The feedback from the final examination paper was positive and seen as one that generally had a good range of questions to give the candidates a chance to show their abilities. All parts were well attempted by the 833 candidates who sat the Biology exam in 2014. The median for each of the sections were Part a – 22, Part B – 20.5; Part C - 21.5; Part D -19; Part E - 18.5. Candidates should read questions carefully and make sure their answers relate to the question being asked, especially when they are assisted by the information sheet. Many ‘A’ standard answers require detailed explanations to show understanding of the concepts and linking of ideas that are being asked in the question rather than a general overview.

**Suggested Marking Scheme and Comments**

Suggested answers with mark allocations for each question are given in the following section along with comments on candidates performance in the exam.

This mark scheme used the following protocol:

1. Each point worth one mark has a separate line and the end is shown by means of a semicolon (;) Half marks can be awarded and are indicated where appropriate.

2. An alternative answer or wording is indicated by a slash (/). Either can be accepted.

3. Words in brackets ( ) are optional and not necessary to gain the mark.

4. Words that are underlined are essential for the mark. Also, in longer answers should be essential for full marks.

5. A mark scheme for longer questions often has more marking points than the total allows in some cases. This is intentional so that candidates are not limited to certain points selected by the marker.

Marking examiners have provided 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 specific details. The suggested answers are by no means prescriptive and a number of them may go into a greater detail than would be required to gain full marks. Candidates providing different but valid answers were given credit for any points that addressed the criterion and relevant to the question.
PART 1 – Criterion 2

Question 1

a) Candidate 3 (1)
b) Candidate 1 has 2 independent variables/more than one independent variable (½) a hypothesis should have only one (½);
   Candidate 2 has written a question (½) not a hypothesis which is a statement (½);
   Candidate 4 does not have a specific independent variable/candidate has too many independent variables/candidate is not controlling other variables (½)/ ‘change in the environment’ is too vague (½);
   ½ mark for identifying what is wrong and ½ mark for a reason

Comments

This question was generally extremely well answered with more than 70% of candidates getting full marks. The most common mistake in identifying the correct hypothesis was suggesting that Candidate 1 was the correct answer. In explaining the wrong hypotheses almost every single candidate identified that a question could not be a hypothesis (Candidate 2). The most common misconception was that saying ‘cooler temperature’ (Candidate 1) was not scientific since it didn’t specify a value. Quite a few candidates said in response to the hypothesis of Candidate 4 that the environment wouldn’t change because the seedlings were grown in a classroom. All candidates attempted this question.

Question 2

a) i) pH (½) (of the soil) (½)
   ii) growth (½) of the plants (½)
b) temperature, volume of water given each day, light intensity, light period, species of plant, age of plants, soil type, size of pots, volume of soil, time period, nutrients, duration of experiment, (½ mark each)
c) the height/weight of each plant could be measured (½) using a ruler/scales (½), this could be done at weekly intervals (½) for about 6 weeks/until plants reach maximum height(½)
   (1 mark for what could be measured and 1 mark for process / frequency etc)
   Other methods such as counting number of leaves, measuring the dry weight after a certain period acceptable provided a full description is given for 2nd mark.
d) mean (½) data for each set (½) of plants would be calculated
   e) A low pH (pH 5) results in increased growth of this species of plant.
      Clear description of IV (1) Clear description of DV (1)
   f) Possible answers:

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Why it would be effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>increase the sample size of plants</td>
<td>the larger sample would better represent the species as a whole;</td>
</tr>
<tr>
<td>from 6 to 20 in each group;</td>
<td></td>
</tr>
<tr>
<td>replicate the experiment twice more</td>
<td>similar results obtained on 3 separate occasions increases the validity of the data;</td>
</tr>
<tr>
<td>conduct the experiment at pH 4,</td>
<td>this will allow the optimum pH for growth of this plant to be determined;</td>
</tr>
<tr>
<td>5, 6, 7 and 8;</td>
<td></td>
</tr>
</tbody>
</table>
Comments

All candidates attempted this question, and all candidates achieved at least some marks for this question. The average mark was about 8/11.

The phrase ‘plant growth’ does not describe clearly enough of what is measured.

2d – A lot of candidates answered this question in their wordy answers to part 2c.

Question 3

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Laboratory experiment involving large tank; Lab experiment involving multiple independent tanks and/or individual fish trials; Field experiment involving paired sites/multiple randomly selected sites with some form of light manipulation at night (e.g. floating buoys with lights) and appropriate sampling technique; other feasible techniques (but NOT simply sampling in different areas of the river). (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>independent variable</td>
<td>Identification explicitly or implicitly of independent variable – light levels (½). Feasible manipulation of independent variable e.g. shading of tank; point light source; light sources of varying intensity etc. (½)</td>
</tr>
<tr>
<td>Fixed / controlled variables</td>
<td>Identification of need to control other variables (½) and examples of at least two fixed variables e.g. water temperature, pH, feeding of fish etc. (½) For field experiments, need to recognise heterogeneity of environment (½) and seek to minimise random error through replication, paired sites etc. (½)</td>
</tr>
<tr>
<td>Sample size</td>
<td>Suitable number of fish – variable according to exact experimental design but generally &gt;10. Given size of mosquito fish, sample size needed to reflect description of tank environment e.g. more fish in larger tanks. (1)</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Explicit or implicit identification of dependent variable number of fish/position of fish relative to independent variable manipulation (½). Some description of sampling technique for dependent variable e.g. video recording, observer scoring, tank dividers etc. (½)</td>
</tr>
<tr>
<td>Control</td>
<td>Identification of need for control to eliminate other factors influencing fish movement (½) and appropriate description of control e.g. treatment with constant light conditions across whole environment (dark, dim or ambient), internal comparison (light end vs dark end) (½)</td>
</tr>
</tbody>
</table>

b) Fish traps with a light attached could be used; light used as a lure for trapping fish; encouraging overhanging vegetation (1)
Comments

Most candidates attempted this question with some success with a considerable number of candidates getting full marks. Some candidates tended to reproduce material from the information sheet without relating their answers to the context of the question. A lot of candidates produced answers without thinking about scale – the drawing of the mosquito fish should have provided guidance for suitable dimensions of experimental tanks (50cm-a few metres depending on the number of fish). About ¾ of the answers suggested an experimental tank setup with the remainder suggesting a field experiment, often just sampling programs without any manipulation, and thus scored fewer marks. Controls were generally identified, but the commonest mistake was failing to mention the fixed variables.

