Specimen Papers and Mark Schemes for Biology

For first AS Examination in 2009
For first A2 Examination in 2010
Subject Code: 1010
Contents

Specimen Papers 1
Assessment Unit AS 1 3
Assessment Unit AS 2 21
Assessment Unit A2 1 39
Assessment Unit A2 2 61

Mark Schemes 81
Assessment Unit AS 1 83
Assessment Unit AS 2 91
Assessment Unit A2 1 99
Assessment Unit A2 2 109

Summary of Changes since First Issue 119
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Biology

Assessment Unit AS 1

assessing

Molecules and Cells

SPECIMEN PAPER

TIME

1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Write your answer to Section B on the lined paper at the end of this booklet.
Answer all nine questions.
You are provided with Photograph 1.3 for use with Question 3 in this paper.
Do not write your answers on this photograph.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.
Section A carries 60 marks.
Section B carries 15 marks.
You should spend approximately 20 minutes on Section B.
You are expected to answer Section B in continuous prose.
Quality of written communication will be assessed in Section B.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Section A

1 Read the following passage on protein structure and write the most appropriate word(s) in the blank spaces to complete the account.

Proteins are made up of individual amino acids joined together by ______________ reactions to form a series of ______________ bonds. The sequence of amino acids in the protein chain is known as the ______________ structure. The protein chain twists or coils due to interactions between its amino acids to form the ______________ structure. Further folding of the chain leads to the ______________ structure. In the case of ______________ proteins, this overall shape is usually spherical.  

[5]
2 The diagram below illustrates a section through part of the wall of the ileum as viewed through a light microscope.

(a) Identify the structures labelled A and B.

A ________________________

B ________________________ [2]

(b) What is the function of the longitudinal and circular muscles labelled in the diagram?

__________________________________________________________

__________________________________________________________ [1]

(c) The villi represent a large surface area within the ileum.

Describe **two other** ways in which the villi are adapted to carry out their function of absorption.

1 _________________________________________________________

__________________________________________________________

2 _________________________________________________________

__________________________________________________________ [2]
3 The electron microscope achieves greater resolution than the light microscope and therefore enables greater useful magnification.

(a) What do you understand by the term ‘resolution’?

__________________________________________________________________________ [1]

Photograph 1.3 is an electronmicrograph which includes an organelle, labelled X, found in most eukaryotic cells.

(b) Identify this organelle.

__________________________________________________________________________ [1]

(c) Outline one possible function for this organelle.

__________________________________________________________________________ [1]

(d) Name the organelle from which the vesicles indicated by the arrows would have been derived.

__________________________________________________________________________ [1]

(e) Use the scale bar provided to calculate the magnification of this electronmicrograph. (Show your calculations)

Magnification ______________________ [2]
Photograph 1.3 (for use with Question 3)
4 (a) (i) What is meant by the term ‘water potential’?

__________________________________________________________________________ [1]

(ii) Outline the relationship between ‘water potential’ and the terms ‘solute potential’ and ‘pressure potential’.

__________________________________________________________________________ [1]

(b) The diagram below shows a plant cell immersed in a bathing solution. The solute potential and pressure potential of the cell and the water potential of the solution are given.

![Diagram of plant cell with solute potential \( \psi_s = -2000 \text{ kPa} \), pressure potential \( \psi_p = 500 \text{ kPa} \), and solution potential \( \psi_{\text{solution}} = -1800 \text{ kPa} \).]

(i) Calculate the water potential of the cell.

__________________________________________________________________________ [1]

(ii) Water movement will take place between the bathing solution and the cell. In which direction will this movement take place? Explain your answer.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [2]
5 The diagram below shows a dividing plant cell.

(a) Name the structures labelled 1, 2 and 3.

1 _______________________

2 _______________________

3 _______________________

[2]

(b) Is this cell dividing by mitosis or meiosis? Give a reason for your answer.

___________________________________________________________________________
___________________________________________________________________________

[2]

(c) Describe how cytokinesis would happen in this cell.

___________________________________________________________________________
___________________________________________________________________________

[1]
6 (a) In order to extract a cytoplasmic enzyme, a piece of liver tissue is liquidised in cold buffered solution.

(i) Explain why the enzyme is extracted in a buffered solution.

(ii) Explain why the solution used is cold.

(b) The diagrams below represent two alternative commercial production systems involving enzymes. In the batch reactor, a fixed amount of soluble enzyme and substrate are mixed together in a solution. In the continuous-flow column reactor, substrate molecules flow past enzymes which are immobilised on an inert support material.

Identify two advantages that the immobilised enzyme system has over the dissolved enzyme system. Explain your answer.
One disadvantage of enzyme immobilisation is that it may change the catalytic activity of the enzyme as shown in the graph below:

Suggest two reasons for the observed change in enzyme activity when immobilised.

1

2

Immobilisation is generally accepted as a strategy to develop more stable enzyme preparations. Thus immobilisation often increases the temperature and/or pH range over which an enzyme remains active.

Suggest how immobilisation may improve enzyme stability. Explain your answer.
The polymerase chain reaction (PCR) is a means of generating large numbers of identical copies of a sample of DNA. PCR technology allows scientists to remove tiny samples of DNA from a single hair follicle or white blood cells in a drop of blood and then make numerous copies of it. This process can be very useful in forensic science.

The steps involved in PCR technology are shown in the diagram below.

(a) Suggest how heating of the original DNA sample to 94°C (step 1) would bring about separation of the two strands of DNA.

(b) In step 2, small lengths of single stranded DNA known as ‘primers’ are added to the sample to stop the two sides of the sample DNA molecule from rebinding with each other.

Why is it important that the sample DNA now remains as two separate strands?
(c) In step 3, describe how the enzyme DNA polymerase would produce new double stranded copies using the single DNA strands and the pool of nucleotides provided.

(d) Suggest why it is important that some of the DNA copies manufactured are recycled in step 4.

In criminal cases, DNA found on the victim can undergo PCR and eventually allow the production of a DNA fingerprint.

The figure below illustrates the DNA fingerprint from a victim, the DNA specimen found on the victim and the DNA fingerprints of three potential suspects.

(e) (i) Use the DNA fingerprints to identify the guilty suspect.

(ii) Why is it important to include the victim’s DNA fingerprint for analysis?
8 (a) The active uptake of solutes by cells involves membrane carrier molecules. The carrier combines with the solute and then, utilising the energy of ATP, transfers it to the inner side of the membrane and releases it. This mechanism is represented in the diagram below.

(i) State the type of molecule of which the carrier is composed.  

(ii) For any particular solute which is actively absorbed there is a specific membrane carrier. Explain this specificity.  

(iii) Explain how water may pass through the membrane.
(b) The uptake of potassium ions by plant tissue immersed in different initial concentrations of potassium chloride solution and at two different temperatures was investigated. The results of the experiment are shown in the table below.

<table>
<thead>
<tr>
<th>Initial concentration of potassium chloride solution/mM</th>
<th>Uptake of potassium ions/arbitrary units hour(^{-1}) at 4°C</th>
<th>Uptake of potassium ions/arbitrary units hour(^{-1}) at 18°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>18</td>
<td>38</td>
</tr>
<tr>
<td>20</td>
<td>22</td>
<td>53</td>
</tr>
<tr>
<td>40</td>
<td>23</td>
<td>55</td>
</tr>
</tbody>
</table>

(i) Plot the above data, using the most appropriate graphical technique. (Use the graph paper overleaf).

(ii) The plant tissue has an internal potassium ion concentration of 50 mM. Explain why the potassium uptake must involve active transport.

(iii) Explain the effect of temperature on the rate of potassium ion uptake.

(iv) Rubidium ions have similar properties to potassium ions and, when present in the external solution, reduce the rate of potassium uptake. Suggest a reason for this observation.

[6] [1] [2] [1]
Section B

In this section you are expected to answer in continuous prose, supported, where appropriate, by diagrams. You are reminded that up to two marks in this question are awarded for the quality of written communication.

