	The experiment should be repeated (½ **mark)** several times to validate results (½ **mark)**. A **bonus** ½ **mark** was given for recommending comparing different soil types or dry/wet soils.

NOTE: It is NOT recommended that candidates present their answer in table format, but rather as a written answer. This should include the information from the right hand column of the above table. Headings can be useful in helping to organise information.

(b)

1 mark	Results that would support hypothesis	If there are (significantly) more burrows in the paddock containing broken soil than in the paddock containing unbroken soil.
1 mark	Results that would negate hypothesis	If there are (significantly) less burrows in the paddock containing broken soil than in the paddock containing unbroken soil (½ mark) or if there is a similar number of burrows in both paddocks (½ mark).

Comments

(a) Generally very well done. However, many candidates discussed the effect of planting seedlings/seeds and rabbits digging up seedlings or seeds. The hypothesis stated that 'Rabbits will burrow more in areas where the soil is already broken' making no reference to seedlings or seeds. Candidates would be well advised to spend more time reading questions more carefully to ensure that they answer what is asked.

(b) Very well done.

Question 15

(a) **Design B** is most appropriate (1 mark). It tests enzymes and substrates together in the same tubes at three different pH's whilst keeping the temperature controlled at 20°C (½ mark). Design B also tests substrates independently of the enzymes at three different pH's, which acts as a control for tubes 1, 2 and 3 (½ mark).

Design A is less suitable as the enzymes are tested independently of the substrates so the effect of pH on enzyme activity cannot be determined (1 mark).

Design C is less suitable as the temperature varies in addition to the pH, introducing a second variable which may give misleading results (1).

Design D is less suitable as the temperature varies (½ mark) and the pH (independent variable) has not been manipulated. As a result, changes in enzyme activity will be due to temperature changes not changes in pH.

Candidates who incorrectly identified the most appropriate design but then correctly discussed the design faults of the other experimental setups were awarded some marks (1-3 marks in total).

(b) A control group would need to be included in the investigation. That group would need to be given a placebo (margarine with no plant sterols added). (1 mark)

Other answers given one mark included:

- Plant sterols must have no harmful or toxic effects, both in the long and the short term, on the participants involved in the investigation.
- All volunteers need to give their fully informed consent prior to participating in the investigation.
- The sample size needs to be large enough to avoid bias, be representative of the population and give significant results.
- All subjects need a history of moderately high blood cholesterol levels.
- The subjects' diets will need to be controlled, as different levels of cholesterol ingestion will ultimately influence blood cholesterol levels.
- The appropriate amount/concentration of plant sterols will need to be determined for safety and performance issues,
- Blood cholesterol levels of all participants needs to be recorded at the start of the investigation in addition to at the conclusion to allow comparisons to be made.
- All animal and human experiments will need to pass before an ethics committee prior to commencement.
- Genetic differences, age, sex, lifestyles and health problems need to be taken into account when selecting participants for the investigation.

In many instances student provided more that three correct answers. Marks were given for each of the three best answers. The additional mark for the question was awarded for the overall quality and depth of the answers provided (1 mark).

$\frac{1}{2}$ marks were given for relevant one or two word answers where candidates hadn't clearly articulated how the factor or concern would influence the investigation. For example – many candidates simply stated 'ethics' or 'sample size' as concerns without further elaboration or clarification of their selections

Comments

(a) The majority of candidates answered this question well. The best answers specifically identified and discussed the reasons why Design B was the most appropriate and systematically identified and discussed all the reasons why the other designs were less suitable. Lesser answers discussed some of the reasons why Design B was the most appropriate selection and hoped that in doing so it would infer why the other designs were not as suitable.

The most common mistake for candidates who correctly identified Design B as the most appropriate was to group Design C and Design D together when discussing the influence of temperature variation but to then ignore the fact that the pH hadn't been manipulated in Design D.

(b) This part of the question was generally answered well by the candidates. However, many candidates did not suitably elaborate or clarify the factors or concerns that they had selected. The allocation of four marks to the three factors or concerns stated should have indicated to candidates that some depth was required in their answers. Short answers such as 'age', 'diet', 'health' and 'sample size' needed further clarification.