Part b was successfully answered by most candidates, usually through the suggestion of some sort of fishing using light as a lure. Some candidates recognised the word ‘control’ in part (b) as referring to the experimental setup and repeated information from part (a).

Question 4

a) Would ask about normal diet (1) of subject, especially intake of foods rich in Vitamin D; Reason: researchers would need to estimate total Vitamin D intake (1);
   Would ask how much time the subject spent outside (1) in the sunshine (1);
   Reason: Vitamin D can be synthesised (1) by the effect of sunlight on the skin;
   Would ask about the skin tone (1) not ethnicity of the subject:
   Reason: Increased pigmentation of the skin reduces (1) the absorption of sunlight for the synthesis of Vitamin D;
   (1 mark for question and 1 mark for reason)
   Other sensible questions with reasons accepted such as: family medical history (1) reason prior disease status indicating vitamin D malabsorption (1)

b) human subjects are very varied / variation (1) as the result of genetic (1) and environmental factors (1); cause of variation was awarded maximum of 1 mark A very large sample size minimises the effects of this variation;

c) approximately half the subjects would be given placebo (1) capsules for a year; the placebo capsule resembles the Vitamin D capsule but contains no Vitamin D (is a ‘sugar pill’) (1) to investigate any possible psychological/mind (1) effects of treatment; the study should be conducted as a ‘double blind’ (1) experiment where neither research or patient knows who is receiving the vitamin D or placebo; that means that neither researcher nor subject know (1) which subjects have Vitamin D and which have the placebo; patient. The word ‘psychological’ was spelt at least ten different ways, some not even phonetically. This part of question 4 was answered poorly.
   This question focuses on what the control is – i.e. aspects of using a placebo

d) subjects should be volunteers (1) who may terminate their involvement at any time; informed consent (1)
   subjects must be told that they may be given Vitamin D or a placebo;
   possible side effects/negative/harmful (1) of excess Vitamin D must be made clear; may be other reasons given too
Comments

Many candidates received nearly full marks or full marks for this question. Not many candidates failed to attempt to answer this question.

a) Many candidates mentioned reasonable questions but failed to provide a reason as to why their question should be asked. The majority of candidates answered sun exposure and diet; of those candidates half failed to mention synthesis of vitamin D caused by UV exposure. Many candidates believed the source of the vitamin D was the sun. Candidates mentioning that the skin produced vitamin D in response to sunlight were awarded full marks. Candidates mentioned falsely that vitamin D was absorbed by the skin. Some candidates mentioned that excessive sun exposure would lead to vitamin D toxicity. This is not true as although the precursor to pre-vitamin D3(7-dehydrocholesterol) is converted to pre-vitamin D3 by UVB, both pre-vitamin D3 and vitamin D3 are deactivated by UV light preventing excessive accumulation. Active vitamin D (1,25-dihydroxy vitamin D) is also readily enzymatically degraded to Calcitroic acid and excreted in the bile.

c) Many candidates failed to mention that a placebo would be required in a human trial. Candidates were rewarded for recognising that the purpose of a control experiment was for comparison to ascertain the effect of the independent variable. Some candidates thought that giving the placebo constituted that action of ‘double-blinding’. Many candidates who received full marks for the other parts of question 4 received no points for this question. Many candidates stated that using the placebo was ‘to trick the patient into believing’ they were taking vitamin D when they were not. This concept then followed into part (d) when candidates claimed that it was unethical to use a placebo as it tricked/misled the participants.

d) Some candidates appeared to not know what the word ethical/ethics meant. Many candidates said the same thing multiple ways were not rewarded for doing so. Informed consent was worth 1 mark. Some candidates placed this notion under three points: consent, informed/told about experiment, signing an agreement.

Generally part (d) was answered well with large numbers of candidate receiving full marks.

PART 2 – Criterion 5

Question 5

(½ mark each)

<table>
<thead>
<tr>
<th>Number</th>
<th>Polymer</th>
<th>Monomer(s)</th>
<th>One function of the polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Starch</td>
<td>Glucose</td>
<td>Energy storage compound in plants</td>
</tr>
<tr>
<td>2.</td>
<td>DNA</td>
<td>Nucleotide</td>
<td>Carries the genetic code/genetic material</td>
</tr>
<tr>
<td>3.</td>
<td>Cellulose</td>
<td>Glucose</td>
<td>Plant cell wall structure/cell wall</td>
</tr>
<tr>
<td>4.</td>
<td>Protein</td>
<td>Amino acid</td>
<td>Prion structure</td>
</tr>
</tbody>
</table>
Comments

Many candidates found this question challenging. The most common scores were 1½ and 2 marks.

Common errors were: nucleic acids instead of nucleotides; cellulose as an energy storage product; stating that the function of cellulose was ‘structure’ with no further information; and reversing the order of proteins and amino acids.

Question 6

a) The substrate does not exactly fit the active site of the enzyme (1) but the enzyme shape adjusts to accommodate the substrate (1). This is the induced fit model of enzyme action (½). It was not possible to gain full marks if a description of the induced fit model was not included. Other answers that were given marks included:
   - When the substrate binds with the enzyme the reaction goes faster/activation energy is lowered (1);
   - The lock and key model, where substrate exactly fits the active site (½).

b) Each substrate (P, Q, R, S) has a different shape (1) so requires a (different) enzyme with a matching active site (1). Enzymes are substrate specific (1).

c) As the concentration of substrate includes the rate of production of Q increases (½) because at higher concentrations of substrate there is an increased likelihood of enzyme-substrate collisions (½). Eventually, the rate of production levels off (½) as all of the enzyme active sites are blocked (½). i.e. 1 mark for describing the results and 1 marks for an explanation in terms of the reacting molecules.

d) When product S inhibits enzyme p, this turns off the pathway, so that no more S is made (1). Or: so the cell can slow down/control/regulate the rate of production of S (1).
   Or: The product is only synthesised when required/when there is not much S (1).