9 Compare and contrast the cellular structures of the following taxonomic groups.

- animals
- plants
- fungi

______________________________________________________________________

______________________________________________________________________

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______________________________________________________________________
ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2009

Biology  
Assessment Unit AS 2  

assessing  
Organisms and Biodiversity  

SPECIMEN PAPER

TIME

1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

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Write your answers in the spaces provided in this question paper.  
Write your answer to Section B on the lined paper at the end of this booklet.  
Answer all nine questions.  
You are provided with Photograph 2.4 for use with Question 4 in this paper.  
Do not write your answers on this photograph.  

INFORMATION FOR CANDIDATES

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Section A carries 60 marks.  
Section B carries 15 marks.  
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Section A

1 The brown rat (*Rattus norvegicus*) is grouped together with other closely related rats and mice in a taxonomic grouping called the muridae. The muridae belong to a group of mammals known as the rodentia. Use this information to help you develop a taxonomic hierarchy for the brown rat.

Kingdom: ____________________________
Phylum: ____________________________
Class: _____________________________
Order: ______________________________
Family: _____________________________
Genus: ______________________________
Species: ____________________________ [5]
The diagram below shows the fine structure of one type of white blood cell.

(a) Identify the type of white blood cell.  

(b) What is the function of the cell? Explain how its fine structure relates to this function.  

(c) State the name of one other type of white blood cell which carries out the same function.  

3 (a) The size of an animal population can be estimated using the ‘mark-release-recapture’ method.

Give two assumptions that must be made when using this technique.

1. ________________________________
   ________________________________

2. ________________________________
   ________________________________ [2]

(b) In estimating the size of a beetle population, 90 beetles were trapped, marked and released. A week later, a second sample was captured. Of these, 33 were found to be marked and 17 were not.

(i) Calculate the estimated size of the beetle population. (Show your working in the space below).

   Answer __________________ [2]

(ii) Give one sampling device that could have been used to capture the beetles.

   ________________________________ [1]
Photograph 2.4 shows a section through the leaf of a heather plant (Erica).

In the space below, draw a block diagram of the tissue layers in the leaf. Identify, in the drawing, three features which indicate that this is the leaf of a xerophytic plant and explain through annotation of the drawing how each feature acts as an adaptation.
Photograph 2.4 (for use with Question 4)
The diagram below shows a section through alveoli and associated structures in the lung.

(a) The diffusion of oxygen from the alveoli into the blood complies with Fick’s Law. This states that the rate of diffusion is:

- directly proportional to the concentration gradient;
- greater when the diffusion distance is short.

A third factor is also involved.

(i) Describe how the concentration gradient of oxygen is maintained between the alveolus and the blood in the capillary.

(ii) Name the type of flattened epithelial cells found lining the alveoli.
(iii) Suggest the third factor that would influence the rate of diffusion in Fick’s law, and describe how this is provided within the lung.

..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
.................................................................................................................................................. [2]

(b) Explain the role of surfactant in the alveolus.

..................................................................................................................................................
.................................................................................................................................................. [1]

(c) The diseases emphysema and bronchitis reduce the efficiency of gas exchange. Explain how each of these diseases reduces the efficiency of gas exchange.

Emphysema

..................................................................................................................................................
..................................................................................................................................................

Bronchitis

..................................................................................................................................................
.................................................................................................................................................. [2]
The graphs below represent pressure changes, changes in ventricular volume and heart sounds in the left side of the heart measured during a cardiac cycle.

(a) Use the information in the graphs and your understanding to answer the following questions.

(i) Explain the peak in atrial pressure at A.

(ii) Explain the rise in ventricular volume at B.
(iii) Explain fully, by referring to the pressure changes, the second heart sound at C.

(b) Recent studies by a team from the University of California have found that cocoa polyphenols found in chocolate could help prevent blood clots and relax the smooth muscle in the walls of blood vessels and so lower the risk of heart disease and heart attacks.

(i) Use your knowledge of blood clotting to formulate a hypothesis to explain how cocoa polyphenols may prevent the formation of blood clots.

(ii) Briefly suggest how the presence of blood clots could lead to a heart attack.

(iii) Suggest how relaxation of smooth muscle in the wall of a blood vessel could reduce the chances of heart disease.
7 The figure below shows the oxygen dissociation curve of haemoglobin at two different partial pressures of carbon dioxide (ppCO₂).

(a) (i) Using information in the graph, complete the following table.

<table>
<thead>
<tr>
<th>Location of haemoglobin</th>
<th>Partial pressure of O₂/kPa</th>
<th>Partial pressure of CO₂/kPa</th>
<th>% saturation of haemoglobin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary capillaries</td>
<td>12.0</td>
<td>5.26</td>
<td></td>
</tr>
<tr>
<td>Muscle capillaries</td>
<td>2.7</td>
<td>6.05</td>
<td></td>
</tr>
</tbody>
</table>
(ii) The partial pressure of oxygen in alveolar air is approximately 13.16 kPa. Describe what happens to the oxygen in the alveolar air when blood enters the pulmonary capillaries.

(iii) Explain the values in the table for the partial pressure of oxygen and the partial pressure of carbon dioxide in the muscle capillaries.

(b) The graph on page 31 showing dissociation curves for haemoglobin illustrates the Bohr effect.

(i) What change in the tissues causes the Bohr effect?

(ii) Which tissue benefits from the Bohr effect?

(iii) What is the advantage gained by this tissue?
The diagram below represents the alternative routes taken by water and mineral salts from the soil to a xylem vessel.

(a) How is the structure of the epidermal cell suited to its role of water and mineral salt uptake from the soil?

(b) The cortex is made up of parenchyma cells. Suggest one way in which the structure of this tissue is suited to the movement of water through it.

(c) Which of the two arrows, A or B, represents the apoplastic pathway?

(d) (i) Describe the role of the Casparian strip shown in the endodermal cell.
(ii) What is the significance of the Casparian strip in water and mineral salt uptake in the plant?

........................................................................................................................................... [1]

(e) A potometer was set up, as shown in the diagram below, and the rate of water uptake by a twig was measured.

(i) State one necessary precaution when setting up the potometer.

........................................................................................................................................... [1]
The experiment was then repeated with a clear polythene bag placed over the twig as shown in the diagram below.

(ii) What effect would addition of the polythene bag have on the rate of water loss from the twig? Explain your answer.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________ [3]

(iii) In a further experiment, the polythene bag was removed, the air bubble was returned to the start of the scale, the upper surface of the leaves was covered with Vaseline and the resultant rate of water uptake was measured.

How would this treatment affect the rate of water loss from the twig? Explain your answer.

________________________________________________________________________
________________________________________________________________________
[2]
Section B

In this section you are expected to answer in continuous prose, supported, where appropriate, by diagrams. You are reminded that up to two marks in this question are awarded for the quality of written communication.

9 Discuss the impact of human activity on biodiversity with a consideration of the following.

- a range of factors adversely influencing biodiversity;
- strategies to encourage biodiversity.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
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______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
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______________________________________________________________________________
______________________________________________________________________________
Biology

Assessment Unit A2 1

assessing

Physiology and Ecosystems

SPECIMEN PAPER

TIME

2 hours

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Write your answer to Section B on the lined paper at the end of this booklet.
Answer all eight questions.
You are provided with Photograph 4.6 for use with Question 3 in this paper.
Do not write your answers on this photograph.

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.
Section A carries 72 marks.
Section B carries 18 marks.
You should spend approximately 25 minutes on Section B.
You are expected to answer Section B in continuous prose.
Quality of written communication will be assessed in Section B.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Section A

1. Distinguish between the following pairs of ecological terms.

   (a) Community and ecosystem

   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________ [2]

   (b) Colonisation and succession

   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________ [2]

   (c) Biotic and climatic climaxes

   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________ [2]
The diagram below represents a single kidney nephron:
(a) Two experiments were carried out to analyse fluid from different regions of the kidney.