Section E

Question 16

(a) *Necturus maculosus* (½ mark); approximately 33% (½ mark). A range of answers between 32-35% allowed.

(b) The amount of carbon dioxide emitted through the skin decreases from 70% in the tadpole to only 20% through the skin in the adult for *Rana catesbeiana* (1 ½ marks);

In contrast, the absorption of oxygen through the skin increases from 60% in the tadpole to about 80% in the adult for *Rana catesbeiana* (1 ½ marks).

(c) *Necturus maculosus* depends upon its skin for about 33% of its gas exchange (1 mark) whereas *Ensatina eschscholtzii* is 100% dependent on its skin for gaseous exchange (1 mark).

Comments

(a) This part was answered very well.

(b) Part b) provided candidates with the greatest challenge. Many candidates lost a mark if they answered the question without reference to skin; others lost marks if the answer did not reference and include the data in their answer..

(c) Generally answered very well. 1 ½ marks were given if the differences in mode of gaseous exchange between the frogs was not quantified and only 1 mark given if one correct frog discussed and quantified.

Question 17

(a) Phytoplankton numbers vary according to the light intensity (1 mark). As the light intensity increases and decreases so does the number of phytoplankton with a decreases in autumn and increases in spring and summer (1 mark). Phytoplankton require light for photosynthesis. Zooplankton numbers vary according to the number of phytoplankton (1 mark). Zooplankton feed on phytoplankton and the predator/prey relationship is characterised by the "lag-time" between predator and prey numbers (1 mark).

(b) In spring/summer the concentration of nitrates [NO_3^-] decreases as the plankton absorb the nitrate ions for protein synthesis (1 mark). In winter the [NO_3^-] levels have increased due to decomposers feeding on dead phytoplankton (as a result of decreased light intensity hence decreased phytoplankton and subsequent decrease in zooplankton) return nitrogen to the lake system as nitrate ions (1 mark).

A mark was also awarded if candidates stated that the increase in nitrate ions in winter was as a result in increased runoff due to winter rains (including storms, lightening) washing nitrates (from atmosphere, soil exposed to farming, land use etc.), into the lake system (1 mark).

Comments

(a) Most candidates obtained 2 or 3 marks out of 4 marks for this question but few candidates mentioned sufficient information regarding the relationships between light intensity, phytoplankton and zooplankton to warrant full marks. In particular, only a few candidates described the importance of the "lag-time" in a predator/prey relationship between the phytoplankton and the zooplankton.

(b) This part of the question really sorted out the capable candidates. Many candidates got this wrong because they tried to relate nitrate levels to temperature or light intensity. Many candidates left it blank and many candidates got half marks because they either mentioned the addition of nitrates into the system via runoff during winter or mentioned either absorption of nitrates by plankton or release of nitrates due to decomposition. Very few candidates obtained full marks.

Question 18

(a) In both fish there is an overall increase in the number of offspring with increasing body size. (1 mark). In the Blue-Headed Wrasse the number of offspring produced is fairly constant until the body size increases to a point where the number of offspring increases dramatically (exponentially). (1 mark). In the Clownfish the number of offspring increases uniformly as body size increases (linear). (1 mark).

(b) No ($\frac{1}{2}$ mark) it is not reasonable to conclude from the graphs alone that the fish of both species will all change from males to females.

- even though the trend is both continuous and uniform in both graphs (1 mark)
- neither graph shows that 100% of the population changes from male to female at: - any given size or the highest indicated body weight. (1 mark)
- we cannot be sure that extrapolation beyond the range of given data will confirm that all males convert to females i.e. that the trend continues. (1mark)
- the fish may die before they reach a body size at which all males are converted to females. (1 mark)
- the graph only shows proportions. The trends shown may be affected by mortality being generally higher among males than females. (1 marks).