Comments

c) many candidates only gained 1 mark as they either talked about the results and didn't provide an explanation, or they described and explained only one part of the results (i.e. the initial increase in rate or the later plateauing of the rate or reaction).

d) was very well done. Candidates who concentrated on products other than S (i.e. so the substrate P will be conserved, or so that Q doesn’t build up) were awarded ½ mark. Answers which only gave and ‘effect’ of the inhibition (e.g. there will be less Q) but did not mention how this might advantage the cell, were awarded ½ mark.

Overall, this question was well answered by the majority of candidates.

Question 7

a) lactic acid / lactate (1) pyruvic acid (½)

b) ATP (½) also for chemical energy used for muscle contraction (½) also for movement or kinetic energy.

c) i) Pathway A = anaerobic respiration; (1)
provides energy as ATP quickly for extreme activity when oxygen cannot be delivered to muscles rapidly enough; (1)
can only be used for a short period because toxic lactic acid builds up in muscles; (1)
part marks for pathway B if candidate implied activity completed before ATP stored in muscles and oxygen in muscles was used up
ii) Pathway B = aerobic respiration ; (1)
can be sustained over a long period because no lactic acid is produced; (1)
part marks for pathway A as race got towards the end as muscle soreness implies lactic acid, or the sprint finish means intensity has increased.

Comments

a) Most candidates got this correct.
b) Many candidates wrote ATP or chemical energy, but a significant number didn’t answer the second part or weren’t sure what was required.
c i) Most candidates chose pathway A, but those that didn’t received some marks if they provided a reasonable explanation, (eg time for activity is less than time used to use up stored ATP and oxygen)
Most candidates recognised the reason for the anaerobic activity was lack of time to get oxygen to muscles and also the rate of ATP use is too high for oxygen supply.
Many candidate didn’t explain the lactic acid build up or didn’t explain the effect of the build-up.
Many candidates who chose pathway B gained some marks if they indicated the very short nature of the activity meant that it could be completed using stored ATP and energy already present in the muscle. (3 x 20 steps is unlikely to be completed with this)
ii) Most candidates chose pathway B and explained the long time involved with the activity and relatively low intensity compared to activity 1 meant that oxygen could be supplied at a rate that allowed aerobic respiration.

Some candidates didn’t show that they recognised that it was a sustainable activity because there was no build-up of lactic acid. Some candidates used general knowledge of long distance races and implied an anaerobic element to the race as an explanation for the sore muscles after a long period of heavy use. The main confusion was for candidates who thought that activity 2 occurred straight after activity 1 and so had a direct effect on it (activity 2)

Question 8

a) Photosynthesis (1)
b) Reactions go faster at higher temperatures (1) as the molecules involved move faster and therefore there are more frequent enzyme-substrate collisions (1).
Alternatively:
Photosynthesis is an enzyme-controlled reaction and is therefore influenced by temperature (1). Enzymes have an option temperature under which they operate (1).
A range of other answers were awarded marks as candidates interpreted ‘warm temperatures’ in many different ways – i.e. ‘warm’ as an elevated temperature or ‘warm’ as a lower temperature than that which would denature enzymes.
c) Light/sunlight
Species X continues to photosynthesise – taking up CO₂ (½). However it is also respiring – giving out CO₂ (½) but at a slower rate. Species Y is only respiring (1). The constant level of CO₂ (330 ppm) from 12 hours is because the rate of CO₂ intake by X is balanced by the rate of CO₂ output by X and Y (1).

Comments

Almost all candidates correctly answered (a) and (c). Answers to (b) were often very vague and general – e.g. photosynthesis is affected by temperature (½). Some candidates tried to link the ‘warm temperature’ to the presence of sunlight and therefore suggested it ensured there was light for photosynthesis. A significant number of candidates ignored the fact that X is a unicellular organism and suggested the warm conditions would keep the stomata open!

A common problem with answers to (d) was the use of the term ‘compensation point’. This term is used to refer to the light intensity at which the rate of photosynthesis equals the rate of respiration in the same organism. In this case, there are two types of organism, present in the right proportion to balance total intake of CO₂ by X with total output of CO₂ by X and Y. Candidates were not penalised for using the term ‘compensation point’.

Overall, this question was answered well.

Question 9

a) Protein / polypeptide synthesis
b) i) transcription
   ii) translation
c) A is DNA / chromosome / gene and B is messenger RNA; the genetic code on the DNA must be transcribed accurately; genetic code must be transported to the ribosomes where proteins are made; unlike mRNA, DNA cannot pass out of the nucleus.
d) mRNA moves to the ribosome (C); transfer RNA (D) picks up a specific amino acid (E) according to the three exposed bases or anti-codon; the first triplet of bases or codon on the mRNA binds with the tRNA anticodon; codon and anticodon bind by complementary base pairing (ie Adenine pairs with Uracil, Cytosine pairs with Guanine); the second codon binds with the complementary tRNA carrying the second amino acid; the two amino acids are brought close together and a peptide bond forms between them; this process continues and the chain of amino acids lengthens becoming a polypeptide / protein (F);
e) All enzymes are made of proteins; many structural components of cells are made of proteins; produces structures for growth and repair. Growth and repair (½)

Comments

Most scored at least two marks.

a) Most candidates answered this correctly. In a few cases DNA replication instead of, or as well as, protein synthesis was given as the answer.
b) This was available on the information sheet and most answered correctly, including those who had given DNA replication in the previous answer.
c) Many candidates identified A and B correctly scoring one mark. The importance of this stage was poorly addressed, with many candidates giving a detailed description of the process of transcription, instead. Many mentioned that mRNA moves out of the nucleus to the ribosomes, scoring ½ mark. Very few commented on the inability of DNA to leave the nucleus. There was a better understanding of the need for accurate transcription, and these candidates scored one mark. About ten candidates scored full marks on this section of the question.

d) Some candidates had learned this very well and gave clear, concise answers, including correct identification of structures C, D, E and F. They scored ¾ mark for each structure and three marks for the correct explanation of the translation process. Those who copied the brief description from the Information Sheet, with no structures identified, scored one mark only.