In experiment one, samples were taken using a micropipette from the three regions, X, Y and Z. These were then tested using Benedict’s (for reducing sugars) and Biuret reagents (for protein). The results are shown in the table below.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Benedict’s</th>
<th>Biuret</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment one</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X (blood plasma)</td>
<td>Brick red ppt.</td>
<td>Intense purple</td>
</tr>
<tr>
<td>Y (glomerular filtrate)</td>
<td>Brick red ppt.</td>
<td>Very pale purple</td>
</tr>
<tr>
<td>Z (start of loop of Henlé)</td>
<td>Blue (unchanged)</td>
<td>Blue (unchanged)</td>
</tr>
<tr>
<td><strong>Experiment two – chilled kidney</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>Yellow/green ppt.</td>
<td>Purple tinge</td>
</tr>
</tbody>
</table>

(i) Explain the difference in the Biuret result between samples X and Y (in experiment one).

(ii) Account for the difference between the Benedict’s result between samples Y and Z (in experiment one).

(iii) In experiment two, the kidney was chilled and a sample was taken from region Z using a micropipette. Explain the results of the Benedict’s and Biuret tests shown above.
(b) Describe the effect of ADH on the functioning of the kidney nephron.
3 Photograph 4.3 is an electronmicrograph of mammalian voluntary muscle in a **contracted** state.

(a) Identify the structures labelled A to F.

   A __________________________
   B __________________________
   C __________________________
   D __________________________
   E __________________________
   F __________________________

[b][6][b]

(b) State **two** changes that would be apparent if this electronmicrograph showed the same section of muscle in a **relaxed** state.

_____________________________________________________

_____________________________________________________

_____________________________________________________

[2]

(c) Three types of muscle are recognised in the body: voluntary (skeletal), smooth and cardiac.

State **one** difference in structure between voluntary (skeletal) and smooth muscle.

_____________________________________________________

_____________________________________________________

[1]
Photograph 4.3
(for use with Question 3)
4 The figure below illustrates the amino acid sequence or primary structure of the human hormone insulin – a relatively small protein of 51 amino acids. Differences in the primary structure between human insulin and pig insulin (*), and human insulin and cow insulin (+) are also shown.

(a) (i) How many nucleotides on a mRNA molecule would code for this insulin molecule?

____________________________________________________________________________________ [1]

(ii) Describe the quaternary structure of the insulin molecule.

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________ [2]

(b) Patients suffering from diabetes mellitus inject insulin directly into the bloodstream rather than taking it orally. Explain.

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________ [2]
Both cow and pig insulin are recognised as ‘human’ by the patient’s cells and can function, but eventually lead to an antibody-mediated immune response which then renders them useless.

(c)  (i) Why are both cow and pig insulin recognised as ‘human’ by human cells?

(ii) Suggest why cow insulin eventually leads to a more adverse immune reaction than pig insulin.

(iii) Which cells in the immune system produce antibodies?

(iv) Antibodies produced eventually lead to the foreign insulin being destroyed by the body’s phagocytic cells. Describe the sequence of events from antibody production in response to the foreign insulin to destruction by the phagocytes.
Many plants contain a light-sensitive pigment, phytochrome, which exists in two interchangeable forms, as shown below:

\[ \begin{array}{c}
\text{daylight} \\
P_{660} \\
\text{darkness} \\
P_{730}
\end{array} \]

(a) Using the information above, and your own understanding, explain precisely how flowering is controlled in short-day plants.
(b) In a particular short-day plant, flowering is induced by exposure to a photoperiod consisting of eight hours of daylight and sixteen hours of darkness. In an experiment, plants were exposed to a photoperiod in which the sixteen hour period of darkness was interrupted with a break of ten minutes of bright light. Light breaks were given at hourly intervals throughout the sixteen hour period but to a different group of plants each time: one group received the light break after one hour, another after two hours and so on. The results are shown below.

(i) What can be deduced from the above results?

(ii) With respect to the action of phytochrome, explain the effect of ten minutes of light applied:

- following the first hour of a sixteen-hour period of darkness
• following the eighth hour of a sixteen hour period of darkness

(c) Suggest an advantage of the photoperiodic control of flowering for:

• plants growing naturally

• commercial flower growers

[2]
6 (a) In the space below, make a drawing from Photograph 4.6 to show the major regions of the spinal cord. Label the diagram to show where the following are located.

- Centrons of the motor neurones
- Axons of the relay neurones

Photograph 4.6
(for use with Question 6)

© Ed Reschke, Peter Arnold Inc./Science Photo Library

This topic removed from final version of specification
(b) A large number of chemicals interfere with the proper functioning of the synapse. The table below summarises the effect of three such chemicals on synaptic transmission. Use the information in the table to help you answer the questions that follow.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Effect on synapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opiates</td>
<td>Block receptor sites on post-synaptic membrane</td>
</tr>
<tr>
<td>Nicotine</td>
<td>Has similar effect to acetylcholine on the post-synaptic membrane</td>
</tr>
<tr>
<td>DIPFP nerve gas</td>
<td>Inhibits the action of cholinesterase enzyme</td>
</tr>
</tbody>
</table>

(i) Which of the three chemicals described could be used as a pain killer? Explain your answer.

Chemical

Explanation

(ii) Which of the three chemicals described would produce a prolonged response in the post-synaptic nerve cell? Explain your answer.

Chemical

Explanation

[3]
(c) At a synapse, transmitter substances must diffuse across a cleft which is 20 nm wide. If the diffusion rate of the transmitter substance is 40 \( \mu \text{m s}^{-1} \), calculate the time delay caused by its movement across the synaptic cleft.

Answer ______________ [2]
Read the following passage on the use of insecticides and use it to help you answer the questions that follow.

A wide range of chemical insecticides is now available to combat parasitic insects in the fields of horticulture, agriculture and public health.

Many insecticides act by disrupting the functioning of the insect nervous system. DDT, for example, prevents the normal transmission of the nerve impulse along the axon of the neurone. Concentrations of DDT which are effective against insects are harmless to birds and mammals. DDT persists unchanged, however, both in the environment and in animal tissues. Pyrethrum, a naturally occurring insecticide, has a mode of action similar to that of DDT. It is, however, subject to photoinactivation and rapid hydrolysis by enzymes.

Organophosphorus insecticides such as malathion act by interfering with the control of synaptic transmission. They inhibit the action of the hydrolytic enzyme, acetylcholinesterase.

(a) What do you understand by the term “parasitic”? (line 1)

__________________________________________________________________________

__________________________________________________________________________ [2]

(b) Following the use of DDT, lethal concentrations have been detected in the tissues of tertiary consumers such as birds. The figure below illustrates the accumulation of DDT which has occurred in a marine ecosystem in the 1970s. (The figures are given in parts per million, ppm).

<table>
<thead>
<tr>
<th></th>
<th>sea water</th>
<th>plankton</th>
<th>shrimps</th>
<th>small fish</th>
<th>cormorants</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm</td>
<td>5 × 10⁻⁵</td>
<td>4 × 10⁻²</td>
<td>1.6 × 10⁻¹</td>
<td>5 × 10⁻¹</td>
<td>26.4 ppm</td>
</tr>
</tbody>
</table>

(i) How many times more concentrated is DDT in the cormorants than in the original sea water?

__________________________________________________________________________ [1]

(ii) Why is more DDT found in organisms at the top of food chains?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [3]
(iii) Why has this problem not arisen with the insecticide pyrethrum?

_________________________________________________________________________[1]

(c) In the space below, with the aid of a diagram explain the terms ‘axon’ (line 5), ‘neurone’ (line 5) and ‘synaptic’ (line 11).

[d] Describe the mechanism by which malathion might interfere with the control of the synaptic transmission in mammals. Suggest the consequences of this interference for post-synaptic neurones and effectors.

_________________________________________________________________________[3]
Section B

In this section you are expected to answer in continuous prose, supported, where appropriate, by diagrams. You are reminded that up to two marks in this question are awarded for quality of written communication.

8 Give an account of the adverse impact of human activity on the environment, to include:

- Impact of intensive farming
- Eutrophication
- Atmospheric pollution

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_________________________________________________________________________

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Biology

Assessment Unit A2 2

assessing

Biochemistry, Genetics and Evolutionary Trends

SPECIMEN PAPER

TIME

2 hours

INSTRUCTIONS TO CANDIDATES

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Section A

1. The diagram below shows a longitudinal section of a carpel from an angiosperm.

(a) (i) Identify the structures labelled A to C.