Comments

(a) Most candidates indicated that they understood from the graphs that an overall increase in the number of offspring with increasing body size is indicated, though many did not go on to describe the nature of the increase. Many candidates described other relationships within the data such as the changing proportion of males to females. Some attempted to **explain** as well as **describe** the relationship between number of offspring and body size. Student were not penalised for attempting explanation so long as they did not indicate a flawed understanding of the relationship indicated between body size and number of offspring in doing so. Some common misconceptions were: - that the curve indicating the number of offspring also indicated the sex of the offspring - depending on whether it coincided with the hatched or unhatched area of the graph and - that the exponential curve for Blue-Headed Wrass reached a terminal situation where at large body size no more offspring were produced.

(b) Not many candidates obtained full marks for this question. Many candidates gave extraneous reasoning without any discussion of the data given in the graphs. A common misconception was that if all males changed to females as they grow in body size, there would be no more males left in the population hence no more breeding and the fish would have become extinct. Many answers were based on an implied (but not stated) assumption that the horizontal axis on the graphs represented all body sizes in the population.

Question 19

(a) (i) 9 mm (ii) 14 mm (iii) 7 mm

(b) At Day 20, Treatment 1 produced greater growth than the control ($\frac{1}{2}$ mark) whilst Treatment 2 appeared to inhibit growth ($\frac{1}{2}$ mark). Whereas, at Day 65 it could be seen that Treatments 1 and 2 were equally as

effective in stimulating growth (½ mark). For all groups, growth stopped in the later stages of the experiment (½ mark)

(c) The best follow-up experiment to enable reliable conclusions to be drawn would be to repeat the initial experiment, this time using a larger sample size of gastropods (1 ½ marks), at least 10 per group (½ mark), to account for individual variation in gastropods (1 mark).

Comments

(a) Answers that were within 1 mm of those given above were accepted. Most candidates scored full marks.

(b) Candidates generally scored well on this part. The most common omissions were in not mentioning the plateauing of growth in the later stages of the experiment, and the fact that Treatment 2 appeared to inhibit growth initially.

(c) Many candidates simply wrote down a number of different experiments that could be done (e.g. testing different types of algae) without addressing the need to complete a follow-up experiment which would improve **reliability** of conclusions). Weaker answers simply pointed to the need to repeat the experiment to improve "accuracy" (as opposed to reliability/validity).

Max of ½ mark (if needed for rounding) for answers which said she needed to repeat the experiment, making sure all variables were controlled.

Question 20

(a) There were two major weaknesses in the original investigation. There was no control group (½ mark). The experiment could be improved by having similar group of non-smokers should be used for comparison of the rate of occurrence of lung cancer (1 ½ marks). There were also a large number of uncontrolled variables (½ mark). An improvement would be to ensure other factors such as past history, genetics, age, exposure to environmental carcinogens etc. which may have a role in the occurrence of lung cancer are accounted for, by having the subjects in the control and experimental groups matched in some way, or by having a sufficiently large sample size. (1 ½ marks). A strength was the long time period of the investigation; long enough for cancer to develop (½ mark). However, the suggestion that an even longer time period would be needed, to allow for development of the disease also received ½ mark. Mention of the sample size (as either a strength because it was large enough, or as a weakness because it needed to be larger) gained up to 1 mark.

(b) Not valid (½ mark), as there was no control group and a lack of controlled variables (1 ½ marks). Credit was given (up to 1 mark) to answers which suggested that 85% of the sample was not yet accounted for, or that 12 deaths out of 100 is not a statistically significant result.

Comments

This question was generally well done. Weaker answers tried to address the deaths from heart attack and traffic accidents. A common misconception was that the data was obtained from an experimental situation, rather than an investigation of retrospective data. Many candidates erroneously saw the fact that "the amount/type of cigarettes they smoked was not controlled" as a major concern, ignoring the importance of comparing smokers to non-smokers. Good answers gave specific, relevant examples of variables which would need to be controlled.

Where candidates made NO mention of the need for a control group or controlled variables, it was possible to gain up to 1 $\frac{1}{2}$ marks for a discussion of the appropriateness of the sample size and time period. Simple mention of the need for a control group (with no indication of what it should comprise of, or why) gained only $\frac{1}{2}$ mark.

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