Common errors included identifying D as an ‘anticodon’ or ‘codon’ instead of transfer RNA, and many candidates either failed to identify the structures or identified them wrongly.

Several candidates, at least twenty, claimed that an anticodon and codon join together to produce an amino acid.

e) The most common answer here was ‘to produce proteins’, which scored zero, followed by ‘growth and repair’ which earned ½ mark. Many mentioned enzymes, with far fewer gaining the full mark for stating that proteins are required for the structural components of cells.

**PART 3 – Criterion 6**

**Question 10**

a) Cell B (½ mark); very small (½ mark); it has no nucleus (1 mark) 

b) Cell A (½ mark); cell wall (½ mark); it has a nucleus meaning it is a eukaryote (1 mark);  
   *if candidate indicates that only plants have cell walls (0 marks)*

c) an animal/a human/a bird/a mammal/a fish, etc. (1 mark)  

d) Cell D is visible as 100 µm which = 0.1 mm (1 mark);  
   *if candidate indicates ‘yes’ without any explanation (0 marks)*

**Comments**

a) Very well answered. Nearly all candidates passed this section. Some candidates stated that ‘cell B was a prokaryote as the nucleus was absent’, without any reference to cell size. They received 1½ marks. A full two marks required two reasons to justify their choice.

b) Most candidates identified A as the correct choice and identified correctly that plant cells have a well-defined nucleus and cell wall. Those candidates just giving cell wall as their evidence, received one mark.

c) Well done by candidates. Most answered ‘animal’ as the organism and received full marks. Some gave an example, such as a ‘horse’, or a ‘lizard’ and also received full marks. A few candidates tried
to justify their answer which gained them no extra marks. A few candidates suggested things like, ‘platelets’, or ‘mitochondria’ and received no marks.

d) Very well answered. Very few candidates had trouble with this question – a small number of candidates didn’t refer back to the original table to find out the size of cell D.

Only a handful of candidates didn’t pass question 10, and a majority of candidates scored 5/6 or more

**Question 11**

a) $I = \text{nuclear membrane} / \text{nuclear envelope} (\frac{1}{2} \text{ mark})$;  
\[II = \text{Golgi body} / \text{Golgi apparatus} (\frac{1}{2} \text{ mark})\]

b) $\text{ribosome } / \text{centriole } / \text{endoplasmic reticulum } / \text{Golgi body } / \text{lysosome } / \text{mitochondria } / \text{cristae} / \text{nucleolus} (1 \text{ mark})$  

$nucleus / cytoplasm (0 \text{ marks})$

c) $\text{organelle III is a mitochondrion} (\frac{1}{2} \text{ marks});$ which is the site of aerobic respiration $(\frac{1}{2} \text{ mark});$ and generates ATP $(\frac{1}{2} \text{ mark});$ large numbers of organelle III suggest that this cell has a high requirement for ATP / energy $(\frac{1}{2} \text{ mark});$ function of cell is to use extra energy for muscle movement $(\frac{1}{2} \text{ mark});$ or active transport $(\frac{1}{2} \text{ mark});$ or phagocytosis $(\frac{1}{2} \text{ mark})$

d) i) $\text{channels which permeate the cytoplasm} (\frac{1}{2} \text{ mark});$ are used to transport proteins $(\frac{1}{2} \text{ mark});$ or  
\[ER \text{ has ribosomes} (\frac{1}{2} \text{ mark}), \text{which are the site of protein synthesis} (\frac{1}{2} \text{ mark})\]

ii) $\text{contains the DNA/genetic code} (\frac{1}{2} \text{ mark})$ which is surrounded by double membrane to protect DNA/genetic code $(\frac{1}{2} \text{ mark});$ or  
\[\text{Nucleus has nuclear membrane with pores} (\frac{1}{2} \text{ mark}) \text{ so that mRNA can be carried to the ribosomes} (\frac{1}{2} \text{ mark});\] or  
\[\text{Nucleus contains nucleolus} (\frac{1}{2} \text{ mark}) \text{ where RNA is synthesized} (\frac{1}{2} \text{ mark})\]

e) Specialised animal cell $(\frac{1}{2} \text{ mark})$

<table>
<thead>
<tr>
<th>Specialised animal cell $(\frac{1}{2} \text{ mark})$</th>
<th>Tissue $(\frac{1}{2} \text{ mark})$</th>
<th>Organ $(\frac{1}{2} \text{ mark})$</th>
<th>System $(\frac{1}{2} \text{ mark})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac muscle cell</td>
<td>Muscle</td>
<td>Heart</td>
<td>Circulatory</td>
</tr>
<tr>
<td>Smooth muscle cell</td>
<td>Smooth muscle</td>
<td>Stomach</td>
<td>Digestive system</td>
</tr>
<tr>
<td>Nerve Cell</td>
<td>Nervous Tissue</td>
<td>Brain</td>
<td>Nervous System</td>
</tr>
<tr>
<td>Red Blood Cell</td>
<td>Blood</td>
<td>Heart/Liver</td>
<td>Circulatory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>\text{(heart/liver etc. accepted, as red blood cell very common cell chosen)}</td>
<td>System/Digestive System/etc</td>
</tr>
</tbody>
</table>

Comments

a) (i) Very few candidates identified nuclear membrane/envelope.  
(ii) Very well done by nearly all candidates.
b) Most candidates wrote, ‘mitochondrion’ (III) as they assumed that they had to choose a number from the diagram. Surprisingly only a small number of candidates chose ‘ribosome’ or ‘cristae’, etc.

c) Again well answered overall. Some candidates still believe that mitochondria must be in a lung cell as they require oxygen. This was a good discriminator.

d) (i) Some candidates either wrote about the function or the structural feature only and received half marks. Some stated both but the structure didn’t reflect the function, and so they only received half marks. A majority gained full marks.  
(ii) Similar to part (i) in that candidates didn’t always link the structure to its function.

e) Not attempted by all candidates but those that did attempt this question often struggled with naming a specialised animal cell or identifying a tissue, that it was located in. A few candidates tried to name plant cells and received nothing for this question.