A __________________________

B __________________________

C __________________________ [3]

(ii) What type of cell division produces the male gametes from the generative nucleus?

____________________________________________________ [1]

(iii) Name the cells produced as a result of fertilisation and state their ploidy.

____________________________________________________

____________________________________________________ [2]
The diagram below shows a stage in the synthesis of a part of a polypeptide.

(a) Name the organelle illustrated in the diagram.

(b) Using the information in the diagram above determine:

(i) the m-RNA codon at 1

(ii) the t-RNA anticodon at 2

(iii) the type of bond formed at 4
The following table shows characteristic features of four multicellular animal phyla. (✔ means that the feature is present, x means that it is absent.)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Phylum A</th>
<th>Phylum B</th>
<th>Phylum C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diploblastic</td>
<td>x</td>
<td>✔</td>
<td>x</td>
</tr>
<tr>
<td>Triplobastic</td>
<td>✔</td>
<td>x</td>
<td>✔</td>
</tr>
<tr>
<td>Through gut (mouth and anus)</td>
<td>x</td>
<td>x</td>
<td>✔</td>
</tr>
<tr>
<td>Intracellular digestion only</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

(a) Identify:

Phylum A

Phylum B

Phylum C

(b) State one other feature of phylum A not given in the table above.

[3]

[1]
Experiments were carried out with isolated liver mitochondria to investigate their metabolism. The mitochondria were kept in a buffer solution containing 0.25 mol dm\(^{-3}\) sucrose solution and inorganic salts.

(a) (i) Explain why the mitochondria were kept in a buffer solution.

__________________________________________________________________________ [1]

(ii) Explain the role of sucrose in the preparation.

__________________________________________________________________________ [1]

In the first experiment, succinate (an intermediate of Krebs cycle) and ADP were added to the preparation and the oxygen concentration measured using an oxygen electrode. Succinate is acted on by the enzyme succinate dehydrogenase which converts succinate into fumarate by dehydrogenation.

The results showing oxygen consumption are given in the graph below.

(b) (i) Explain how the dehydrogenation of succinate leads to the consumption of oxygen as shown in the above graph.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [3]
(ii) Suggest why the graph levels off even though there is surplus succinate and ADP in the preparation.

__________________________________________________________________________ [1]

(iii) Suggest why the respiratory substrate used was an intermediate from Krebs cycle and not glucose.

__________________________________________________________________________ [1]

In a second experiment succinate was added initially but ADP was added later. The results are shown below (with the results of the first experiment shown as a dotted line).

(c) Explain the results of the above experiment.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [3]
Mendel hypothesised that the pairs of alleles which determine particular traits segregate independently of pairs of alleles which determine other traits.

To investigate this, he transferred pollen from pure breeding plants with smooth yellow seeds to plants with wrinkled green seeds. The F₁ generation were allowed to self-pollinate and when the seeds produced were germinated and allowed to grow to maturity, the F₂ produced were as follows.

<table>
<thead>
<tr>
<th>Seed Characteristic</th>
<th>Number of Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth and yellow</td>
<td>315</td>
</tr>
<tr>
<td>Wrinkled and yellow</td>
<td>101</td>
</tr>
<tr>
<td>Smooth and green</td>
<td>108</td>
</tr>
<tr>
<td>Wrinkled and green</td>
<td>32</td>
</tr>
</tbody>
</table>

The above data was analysed using a chi-squared test, which gave a $\chi^2$ value of 0.47.

If his hypothesis was correct, the anticipated F₂ ratio would be 9:3:3:1.

(a) Calculate the number of seeds expected on the basis of this hypothesis.

smooth and yellow

wrinkled and yellow

smooth and green

wrinkled and green [2]

(b) State an appropriate null hypothesis.

________________________________________________________

________________________________________________________ [1]
(c) Complete the statistical analysis, stating the following:

- degrees of freedom used in reading the statistical table;

- probability value (or range) for the test statistic;

- decision about the null hypothesis.

(d) What can you conclude about the inheritance of seed texture and colour in the garden pea?
6 (a) **Photograph 6.6** is an electron micrograph of a mature chloroplast ($\times$ 100 000)

Identify the structures labelled A to E

A

B

C

D

E [4]

(b) The blue dye DCPIP becomes decolorised when reduced by electrons:

$$\text{DCPIP (dark blue)} \xrightarrow{\text{electrons}} \text{reduced DCPIP (colourless)}$$

An experiment was devised to test the hypothesis that chloroplasts may release electrons. Chloroplasts were extracted from leaf tissue, added to a blue solution of DCPIP and illuminated.

(i) Explain how chloroplasts might release electrons.

(ii) Assuming the hypothesis to be correct, describe what should happen to the DCPIP solution.

(iii) State two controls which should be performed along with the above experiment, and in each case explain its use.
(iv) Explain what normally happens to electrons released within illuminated chloroplasts.

(v) Mitochondria are also known to release electrons. Suggest how you would modify the experiment to find out if there were mitochondria also present in the leaf tissue extract. Explain your answer.
Photograph 6.6 (for use with Question 6)
7  (a) Explain each of the following genetic terms.

(i) Codominance

(ii) Lethal gene

(iii) Multiple alleles

(iv) Sex linkage

(b) In cats, both coat colour and the tabby marking pattern are controlled by two independently inherited genes which are not sex-linked. The genetics of the two traits are summarised below.

<table>
<thead>
<tr>
<th>Gene</th>
<th>Allele</th>
<th>Symbol</th>
<th>Dominance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Black</td>
<td>B</td>
<td>Dominant to b</td>
</tr>
<tr>
<td></td>
<td>Brown</td>
<td>b</td>
<td></td>
</tr>
<tr>
<td>Tabby</td>
<td>Abyssinian</td>
<td>T^A</td>
<td>Dominant to T^M and T^b</td>
</tr>
<tr>
<td></td>
<td>Mackerel</td>
<td>T^M</td>
<td>dominant to T^b</td>
</tr>
<tr>
<td></td>
<td>Blotched</td>
<td>T^b</td>
<td></td>
</tr>
</tbody>
</table>

(i) Determine the genotypes possible for each of the following phenotypes.

Brown and blotched tabby

Brown and Abyssinian tabby

Black and mackerel tabby

[4]
(ii) Use a genetic diagram to show the possible genotypes and phenotypes of a cross between

\[ \text{BbT}^\lambda \text{T}^b \times \text{BbT}^\mu \text{T}^b \]
Consider the following passage and then answer the questions below.

There are two forms of polyploidy, autopolyploidy and allopolyploidy.

**Autopolyploids** may arise following mitosis. If the chromatids separate normally at anaphase but then the cytoplasm fails to divide, a tetraploid (4n) cell with a larger nucleus is produced. This cell may subsequently undergo normal mitotic division to produce tetraploid daughter cells. The amount of cytoplasm in these cells tends to increase, preserving the balance between the volume of the cytoplasm and that of the nucleus. **Autopolyploids** can result in advantageous characteristics but they are generally less fertile than the diploids from which they were formed.

Polyploidy involving the chromosomes of a hybrid of two different species is termed **allopolyploidy**. This type of polyploidy can restore fertility to a sterile hybrid as described below.

A hybrid zygote, formed by the fusion of gametes from two different species, is normally sterile. Fertility may be subsequently restored as a result of polyploidy during vegetative reproduction and a new species formed. For example, *Spartina maritima* (2n = 60) and *Spartina alterniflora* (2n = 62) has interbred to form a sterile hybrid called *Spartina townsendii*. This plant is extremely vigorous and reproduces rapidly by vegetative means. **Allopolyploidy** in this hybrid has given rise to a fourth species, *Spartina anglica*, which is fertile.

(a) (i) What is a polyploid cell?

(ii) On the basis of the information in the passage, explain the difference between the terms autopolyploid and allopolyploid.

(iii) Commercial plant breeders have produced autopolyploids of tobacco, tomatoes and sugar beet plants. What are the advantageous characteristics of such plants?
(b) (i) Describe briefly the significance of the pairing of homologous chromosomes during meiosis in terms of the distribution of genetic material to the daughter cells.

(ii) Why might problems arise at this point in meiosis in:

- an autopolyploid

- a hybrid such as Spartina townsendii?

