Tasmanian Certificate of Education

BIOLOGY
Senior Secondary

Subject Code: BIO315109

External Assessment

2012

Part 1

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the course statement:

Criterion 2  Develop interpret and evaluate biological experiments.

<table>
<thead>
<tr>
<th>Section Total</th>
<th>/33</th>
</tr>
</thead>
</table>

Pages: 12
Questions: 3

© Copyright for part(s) of this examination may be held by individuals and/or organisations other than the Tasmanian Qualifications Authority.
CANDIDATE INSTRUCTIONS

Candidates **MUST** ensure that they have addressed the externally assessed criterion on this examination paper.

Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

You should make sure you answer all parts within each question so that the criterion can be assessed.

This examination is 3 hours in length. It is recommended that you spend approximately 35 minutes in total answering the questions in this booklet.

The 2012 Biology Information Sheet can be used throughout the examination.

All written responses must be in English.
Question 1

A student conducted an experiment in a glasshouse to determine the effect of a new fertiliser, Growell, on barley plants. Each pot contained ten seeds and the amount of Growell fertiliser applied is shown in the table, and the diagram shows the seeds’ growth.

<table>
<thead>
<tr>
<th>Treatment (pot)</th>
<th>Growell (g/pot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
</tr>
<tr>
<td>C</td>
<td>80</td>
</tr>
<tr>
<td>D</td>
<td>120</td>
</tr>
</tbody>
</table>

(a) State **ONE** measurement the student might take to determine the effect of Growell on barley. (1 mark)

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

(b) Describe **TWO** ways that this student’s experimental design has increased the reliability of results. (4 marks)

1. ........................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................

Question 1 continues opposite.
Question 1 (continued)

2. ........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

(c) What are FOUR factors (variables) that cannot be adequately controlled when conducting this experiment in the field? Explain. (4 marks)

1. ........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

2. ........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

3. ........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

4. ........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
The disease melioidosis is caused by the bacterium *Burkholderia pseudomallei*, and is endemic in northern Australia. The bacterium is present in soil and surface water and outbreaks of the disease follow episodes of high rainfall and flooding during the ‘wet season’ when people are exposed to mud and surface water.

A scientist investigated the effectiveness of an antibiotic in treating five different strains of the bacterium which causes melioidosis. She prepared an agar plate with a concentration gradient of the antibiotic. She then spread the different strains of the bacterium across the agar plate in five different lines, labelled A to E in the diagram below. The plate was incubated for 12 hours at 37°C.

(a) Which strain of bacterium is the most resistant to the antibiotic? Explain your answer. (2 marks)

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

---

**Question 2 continues opposite.**
**Question 2 (continued)**

The scientist then designed an experiment to investigate the effectiveness of the antibiotic in treating the disease melioidosis itself. She decided to use laboratory-bred mice to test the following hypothesis:

‘Mice with melioidosis are cured of the disease after treatment with an appropriate dose of the antibiotic (chemical drug).’

(b) In the above hypothesis:

(i) what is the independent variable?  
....................................................................................................................................

(ii) what is the dependent variable?  
....................................................................................................................................

(c) If the scientist’s goal is to develop an antibiotic for treating the disease melioidosis, is conducting the above experiment a waste of time? Explain your answer.  
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................

(d) Discuss TWO difficulties faced by the scientist in carrying out drug trials involving people in order to have the new antibiotic approved for use in treating people with the disease melioidosis.  
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
2. .............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
Tall fescues are deep-rooted perennial grasses, which may be infected with a fungus. The fungus and the plant have a symbiotic relationship where the fungus is supplied with nutrients and is able to spread via the host plant’s seed. In return the fungus produces chemicals that help the fescue to survive in the field. Unfortunately some of these chemicals cause a disease in sheep and cattle called ‘fescue foot’.

New cultivars (or varieties) of fescue grasses, such as Demeter, Quantum and Resolute, are being grown with a strain of fungus called MaxP that is safe for livestock to graze. As a bonus the MaxP fungus continues to produce chemicals that improve the fescues’ tolerance to attack from pests such as the introduced African Black Beetle, and its persistence in the field.

The new cultivars, infected with the fungus MaxP, were trialled at Cressy Research Station where their performance was measured as average liveweight gain/hectare of merino sheep.