Question 12

a) D – facilitated diffusion (½ marks for just diffusion)  
   E – active transport  
   F – diffusion (1 mark each)  

b) E would be inhibited (½ mark).  
   Reason: active transport requires energy (as ATP) (1 mark) which comes from respiration (½ mark).  
   D and F are forms of passive movement, which do not require energy and will therefore be unaffected (1 mark).

c) i) the bag would become swollen (1 mark) due to the movement of water by osmosis (1 mark) from the beaker into the bag;  
   because the contents of the bag were hypertonic to / contained a higher solute concentration than / were less dilute than / contained less water than the surroundings (1 mark).  
   ii) The *Paramecium* has a contractile vacuole (1 mark) that pumps / expels (½ mark) water out so it does not swell / is able to osmoregulate / maintain homeostasis (½ mark).

Comments

a) This question was done quite well done by at least half the candidates, although not everyone identified facilitated diffusion. Those that identified active transport often responded that the other two pathways were ‘passive transport’. No marks were given for this. Lots of candidates answered osmosis for at least one of the options.

b) This question was well done by most candidates although not all candidates articulated the link between respiration and energy or ATP production.  
   If candidates could demonstrate their understanding of active transport and diffusion and the importance of energy, they gained their marks despite the fact that they may have mixed up the letters for the processes and their options from part a) did not match.  
   Many candidates thought the embedded proteins were guard cells. Endocytosis and exocytosis were also common incorrect responses. The membrane in the diagram would have to be enormously infolded and deformed for these to be considered a reasonable response. Some candidates pointed out that the inside or outside of the cell were not indicated but for the sake of this question it was irrelevant.  
   Also a number of candidates thought inhibition referred to enzyme inhibition and that the protein channels were active sites. Other candidates tried to identify the actual substances and so when respiration was inhibited they thought the glucose levels (the reactants) might stay the same or
build up and the carbon dioxide and water (product) levels would decline and this would affect the concentrations and thus the transport into or out of the cell. No marks were awarded.

c) i) This question was well done by most candidates although not all candidates identified that osmosis would occur. Candidates needed to mention osmosis to gain full marks. They also needed to indicate the differences in concentrations in some way. Some candidates mention high and low concentrations but did not indicate whether they were talking about the solute concentration or the relative amount of water. They may have received ½ mark for saying water moves down the concentration gradient if the rest seemed to make sense. Quite a few candidates did not answer the question and say what would happen to the bag.

Most candidates said ‘the water would diffuse into the bag by osmosis’. Whilst osmosis is a special case of diffusion, it is sufficient to say ‘water moves into the bag by osmosis’.

ii) This question was well done by most candidates. About 90% of candidates knew what a *Paramecium* was and how it maintained osmotic balance. Quite a few candidates lost ½ mark because they did not give a reason for water being pumped out of the cell e.g. to maintain homeostasis. About 50% of candidates labelled the diagram by pointing to the contractile vacuoles, in order to better illustrate their answer. This was reassuring.

**Question 13**

a) (1 mark) cell size is limited by surface area: volume ratio;(½ mark) as a cell grows its surface area : volume ratio decreases;(½ mark) this means that it is not able to obtain materials or expel wastes adequately;1 mark for DNA regulates the size of a cell.

Maximum of a half mark for energy available, nutrient levels available or temperature regulating cell size.

b) G = mitosis   H= meiosis

½ mark for DNA replication or cell division for both G and H. No marks for labelling a phase of cell cycle.

c) halves the chromosome number in the production of haploid gametes; so that at fertilisation the full diploid number is restored; also results in variation in gametes due to crossing over; this variation is the raw material for natural selection; only 1 mark for just reporting what was happening to DNA in the graph

If candidate got b) wrong a maximum of 1 ½ marks was given if candidate could explain the process they had stated and show the significance for that process.

d) K = gamete production

½ marks for meiosis, second division, no change to the cell (as long it candidate showed understanding it was a gamete and it was being stored for fertilisation)

L = fertilization

**Comments**

Candidates struggled with this questions with over 1/3 scoring less than 2 marks out of 10.

a) Candidates did best in this section with a good understanding of surface area to volume ratio.

b) Candidates seemed to struggle with what the graph was talking about and what section was linked to what part of the cell cycle.
c) Candidates often did an information dump going through various phases in meiosis. They just explained what was happening in the graph and did not discuss the significance of the process at all.

d) K – many candidates not sure where the arrow was pointing.
L – Candidates did better on this questions than the one above.

PART 4 – Criterion 7

Question 14

a) i) Gizzard grinds the food (=physical digestion) increasing the surface area (1);
therefore more surface area for the action of enzymes (= chemical digestion)(1).
ii) Any two of teeth, stomach muscles, gall bladder (¼ each)
b) Any two of glucose, amino acids, fatty acids, glycerol (¼ each)
c) Large surface area (½) provided by structures such as folds, ridges, projections, villi (any reasonable suggestion: (¼). Hence ensuring efficient absorption (¼) of nutrients (¼).
OR:
Blood supply/capillary network (1)
For absorption (¼) of nutrients (¼) into the blood
(Some credit was given for alternatives such as short diffusion pathways between intestine contents and body fluids, but it was important to explain how this was achieved structurally)
d) Probably not, because carnivores eat meat/flesh which is much easier to digest so grinding in a gizzard would be unnecessary (1) (¼ for candidates who did not explain in full but showed understanding that the diet consists of protein/meat).
The herbivorous worms need the gizzard because the cellulose (½) in plant cell walls is very difficult to digest and grinding the plant materials helps to release the nutrients trapped inside the cells (¼ for indicating this understanding).
Credit was given for candidates who suggested that prey with hard bodies (eg insects) or bones could usefully be ground up in a gizzard but this did not gain full marks as the C7 knowledge of herbivore vs. carnivore diets should have been shown here.