(iii) Explain how polyploidy might facilitate gamete formation and thus restore fertility in Spartina townsendii.

(c) In the space below, draw a family tree illustrating the formation of Spartina townsendii and Spartina anglica. Indicate on your diagram the processes involved in the formation of each species and the number of chromosomes in diploid and haploid cells of each plant type.
Section B

In this section you are expected to answer in continuous prose, supported, where appropriate, by diagrams. You are reminded that up to two marks in this question are awarded for the quality of written communication.

9 Give an account of the following aspects of gene technology.

- transgenic plants
- gene therapy
- human genome project
Divider back
QWC

Marks can only be awarded where candidates express themselves clearly and coherently and use the correct biological terms and expressions indicated in the mark scheme.

Section A

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold

1

- condensation
- peptide
- primary
- secondary
- tertiary
- globular

Six for [5], five for [4], four for [3], three for [2] and two for [1]

2 (a) A: serosa/connective tissue
   B: muscularis mucosa

(b) Peristalsis/mixing of food with enzymes (local constrictions and pendular movements);

(c) Any two from

- villus epithelium has microvilli which further enhances the absorptive surface
- epithelial cells have numerous protein carrier molecules to help uptake/epithelial cells have numerous mitochondria to provide ATP for active transport
- each villus has capillaries and a lacteal for transport of the products of digestion
- villi may be moved by the underlying muscularis mucosa so enhancing diffusion gradients for uptake
3 (a) The ability to distinguish between two objects as separate/the fineness of detail; [1]

(b) Golgi body; [1]

(c) **Any one from**

- production of conjugated proteins/quaternary proteins
- packaging and processing of materials for secretion
- production of secretory vesicles/lysosomes
- production of plant cell walls
- as appropriate for (b) [1]

(d) Endoplasmic reticulum; [1]

(e) Scale bar = 50 mm = 50,000 µm;
   Scale bar represents 1 µm therefore magnification = \( \times 50,000 \); [2] [6]

4 (a) (i) The chemical potential of water in a solution (relative to pure water)/amount of free kinetic energy that water molecules have in a solution/the water potential is the capacity for a solution to lose water; [1]

(ii) Water potential = solute potential + pressure potential/\( \Psi = \Psi_s + \Psi_p \); [1]

(b) (i) \( \Psi_{cell} = -1500 \) kPa; [1]

(ii) Water moves out of the cell (by osmosis);
   Movement takes place from a region of higher to lower water potential; [2] [5]

5 (a) 1 Chromosome/chromatid;
   2 spindle fibre;
   3 centromere; [2]

(b) Mitosis;
   No homologous pairs/bivalents; [2]

(c) Cell plate forms across equator of cell/golgi vesicles gather across equator; [1] [5]
6 (a) (i) to prevent pH fluctuation; thereby preventing enzyme denaturation; [2]

(ii) to prevent high temperature denaturation of the enzyme; [1]

(b) 1 because immobilised enzymes are physically confined within the reactor, they can be used continuously; this is more cost-effective for an industrial process; or in the batch reactor some of the enzyme is lost with the product, and therefore there is a loss of activity in the reactor; this is costly/less effective for an industrial process; [2]

2 in the immobilised enzyme system, the final product is not contaminated with enzyme; therefore no (costly/time-consuming) purification is needed; or in the batch reactor, the final product is contaminated with enzyme; therefore the product and enzyme need purification (which is costly/time-consuming); [2]

(c) Any two from

immobilisation may alter the active site of the enzyme; thus affecting binding of the enzyme;

and/or

the enzyme may be immobilised with the active site facing into the support material; thus access to the active site is limited/substrate binding is made more difficult;

and/or

continuous flow may reduce the opportunity for substrate molecules to bind with the immobilised enzyme; therefore there is a slower rate of ES complex formation; [4]

(d) (covalent) bonding between the enzyme and its support material/physical confinement of the enzyme within the material; helps resist disruption of the tertiary structure of the enzyme molecule by high temperatures or pH change; [2] [13]
7 (a) Heating breaks down hydrogen bonds/bonds holding the two strands together/bonds between the bases; [1]

(b) Each strand acts as a template against which free nucleotides combine (as in semi-conservative model); [1]

(c) Any two from

- nucleotides are arranged in place opposite the exposed bases on each strand according to the complementary base pairings (A-T, C-G, T-A, G-C)
- the complementary bases are held together by hydrogen bonds
- the sugar of one nucleotide is joined to the phosphate group of the next nucleotide
- a condensation reaction forms the bond [2]

(d) This ensures that multiple copies of the DNA are manufactured; [1]

(e) (i) Suspect one;

(ii) To ensure that the DNA specimen is not that of the victim; [2] [7]

8 (a) (i) Protein; [1]

(ii) The protein carrier has a specific receptive site (similar to the active site of an enzyme);
- the shape of the receptive site and the solute to be carried are complementary; [2]

(iii) Water passes through the hydrophilic pores of proteins in the membrane; [1]

(b) (i) Caption

- \( x \) axis labelled with units of measurement;
- \( y \) axis labelled with units of measurement;
- points accurately plotted;
- points joined with short straight lines \([\frac{1}{2}]\)
- key or labels for each temperature curve \([\frac{1}{2}]\)
- concentration on \( X \) axis \([\frac{1}{2}]\)
- appropriate scaling \([\frac{1}{2}]\) [6]
(ii) Uptake occurs against a concentration gradient;

(iii) Increased temperature increases the rate of respiration/enzyme activity; so greater availability of ATP for active processes and thus faster uptake;

(iv) Rubidium ions ‘compete’ for the site of attachment on the carrier molecule;
Section B

9 Thirteen points with at least six in each section.

Comparison of animals, plants and fungi:
- animals, plants and fungi possess eukaryotic cells
- with membrane-bound nuclei containing histone bound chromosomes
- mitochondria are responsible for aerobic respiration
- rough ER has attached ribosomes and is where protein synthesis takes place
- while smooth ER is responsible for lipid synthesis
- Golgi apparatus is where primary proteins are modified
- into glycoproteins/lipoproteins/enzymes
- which are then packaged into secretory vesicles for transport to the cell membrane/exocytosis
- or into lysosomes containing hydrolytic enzymes for use within the cell

Contrasting features of animals, plants and fungi:
- animal and plant cells contain only one nucleus per cell while fungal ‘cells’ may have several nuclei
- animal cells are bounded only by a cell membrane while both plants and fungi also have a cell wall
- in plants the cell wall is made of cellulose while in fungi the cell wall is made of chitin
- plant cell walls also possess a middle lamella made of calcium pectate cementing cells together
- and cytoplasmic strands/plasmodesmata connecting neighbouring cells
- plant cells also have a large, permanent vacuole which gives the plant support/turgor/stores cell sap
- chloroplasts, found only in plant cells, are responsible for photosynthesis
- plant cells store carbohydrate as starch grains while both animal cells and fungi store carbohydrate as glycogen granules
- animal cells have centrioles while plant cells do not

Quality of Written Communication

2 marks

The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well structured. There are few errors of grammar, punctuation and spelling.

1 mark

The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.
0 marks

The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.
QWC

Marks can only be awarded where candidates express themselves clearly and coherently and use the correct biological terms and expressions indicated in the mark scheme.

Section A

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold

1
• animalia
• chordata
• mammalia
• rodentia
• muridae
• rattus
• norvegicus

Seven for [5], six for [4], five for [3], four for [2] and three for [1] [5] [5]

2 (a) Polymorphonuclear leucocyte/polymorph/granulocyte/neutrophil; [1]

(b) Phagocytosis of invading bacteria/bacteria engulfed by polymorph; digested inside vesicles by lysozymes contained in lysosomes; lysosomes produced by the Golgi body; [3]

(c) Monocyte/macrophage; [1] [5]

3 (a) Any two from
• that animals are not moving in or out of the population/that there is no migration
• that there are no births or deaths during the period of the exercise
• that the marks are not lost/marks do not make the animals more obvious to predators/marks do not influence the survival of the animal
• that the second sample is random and representative of the population
• that there is no trap shyness/attraction
• other appropriate response [2]

(b) (i) 33 out of 50 beetles are marked
since a total of 90 are marked, the population size is estimated as 136 [2]

(ii) Pit-fall trap/pooter/sweep net/beating tray [1] [5]
4 Drawing skills:

- block diagram shown (of leaf tissues);
- accurate representation of the photograph;
- quality of drawing (e.g., clear lines drawn, not sketchy);  

Xerophytic features:

Any three from

- thick waxy cuticle – reduces evaporation through the cuticle
- thick upper epidermal layer – reduces evaporation
- curvature of leaf (round lower surface) – maintains a high humidity immediately outside the stomata
- sunken stomata – maintains the high humidity
- epidermal hairs – maintains a high humidity immediately outside the stomata
- low density of stomata – reduces stomata evaporation
- few air spaces – reduces surface area for evaporation
- succulent mesophyll – stores water

5 (a) (i) The lung/alveolus is ventilated;
so that a high concentration of oxygen is maintained in the alveoli;
or
the oxygenated blood is transported away from the lung/deoxygenated blood is brought to the alveolar surface;
so maintaining a low concentration of oxygen in the blood;

(ii) Squamous epithelium;

(iii) Surface area;
a large surface area is provided by numerous alveoli in the lung;

(b) Surfactant reduces the surface tension in the water film on outer surface of alveoli/preventing water film within the alveoli coalescing/preventing the alveoli collapsing;

(c) Alveoli broken down (so reducing the surface area for gas exchange)/loss of elasticity in alveolar walls/alveoli stay inflated on expiration/difficulty in exhaling;

Inhalation/exhalation delivers less air (to alveolar surface so affecting the concentration gradient)/inflammation of bronchi or bronchioles/narrowing of bronchi or bronchioles/build-up of mucus in bronchi or bronchioles;
6  (a)  (i)  Atrial muscle is contracting (systole) increasing atrial pressure;  
(ii) During atrial systole, blood enters the ventricles via the open bicuspid and tricuspid valves leading to an increase in volume;  
(iii) The sound is due to the closure of a valve;  in this case (second heart sound) closure of the semi-lunar (aortic) valve;  since ventricular pressure is falling below aortic pressure/ and so blood is prevented from refluxing;  

(b)  (i)  Inhibits the production of thromboplastin/prevents conversion of prothrombin to thrombin/removes calcium from the plasma/inhibits the action of the various clotting factors/stops the conversion of fibrinogen to fibrin/dissolves fibrin/anything feasible;  
(ii) Blood clots cause a blockage in the coronary arteries;  heart tissue starved of oxygen/food and dies leading to loss of function;  
(iii) Lumen of blood vessels increase in size;  allows for greater delivery of oxygen (or metabolites)/decrease in blood pressure;
(a) (i)

<table>
<thead>
<tr>
<th>Location of haemoglobin</th>
<th>Partial pressure of $O_2$/kPa</th>
<th>Partial pressure of $CO_2$/kPa</th>
<th>% saturation of haemoglobin</th>
</tr>
</thead>
<tbody>
<tr>
<td>pulmonary capillaries</td>
<td>12.0</td>
<td>5.26</td>
<td>97</td>
</tr>
<tr>
<td>muscle capillaries</td>
<td>2.7</td>
<td>6.05</td>
<td>23</td>
</tr>
</tbody>
</table>

(ii) Any two from

- oxygen diffuses into the plasma
- along the diffusion gradient
- combining with haemoglobin in the red blood cells

(iii) Low oxygen partial pressure as oxygen is used in respiration; high carbon dioxide partial pressure as carbon dioxide is produced by the respiring cells;

(b) (i) Increased carbon dioxide concentration/increased temperature/decreased pH of blood;

(ii) Tissue with increased oxygen demand/appropriate example;

(iii) Greater unloading of oxygen to these cells; and so increased respiration/increased ATP production;
(a) Large surface area for water and mineral salt uptake/lack of waxy cuticle to promote water uptake; [1]

(b) Possession of cellulose walls facilitates apoplastic pathway/large vacuoles/plasmodesmata/lack of lignin allows easy movement of water along cell walls; [1]

(c) Arrow A; [1]

(d) (i) Prevents water moving along the apoplastic pathway/along cellulose (cell) wall/waterproofs cellulose (cell) wall; [1]

(ii) Water (and dissolved minerals) must pass through the symplastic pathway/offers the plant control of what enters the xylem; [1]

(e) (i) Cut twig and insert into sleeve under water/ensure no air leaks/cut twig at slant; [1]

(ii) Rate of water loss would be reduced; polythene bag would create a humid environment around twig; which reduces evapotranspiration; [3]

(iii) Little or no effect on water loss; fewer stomata on upper surface to be blocked by Vaseline; [2] [11]
Section B

9 Thirteen points with at least six in each section

Factors adversely influencing biodiversity:

- removal of trees and hedgerows/poor maintenance of existing hedgerows (neglect/poor timing of pruning, tree senescence without re-planting)
- results in increased soil erosion (by wind or rain)/loss of nesting sites/loss of food source (and thereby reduced biodiversity)
- increased use of pesticides may remove soil organisms that improve soil structure
- increased use of pesticides may remove natural predators of pest species which may result in the emergence of resistance strains of pest
- increased use of herbicides reduces the variety of food available (and thereby reduces biodiversity)
- increased use of monocultures reduces biodiversity since the variety of food sources is reduced
- increased use of artificial fertilisers may result in loss of soil quality (loss of crumb structure and thereby increased soil erosion)
- nitrogenous fertilisers tend to promote growth of some plant species only which out-compete other species and thereby reduce plant and animal diversity
- drainage schemes, ploughing and re-seeding of unimproved pasture reduces biodiversity (unimproved pasture is a reservoir of biodiversity)
- over-grazing due to increased animal stocking rates may prevent regeneration of hedgerows/woodland

Strategies to encourage biodiversity:

- better management of hedgerows (laying/timing of pruning to allow re-growth/re-planting)
- use of polyculture instead of monoculture
- use of set-aside land schemes (allows a greater variety of plant and animal species to become established)
- increased use of crop rotation and N₂-fixing plants to improve soil fertility
- increased use of organic fertiliser (farm yard manure) to improve soil quality (better crumb structure/aeration/drainage) and therefore support a greater range of plant and animal species
- use of integrated pest management schemes to decrease the dependency on pesticides
- including use of natural predators (biological control) of insect pests
- and genetically modified crops with increased resistance to pests and diseases
- use of predator strips to encourage the establishment of populations of natural predators adjacent to crops
- identification and protection of sites of special scientific interest/special areas of conservation.
Quality of Written Communication

2 marks

The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs which discuss causal relationships, not merely listing factors/strategies but producing well-structured coherent arguments with few errors of spelling.

1 mark

The candidate expresses ideas clearly, if not always fluently. The discussion may stray from the point and may not show causal relationships between aspects of factors/strategies. There are some errors in spelling.

0 marks

Answers may be of doubtful relevance or obscurely presented with little evidence of linkage. Errors in spelling are sufficiently intrusive to disrupt the understanding of the passage.
Biology

Assessment Unit A2 1

Physiology and Ecosystems

SPECIMEN PAPER

MARK SCHEME
QWC

Marks can only be awarded where candidates express themselves clearly and coherently and use the correct biological terms and expressions indicated in the mark scheme.