Comments

Almost all candidates attempted this question and most gained some marks with very few candidates achieved full marks.

a) i) many candidates did not read the question + 4 lines of writing above the diagram carefully enough. As a consequence, these candidates did not grasp that the gizzard is carrying out physical digestion only, and all chemical digestion (as well as absorption of nutrients) occurs in the intestine. Some candidates overlooked the fact that the question was asking for an explanation of why the sequence (gizzard before intestine) matters. Many candidates copied out large chunks of the question and/or stimulus material ‘word for word’ instead of explaining the answer in their own words. This gained no marks.
Some candidates thought that soil was an ‘enzyme’ in this situation (demonstrating lack of understanding of what an enzyme is). Many candidates demonstrated lack of understanding of the difference between chemical and physical digestion and between digestion and absorption (including the fact that absorption can only occur after digestion).
Most candidates gained a full mark for a) ii).

b) Very few candidates gained the full mark, by indicating 2 final breakdown products (nutrients).

c) Fairly well answered, with most candidates gaining some marks. The best answers used terms such as ‘probably’, ‘possibly’, since the candidates were not expected to know the internal structure of a worm’s intestine. (In fact, no invertebrates have villi, and earthworms use folding of the inner surface of the intestine to increase surface area). All reasonable suggestions received credit.

One fairly common error was to describe the intestine as ‘long’. A ‘long’ intestine is long in relation to the length of the animal: the intestine itself is looped/folded, and thus is longer than the distance from mouth to anus. This is not the case in the worm in the diagram.

Another error was to describe the intestinal wall as ‘thin’ (rather than its lining, which separates blood vessels from digested food). The wall of the intestine needs to be strong and muscular, so it is not ‘thin’ overall.

‘Reabsorption’ of nutrients (rather than just ‘absorption’) was a common error here. ‘Caecum’ was not considered a valid suggestion as the question focuses on absorption of digested nutrients, not the digestive process itself.

d) Fairly well answered and most candidates gained some credit, even if only for knowing that the diet of a carnivore includes meat / flesh.

A very common error among candidates is to think that ‘meat is tough’ and requires more effort to digest. This is incorrect as protein is easily digested by enzymes, whereas the tough cellulose cell walls of plant foods (eg dead leaves) is very difficult to digest, which is why grinding in the gizzard is needed to break up the tough plant material prior to chemical digestion.

The question was not looking for descriptions of the role of a stomach or stomach acid, so these suggestions were not relevant. Many candidates seem to think it is not possible to digest proteins without acid. This is incorrect: in humans, proteins are digested by proteases at around neutral pH’s in the small intestine (as well as in the acidic stomach environment).

Many candidates talked about a need for teeth, but again, this was not really what the question was asking for.

**Question 15**

a) i) stomates tend to be open in the light / day (½ mark) and closed in the dark / night (½ mark)

ii) stomates are pores which allow gas exchange; plants photosynthesis in the light; therefore stomates open in the light to allow carbon dioxide (to diffuse in) and oxygen (to diffuse) out; stomates allow evaporation of water which creates a transpirational pull; This draws water into the leaves so that photosynthesis can occur (½ mark); Transpiration allows evaporative cooling for the leaves, thus reducing overheating for the plant (½ mark)

b) closing of stomates in the middle of the day suggests that plants are wilting / water stressed / temperature is very high / drying conditions such as hot winds, low humidity; closing stomates in these conditions is an adaptation to conserve water; a significant decrease in available sunlight due to storm/heavy cloud cover may have caused stomates to close (½ mark)

Comments

a) (i) A common barrier to achieving a full mark for this question was the failure to identify a trend that encompassed the closing of the stomates as well as the opening. Consequently many
achieved only ½ mark for identifying that stomates mostly opened between certain hours, or that the highest recorded percentage of opening was at 10.00 hours.

(ii) This was generally well answered. Many achieved full marks. Full credit was given if candidates discussed gas exchange as a mechanism for photosynthesis as this is the prime importance of the opening and closing pattern of stomates during the first two days. Half a mark was generally deducted if candidates only mentioned CO₂ without mentioning O₂ and/or gas exchange. Some credit (up to 1½ marks) was given for discussing transpiration as a mechanism for thermoregulation.

b) This was well answered by many. If the answer addressed excessive heat or dehydration then candidates generally went on to link that with closing of stomates during the heat of the middle of the day. The best answers also referred to the data but this was not necessarily a prerequisite for full marks. Almost all candidates who did not discuss heat stress, discussed a drop in sunlight / temperature due to heavy cloud cover and stated that this closed the stomates (which happens at night). Half a mark was awarded for this or any other sensible possibility that may have caused stomates to close on day 3.

Question 16

a) all the glucose in the blood / renal artery / glomerulus is filtered into Bowman’s capsule / kidney tubule / kidney filtrate (therefore these have the same conc); all the glucose is reabsorbed into the blood capillaries (from the kidney tubule) leaving none in the urine.

b) urea is filtered out of the blood and is not reabsorbed. It is a waste product; conc of urea is increased in the urine because most of the water is reabsorbed;

c) proteins are not filtered out of the blood because the molecules are too large; therefore there is none in the urine either;

(1 mark for describing the change / 1 mark for explaining the change)

Comments

a) Generally answered very well with large number of candidates gaining full marks. Common mistake made that glucose concentration went down due to it being ‘used up’ in the nephron for energy. Specifically looking for candidates to be aware that glucose is reabsorbed not excreted. Some half marks deducted for failure to mention concentration changes.

b) Candidates consistently knew that urea must be expelled from the kidney however they were often unsure as to why the concentration increased. Many candidates wrote that urea builds up as the kidney creates urea along the nephron structure. Candidates needed to state that water reabsorption was the reason for increased concentration to get full marks. Some half marks deducted for failure to mention concentration changes.