Section A

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold

1  (a) A community involves only the living organisms present in a given area; an ecosystem involves how the community/communities interact with their non-living environment; [2]

(b) Colonisation is the initial establishment of pioneer organisms in an uninhabited area; succession is a gradual change over time in species composition of a community, from the initial pioneers towards a stable climax community; [2]

(c) Biotic climax is a community that is maintained in a stable condition because of some biotic or living factor such as grazing; climatic climax is where a non-living factor such as rainfall maintains a community in a stable condition; [2] [6]

2  (a) (i) Most large plasma proteins held back by ultrafiltration; smaller proteins may get through into capsule leading to pale stain; [2]

(ii) Sugars reabsorbed in proximal convoluted tubule; [1]

(iii) Chilling reduces metabolic activity and inhibits production of ATP; so preventing active transport in nephron epithelial cells; thus some sugar/protein remains at end of proximal convoluted tubule; [3]

(b) ADH increases the permeability of the distal convoluted tubule/collecting duct; so more water is re-absorbed/urine produced more concentrated [2] [8]
3  (a)  A mitochondrion;  
    B  A band;  
    C  I band;  
    D sarcomere;  
    E M disc/line;  
    F Z disc/line;  

(b) Any two from
  
  - I bands longer/C longer  
  - H bands longer  
  - sarcomere distance longer

(c) Any one from
  
  - skeletal muscle multinucleate, smooth muscle uninucleate  
  - striations visible in skeletal, not visible in smooth  
  - longer fibres in skeletal muscle, shorter fibres in smooth  
  - greater number of mitochondria in skeletal muscle  
  - elongated shape in skeletal muscle, smooth muscle spindle-shaped  
  - skeletal attached to skeleton, smooth muscle not attached
4  (a)  (i)  153 nucleotides (allow for extra in multiples of three for starter/terminator codons);  [1]

(ii) Insulin consists of two polypeptide chains; held together by disulphide bonds;  [2]

(b)  Any two from

- insulin would be broken down into individual amino acids by the protease enzymes in the gut and so is rendered ineffective

- individual amino acids could not be reassembled into insulin due to lack of genetic information

- injection places the intact insulin molecule into the bloodstream and so maintains its quaternary structure  [2]

(c)  (i)  They have a similar structure to human insulin;  [1]

(ii) Cow insulin is more different to human insulin (three amino acids different) than pig insulin (one amino acid different);  [1]

(iii) Plasma cells;  [1]

(iv)  Any three from

- specific receptor sites on B lymphocytes detect foreign insulin
- B lymphocytes clone to form plasma cells and memory cells
- plasma cells produce and liberate antibodies into blood plasma
- antibodies attach to insulin causing clumping
- insulin taken into phagocytic cell by endocytosis
- fusion of primary lysosome with endocytosed vesicle
- discharged contents of lysosome digests insulin which is absorbed into cytoplasm  [3]  [11]
(a) Any four from

- phytochrome exists in two interchangeable forms of which P$_{730}$ is the active form
- in short day plants P$_{730}$ inhibits flowering
- short day plants, require a long, uninterrupted period of darkness to induce flowering
- during this period P$_{730}$ is slowly converted to P$_{660}$
- P$_{730}$ inhibition is removed to allow flowering to occur

(b) (i) The further into the period of darkness the light break is administered, it is less likely that flowering will occur; short day plants require at least 8 hours of continuous darkness to stimulate flowering;

(ii) The bright light causes the conversion of P$_{660}$ to P$_{730}$; there is long enough period of continual darkness following this light treatment to remove the P$_{730}$ formed and so removes P$_{730}$ inhibition, allowing flowering to occur;

The period of darkness following the light treatment is too short to remove all of the P$_{730}$ created during the light treatment;
The remaining P$_{730}$ inhibits flowering in this short day plant;

(c) Natural synchronises flowering within a species, increasing the chances of cross-polination;

Commercial plant growers can stimulate flowering at any time of the year by manipulating lighting regimes;
6 (a) Drawing Skills:

- accurate representation of the photograph (a drawing of the photograph rather than a textbook diagram, eg showing central canal, etc, and with smooth continuous lines, eg not sketchy);
- accurate positioning and proportionality of the regions (white and grey matter clearly illustrated);
- centrons of motor neurones identified in ventral horn of grey matter;
- axons of relay neurones identified in the white matter [4]

(b) (i) Chemical: Opiates;

Explanation: acetylcholine produced by sensory neurone could not evoke an excitatory post-synaptic potential in intermediate neurone (as receptor sites are blocked); [3]

(ii) Chemical: DIPFP nerve gas

Explanation: acetylcholine cannot be broken down; post-synaptic cell remains depolarised; [3]

(c) \[40 \, \mu \text{m s}^{-1} = 40,000 \, \mu \text{m s}^{-1}\] [unit conversion]

\[
\frac{20 \, \text{nm}}{40,000} \, \mu \text{m s}^{-1} = 0.0005 \, \text{s (0.5 ms)} \] [rate to time conversion] [2] [12]
(a) A relationship between two organisms which is detrimental to one partner (the host); and beneficial to the other partner (the parasite); [2]

(b) (i) 528 000 times greater (26.4/5 \times 10^{-5}); [1]

(ii) Any three from

- animals at the top of food chain must eat many organisms from lower trophic levels
- as little energy is transferred from trophic level to trophic level/as a result of inefficiency of energy transfer (10% rule)
- each meal contains small amounts of DDT
- DDT being persistent or non-biodegradable builds up in the tissues of the organisms [3]

(iii) Pyrethrum is deactivated by photoinactivation or is readily hydrolysed and so is not persistent; [1]

(c) Axon labelled correctly as structure leaving centron; neurone labelling entire cell; synaptic referring to gap between adjacent neurones/referring to space beyond end of axon; quality of diagram; [4]

(d) Any three from

- the enzyme acetylcholinesterase is inhibited and so acetylcholine remains bound to the specific receptor sites on the post-synaptic membrane
- as a result of this the post-synaptic membrane remains depolarised
- further nerve impulses cannot bridge the synaptic cleft
- post-synaptic neurone cannot convey nerve impulse/effecter organ is not stimulated [3] [14]
Sixteen points (with at least five from each section)

Adverse impact of intensive farming:

- increased use of monocultures increases the risk of problems with weeds, pests and diseases
- increased dependency on artificial fertilisers results in the loss of soil crumb structure
- and increased risk of leaching during heavy rainfall (due to solubility of artificial fertiliser) and thereby increased risk of eutrophication
- use of broad spectrum, non-biodegradable pesticides results in bioaccumulation in food chains
- and potentially target pest resurgence/emergence of resistant strains of pests
- removal of hedgerows to facilitate agriculture increases the risk of soil erosion/loss of habitat/food sources and thereby reduces biodiversity
- disposal of slurry can smother aquatic vegetation (due to suspended solids)
- slurry may cause a population explosion of bacteria in water bodies and thereby increased BOD and consequently reduces biodiversity

Eutrophication:

- this is the mineral enrichment of water bodies
- due to leaching of nitrates and phosphates (from artificial fertilisers)
- resulting in algal blooms
- these algae die when the minerals in the water body become depleted
- decomposition decreases the oxygen level in the water/increase the BOD
- populations of fish and aquatic invertebrates decline
- there is a health risk from drinking water contaminated with toxic algae
- economic cost of removal of toxic algae from drinking water

Atmospheric pollution:

- combustion of fossil fuels increases the level of CO₂ in the atmosphere
- this results in global atmospheric warming
- melting of polar ice/increased sea level/coastal flooding
- changing climatic patterns
- use of CFCs has resulted in thinning of the ozone layer/holes in the ozone layer
- increased penetration of UV light
- increased risk of skin cancer/eye cataracts
- combustion of fossil fuels also increases levels of SO₂ and NO₂ in the atmosphere
- resultant acid rain is directly toxic to plants/interferes with the solubility of mineral ions in the soil/causes aluminium ions to be leached into waterways
- which stimulates mucus production in fish gills with concomitant asphyxiation

[16]
Quality of Written Communication

2 marks
The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well structured. There are few errors of grammar, punctuation and spelling.

1 mark
The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks
The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.
ADVANCED
General Certificate of Education
2010

Biology
Assessment Unit A2 2
Biochemistry, Genetics and Evolutionary Trends

SPECIMEN PAPER

MARK
SCHEME
QWC

Marks can only be awarded where candidates express themselves clearly and coherently and use the correct biological terms and expressions indicated in the mark scheme.