c) Very straightforward and well written answers. Most candidates received full marks for stating that proteins are too large and will not be filtered out of the blood. The only common mistake was that candidates thought that protein was filtered but immediately reabsorbed. Some half marks deducted for failure to mention concentration changes.
Question 17

a) After consuming the drink, glucose is absorbed into the blood stream through the stomach/small intestine (½ mark); 
increasing concentration of glucose in the blood causes the pancreas to secrete more insulin; 
an increase in concentration of insulin in the blood stimulates the removal of glucose from the blood; 
insulin stimulates the conversion of glucose to glycogen (stored in the liver and muscles); 
as a result the concentration of blood glucose falls and insulin concentration decreases too;
b) during exercise blood glucose is used for respiration/to provide ATP/to provide energy for muscular contraction; 
as glucose is used the blood concentration therefore decreases; 
a decrease in blood sugar concentration results in a decrease in insulin production; 
this causes the pancreas to secrete glucagon; 
glucagon causes stored glycogen to be converted to glucose, bringing the blood glucose level back to normal;
c) homeostasis means the ability of an organism to maintain a condition of equilibrium/stability; 
negative feedback occurs when a change / stimulus elicits a response that results in a transmission of a message which counteracts the original change; 
negative feedback occurs when a stimulus is detected by a receptor that results in transmission of a message to an effector which results in a response that reverses the original change; 
in this example an increase in blood glucose concentration causes a response which bring the concentration back to normal;

Comments

a) Candidates were asked to describe and explain the processes that were occurring during the monitoring. Many lost marks by failing to address these requirements in their answers. Many just described the curves for blood sugar and insulin and so just repeated the information given in the graph.
Other common errors included:
• referring to the brain/hypothalamus/pituitary gland as the receptor for blood sugar regulation.
• Referring to neural transmission as the communication method between receptor and the liver instead of identifying insulin as a hormone that is the communication between pancreas and liver.
• Stating that it was the liver that releases insulin.
b) Many candidates confused the terms glucose, glucagon and glycogen with each other. Many had handwriting that made it difficult/impossible to differentiate between the three words. A significant number stated that glucagon was the stored form of glucose. Another barrier to full marks was often a failure to address decreasing blood glucose levels due to exercise.
Well explained, clearly set out and logical responses often attained full marks for this question.
c) Many did not achieve full marks for this question as they simply restated one of the sugar regulatory mechanisms they addressed in the first parts of the question. To gain full marks candidates also had to demonstrate understanding of the concepts of:
• Homeostasis – the ability to maintain internal stability despite internal or external changes.
• Negative feedback - a process that reverses a trend
By applying it to either the insulin or glucagon effect.
A significant number chose to draw a diagram. If this was well labelled and correctly structured it achieved up to full marks.

Question 18

a) First generation 1 - $X^bX^b$ (1½ mark for xx)
First generation 2 – $X^BY$ (1½ mark for XY)

b) i) all sons from an infected mother should inherit an affected allele from her; and only the Y chromosome from the dad and so all sons should show the trait, as they do
ii) As males only need a single affected $X^b$ chromosome to show the trait there is generally more males affected than females who inherit from both parents in order to show the trait;
iii) In order for females (daughters) to be affected they must have an affected father due to requiring 2 affected X chromosomes
iv) ½ mark for stating that it cannot be Y linked recessive otherwise no males would have received it from the first generation father.

c) Individual 5 is $X^BX^b$ Colour blind male is $X^bY$

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Genotype: $X^B X^b X^b X^b Y X^b Y$
(2 marks including Punnett square or some sort of working)
Phenotype: 2 colour blind children (1 boy 1 girl) 1 normal boy and 1 carrier female

So
Chances of colour blind child: 50% or ½ (0.5 probability) 1 boy and 1 girl
(1 mark for indicating probability and what gender)

Comments

a) Candidates generally answered this question well with majority of answers gaining more than half marks. Common error is lack of candidates using X and Y to represent the chromosomes. Many candidates used lowercase and uppercase C or B to show genotype which lead to issues when writing the Males genotype. Some candidates wrote phenotype instead of genotype.

b) This part was answered least correct out of the 3 questions. Many candidates gave 1 reason why it is X linked but failed to gain the second mark. Common mistake was candidates giving reasons for it being recessive but this was not explicitly asked for in the question. Many candidates wrote that it is more common in Males but did not give an explanation. A lot of creative answers to do with males receiving 1 X chromosome from their mother (this was the most common answer)

c) Unfortunately a lot of candidates did not correctly explain or draw a Punnett square as they had not used the correct genotype in part a. Candidates were not double penalised for this but still lost half to full marks depending on what genotype they used. Majority of candidates correctly identified that 50% of children will be colour-blind but many did not give a reason why. Those that
drew a correct Punnett square found it very easy to explain the answer. A minority of candidates drew Punnett squares with 8 genotypes around the outside rather than 4.

PART 5 – Criterion 8

Question 19

a) Oystercatcher

\[ Lottia\ digitalis, \quad Lottia\ pelta, \quad Lottia\ strigatella. \]

Green Algae

(½ mark for including all arrow heads in correct direction, 1 mark for food chain no arrows, 1½ given for food chain and 1½ marks for food web with all organisms)

b) predator / prey relationship; (1 mark)

(interspecific) competition; (1 mark)

c) the limpets are closely related because they are all members of the same genus – \textit{Lottia}; (1 mark)

these are three different species of limpet because they all have different specific names; (1 mark)

d) i) total number of limpets increased (1 mark for any term used for an limpet increase)

ii) number of \textit{L.strigatella} decreased when the oystercatchers were removed suggesting that oystercatchers normally keep a competitor of \textit{L.strigatella} in check; (1 mark)

data suggests that this competitor may be \textit{L.digitalis} and without the oystercatchers this species out-competes \textit{L.strigatella}; (1 mark)

Other suitable suggested answers (½ mark given for any reasonable biological answer not relating to the graph)

Comments

Overall the candidates went very well on this question with the majority of candidates scoring greater than 4. The 3 main problems experienced in this question were:

a) In many cases a food chain rather than a web was constructed

b) only the species was discussed or the genus rather that referring to both parts of the scientific name

c) ii) the majority of the candidates missed that the oystercatchers kept the competitors of \textit{L.strigatella} in check