Section A

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold

1 (a) (i) A: pollen grain;
       B: tube nucleus/vegetative nucleus;
       C: embryosac; [3]

       (ii) mitosis; [1]

       (iii) diploid zygote;
              triploid primary endosperm nucleus; [2] [6]

2 (a) ribosome; [1]

(b) (i) CCU; [3]

       (ii) UUC; [4]

       (iii) peptide bond; [3] [4]

3 (a) Phylum A: Platyhelminthes/flatworms;
       Phylum B: Cnidaria;
       Phylum C: Annelida/Chordata; [3]

(b) acoelomate/dorsoventral flattened/bilateral symmetry/digestion mainly intracellular; [1] [4]

4 (a) (i) To maintain a constant pH; [1]

       (ii) To maintain an isotonic solution/to prevent osmotic lysis; [1]

(b) (i) Hydrogen removed from succinate/hydrogen removed in Krebs cycle;
       hydrogen/electrons passed along the respiratory chain;
       oxygen acts as the final acceptor; [3]

       (ii) oxygen used up; [1]

       (iii) Mitochondria cannot metabolise glucose/glucose is metabolised in the cytoplasm/glucose is metabolised during glycolysis; [1]
(c) ADP is required for oxidative phosphorylation; phosphorylation is necessary for the operation of the respiratory chain; without the operation of the respiratory chain no oxygen is used/oxidative phosphorylation is not just associated with the respiratory chain but is tightly coupled to it/the slight rise initially is due to residual ADP within the mitochondria; [3] [10]

5  (a) Smooth and yellow 312.75
wrinkled and yellow 104.25
smooth and green 104.25
wrinkled and green 34.75

½ mark each [2]

(b) There is no significant difference between the observed F_2 ratio and the anticipated F_2 ratio, any difference between the two ratios is due solely to chance; [1]

(c) 3;
> 0.9;
accept; [3]

(d) The alleles controlling seed texture and colour in peas are segregating independently of each other; [1] [7]
6  (a)  
A  Chloroplast envelope  
B  starch grain  
C  thylakoids/grana/lamellae  
D  lipid droplet  
E  stroma  

Five for [4], four for [3], three for [2] marks and two for [1]  

(b)  
(i)  Chlorophyll molecules are excited by light;  

(ii)  DCPIP turns colourless;  

(iii)  DCPIP solution without extract (or with boiled extract), to show that living chloroplasts are the source of the electrons/there is no other source of the electrons;  

DCPIP solution with extract in the dark, to show that light is the agent for electron release;  

(iv)  Electrons picked up by electron acceptor;  
flows through electron transfer system with the production of ATP (photophosphorylation);  
finally reduces NADP to produce NADPH$_2$;  

(v)  Repeat experiment in the dark;  
if mitochondria present, DCPIP would be decolourised;  
chloroplasts would have no influence, since they are inactive in the dark;  

or  

Repeat experiment at low temperature (eg 5°C);  
if mitochondria present, there would be a decreased rate of colour change (due to suppressed mitochondrial activity);  
chloroplast activity would remain the same, since photochemical activity is not temperature sensitive;
Codominance – both alleles in a genotype are expressed (functional proteins produced by each)/where the heterozygote has a phenotype distinct from either homozygote;  

Lethal gene – one genotype produces sufficiently drastic effects to kill the bearers of that genotype (often at an early stage of development);  

Multiple alleles – there are more than two different forms of the same gene;  

Sex linkage – a gene located on a chromosome determining sex/where the inheritance of the alleles of a gene is influenced by the gender of an organism/where reciprocal crosses give different results;  

Gametes possible:

- genotypes accurately shown;
- phenotypes accurately shown;
- phenotype ratio;

\[
\begin{array}{cccc}
\text{BbT}^{bTb} & \times & \text{BbT}^{Mtb} \\
\text{BTA} & \text{BTA} & \text{bTA} & \text{bTA} \\
\text{BTb} & \text{BTb} & \text{bTb} & \text{bTb} \\
\text{BTM} & \text{BTM} & \text{bTM} & \text{bTM} \\
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(a) (i) A cell with more than twice the normal haploid number of chromosomes;

(ii) Autopolyploid cells contain twice the normal haploid number of chromosomes but all the chromosomes are from the same species;

allopolyploid cells result from the hybridisation of two species;

and as a result contain twice the normal haploid chromosome number but the chromosomes are from two different species;

(iii) Plants would have an increased size/greater hardiness/increased resistance to disease/any other appropriate answer;

(b) (i) Allows for the halving of chromosome number; allows for the segregation of the alleles at each gene locus;

(ii) Autopolyploid may affect the ability of meiosis to produce daughter cells with a balanced set of chromosomes and so affect fertility (especially in autotriploids);

hybrids cannot form homologous chromosome pairs and so normal chromosome segregation cannot occur to produce viable gametes;

(ii) Chromosomes now have homologous chromosomes to pair up with which allows meiosis to take place;
Haploid number of gametes;
Diploid number of *Spartina townsendii*;
Complete non-disjunction;
Diploid number of *spartina anglica*; [4] [14]
Sixteen points (with at least five from each section)

Transgenic plants:

- isolating a desired gene from chromosomal DNA cut into fragments using restriction endonuclease
- the DNA is cut either side of the gene (and not in the middle of the gene) by choosing a particular restriction enzyme (out of hundreds available)
- identification of the DNA fragment containing the required gene by a gene probe/‘Southern blotting’ technique
- restriction enzymes producing ‘sticky’ ends are most useful (as the DNA fragment will more readily attach to the vector opened with the same restriction enzyme since the exposed bases are complementary)
- when plant cells are to be modified, the gene is inserted into a Ti (‘tumor-inducing’) plasmid
- opened by restriction endonuclease (the same one as used to obtain DNA fragments so that ‘sticky’ ends produced are complementary) with ‘cut’ ends sealed (annealed) using DNA ligase
- the recombinant Ti plasmid is introduced into the bacterium Agrobacterium tumefaciens
- which readily invades plant tissue that has had the cellulose wall digested (it will naturally reform afterwards)
- example of genetically engineered plants (eg ‘Flavr Savr’ tomato, roll leaf virus resistant potato, thioesterase oil seed rape)

Gene therapy:

- genetic disorders are caused by an absent or faulty gene/an incorrect nucleotide sequence
- resulting in a non-functional protein (or no protein) being produced and so abnormal metabolism
- example of genetic disorder (eg in cystic fibrosis the chloride ion membrane-pump is non-functional)
- gene therapy as the introduction of a functional gene to restore normal metabolism (and so eliminate the disease)
- isolation and identification of the normal gene using restriction enzymes and gene probes
• problems of introducing the gene into sufficient somatic cells

• introducing the gene for curing cystic fibrosis into the lungs using liposomes

• other example of gene therapy (eg inserting the gene coding for the enzyme adenine deaminase (ADA) into the blood cells of people suffering from severe combined immune deficiency (SCID) has been used to ‘cure’ the symptoms of SCID)

Human genome project:

• genome of an organism as the complete DNA sequence (on one set of chromosomes)

• genome sequencing as the determination of the order of nucleotides (bases) and so the genetic code

• human genome project determines the sequence of approximately 3 million nucleotides in the human genome

• and identifying all the genes (approximately 25 000)

• knowledge of the genetic code allows the structure of proteins to be determined

• the human genome project supports the use of gene therapy

• supports genetic testing whereby DNA ‘chips’ can be used to determine if an individual is a carrier of a genetic disorder

• supports improved diagnostics to test for the presence of genes that increase susceptibility of a person to a disease (eg cancer or heart disease)

• supports the development of ‘designer’ drugs matched to an individual’s genetic profile

Quality of Written Communication

2 marks

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1 mark

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Summary of Changes since First Issue

*(all document changes are marked in red)*

<table>
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<th>Date of Change</th>
<th>Page Number</th>
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<td>Version 2</td>
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<td>51</td>
<td>Specimen Paper A2 1 – Annotation to Question 6 (a)</td>
</tr>
<tr>
<td>Version 2</td>
<td>28 May 2010</td>
<td>73</td>
<td>Specimen Paper A2 2 – Reworded Question 7 (b) (part ii)</td>
</tr>
<tr>
<td>Version 2</td>
<td>28 May 2010</td>
<td>104</td>
<td>Mark Scheme A2 1 – Annotation to Question 6 (a)</td>
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<tr>
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<td>28 May 2010</td>
<td>110</td>
<td>Mark Scheme A2 2 – Change to answer for Question 2 (b) (part iii)</td>
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