Question 20

a) i) Y represents carbon dioxide (½ mark) given off from land systems into the atmosphere due to respiration (½ mark); this carbon dioxide comes from respiration of plants & animals (½ mark) and decomposers (½ mark);
ii) Z represents carbon dioxide (½ mark) absorption into the ocean system due to photosynthesis (½ mark); the main photosynthetic organisms in ocean system are phytoplankton (1 mark); Aquatic algae (1 mark); Aquatic plants (½ mark).

b) increased combustion of fossil fuels (½ mark) converts carbon stored in fuels into carbon dioxide in the atmosphere (½ mark); deforestation / removal of vegetation (½ mark) means less carbon dioxide is removed from the atmosphere by photosynthesis; (½ mark); ocean warming (½ mark) means it can hold less carbon dioxide; (½ mark); less phytoplankton in ocean due to global warming (½ mark) or toxicity means less carbon dioxide removed from the atmosphere by photosynthesis (½ mark);

Mining or plastics production ½ mark

c) matter is recycled and the matter on the Earth remains unchanged / exchanged between the community and the physical surroundings;
energy however is lost (as heat) at each step of a food chain / not recycled;
energy must continually be replaced by the sun;

Comments

a) (i) This question was well attempted and answered and most candidates gained some marks. Lost marks were typically due to just writing carbon rather than carbon dioxide.
(ii) Most attempted and generally well answered. Again, candidates lost marks for not identifying carbon dioxide and just writing carbon. They also lost marks for not identifying phytoplankton. Some candidates were too general in saying photosynthesis and did not acknowledge that it was occurring in the ocean. Many candidates skipped photosynthesis and spoke about limestone formation due to misreading the information sheet.

d) This question was really well answered. Unfortunately, some candidates only wrote one reason rather than two. More people or animals in the world were common but received no marks.

Question 21

a) population is growing (exponentially) because environmental resistance is low;
food supply is not limiting so there is no competition for food;
hunting pressure must be low;
birth rate > death rate;

population is growing ( ½ ), increased birth rate ( ½ ), increased in food ( ½ ), decrease in competition for resources (food) ( ½ )

b) decrease in food supply;
increase in hunting pressure;
increase in disease;

Comments

a) Some candidates did not attempt this question and some did not address the question in their answer. A large % of candidates did not read the question. Answers included a full description of...
the graph instead of responding to the question only (ie 20 – 30 years). These candidates only received marks for the section of their answer that addressed the 20-30 years. Full marks were awarded when answers identified that the graph was showing an increase in population was not stated by some and full marks were. Many candidates commented on emigration and immigration. As this was an island, it was a highly unlikely answer and received zero marks.

b) Candidates who copied from the information booklet, without relating it to the deers on this island received no marks. Some candidates did not give density dependant type answers but instead described density independent reasons. No marks awarded. Answers needed to relate reasons for the decrease in population.

There were some very good and well detailed responses that showed that the candidate understood how the food source was removed by such a high population. Some candidates mentioned abiotic reasons for a decrease in food supply and only received half marks if their response then included competition for the reduced food supply and this leading to an increase in deaths. Those who explained reasons that would lead to the population staying at carrying capacity and not a decline in numbers also received (½ ) marks or 0 depending on the extent/detail of their answer

Question 22

a) variation in head and jaw size due to random mutation;(1mark) snakes with small head and jaws have a survival advantage because they cannot consume toxic toads; (1mark) these snakes will (live longer and) produce more offspring than snakes which die from consuming toads; (1mark) passing on the genetic trait for small head and jaw size to the offspring; (1mark) after several generations the population of Death Adders in the toad habitat will have smaller heads and jaws; (1mark)

b) population with small jaws must become isolated from other populations; eg geographically / ecologically – consuming different food, breeding at different at times of year; (1mark) isolated populations become adapted to local conditions / have their own mutations / gene flow interrupted; (1mark) eventually isolated population becomes so different that it will no longer interbreed with other populations = speciation; (1mark)

Comments

a) Most candidates answered the question and explained how the large jawed adders were being killed by the cane toads and the surviving, small jawed toads were the ones that were reproducing and hence able to pass on the genetic trait. However, only the few candidates who explained the variation in the population as the reason for the small jaw and its advantage under the selective pressure, were awarded full marks.

b) Most candidates were able to explain the importance of isolation and restriction of gene flow for speciation but failed to discuss the importance of adaptations of the populations, in the new environments, leading to differences in populations and therefore did not score full marks. A number of candidates had an information dump on speciation from the information sheet and did not link it to the question and they did not score full marks either.
Question 23

a) **Physiological adaptation:**
   - production of very concentrated urine;
   - thus conserving water;
   - uric acid (nitrogenous waste product), excreted as a paste;
   - thus conserving water;
   - low rate of evaporation from lungs;
   - thus reducing water loss;
   - low rate of evaporation from skin;
   - thus reducing water loss;

b) **Behavioural adaptation:**
   - Would expect that the Thorny Devil would be more active at night than the day;
   - thus conserve energy / water by not being in the heat of the day
   - While seeking a cool place to shelter during the heat of the day – avoids exposure to hot and drying conditions during the day;
   - reduce evaporative loss of water
   - Behaves as a solitary creature, making it easier to hide from predators;
   - thus conserves energy as not as easily detected
   - Makes itself scary by ‘spiking up’;
   - thus making itself less of a threat to predators.
   - Moves fast which allows itself to obtain prey / avoid predators;
   - thus conserving energy or water by not expending both in these events

**Comments**

a) **Many candidates (>50%)** were not able to recognise physiological adaptations and gave responses that referred to structural adaptations (no marks awarded). Those who understood the question scored full marks

Most candidates were able to describe a behavioural adaptation but some did not explain its advantage. Some candidates described adaptations that did not refer to the information that was in the question e.g. assumed the lizards would require more heat and needed to sit in the sun to gain heat for energy.
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### Student Distribution (SA or better)

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