### Average Liveweight gain per hectare (kg lwg/hectare) by season at Cressy.

<table>
<thead>
<tr>
<th>Cultivar/Season</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolute MaxP</td>
<td>157</td>
<td>384</td>
<td>113</td>
<td>117</td>
</tr>
<tr>
<td>Demeter MaxP</td>
<td>156</td>
<td>354</td>
<td>173</td>
<td>104</td>
</tr>
<tr>
<td>Quantum MaxP</td>
<td>142</td>
<td>375</td>
<td>163</td>
<td>123</td>
</tr>
</tbody>
</table>

(a) Give a likely hypothesis for the experiment at Cressy. (3 marks)

.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
Question 3 (continued)

(b) Using the data in the table, which cultivar would provide a farmer with the highest average liveweight gain per hectare of sheep? Justify your answer. (3 marks)

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

(c) How much confidence can you have in the conclusions you made in your answer to part (b) above? Justify your answer. (2 marks)

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

(d) By referring to the results in the table, identify what you would consider to be an important biotic factor influencing Average Liveweight gain/hectare for sheep, and justify your answer. (2 marks)

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

Question 3 continues over the page.
Question 3 (continued)

(e) If you had to repeat the original field trials at Cressy, what further information would you first need to obtain from the scientist who conducted the original trials? Explain why. (4 marks)

...........................................................................................................................................
This question paper and any materials associated with this examination (including answer booklets, cover sheets, rough note paper, or information sheets) remain the property of the Tasmanian Qualifications Authority.
Tasmanian Certificate of Education

BIOLOGY

Senior Secondary

Subject Code: BIO315109

External Assessment

2012

Part 2

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the course statement:

**Criterion 5**  Demonstrate knowledge and understanding of the chemical basis of life.

<table>
<thead>
<tr>
<th>Section Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>/33</td>
</tr>
</tbody>
</table>

Pages: 12
Questions: 5

©Copyright for part(s) of this examination may be held by individuals and/or organisations other than the Tasmanian Qualifications Authority.
CANDIDATE INSTRUCTIONS

Candidates MUST ensure that they have addressed the externally assessed criterion on this examination paper.

Answer ALL questions. Answers must be written in the spaces provided on the examination paper.

You should make sure you answer all parts within each question so that the criterion can be assessed.

This examination is 3 hours in length. It is recommended that you spend approximately 35 minutes in total answering the questions in this booklet.

The 2012 Biology Information Sheet can be used throughout the examination.

All written responses must be in English.
Question 4

Refer to the following diagram, which shows process A, compound B, and structures 1, 2 and 3 in a cell.

(a) Examine the figure above and answer the following:

(i) What is the function of: (2 marks)

compound B? ...........................................................................................................
structure 3? .............................................................................................................

(ii) What type of nucleic acid is found in structure 3? (1 mark)
....................................................................................................................................

(b) (i) What is process A? (1 mark)
....................................................................................................................................

(ii) Consider structures 1 and 2, and compound B. What do all three have in common? (1 mark)
....................................................................................................................................

Question 4 continues opposite.
Question 4 (continued)

(c) A length of mRNA codes for the production of a polypeptide that is 120 amino acids long. How many DNA bases code for the amino acids in this polypeptide? Explain, showing your working. 

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

The following diagram shows a portion of an unknown macromolecule found in plant cells. The remaining portion of the molecule contains the same repeating unit.

Two biology students were discussing this diagram. Ella suggested it represented cellulose, but Kyle disagreed. He suggested that the diagram represents the enzyme cellulase.

(d) Name the student who is correct and explain why that student is right and the other student is wrong. 

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

/10
Question 5

Refer to the following diagram, which shows a part of two DNA molecules from the same type of bacterium grown in different media.

Bacteria were grown for several generations in a medium containing non-radioactive nitrogen. The bacteria were then grown in a medium containing radioactive nitrogen.

(a) Which one of the diagrams below best represents the DNA molecules produced after the bacteria had divided once in the medium containing radioactive nitrogen? Explain your choice. (2 marks)

(i) Choice of Letter:

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

(ii) Explanation

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

(b) What is the name commonly given to the process illustrated in the above diagram? (1 mark)

............................................................................................................................................
Question 6

Hydrogen cyanide is a well known inhibitor of enzyme activity involved in aerobic cellular respiration. The hydrogen cyanide molecule stops or inhibits the enzyme *cytochrome c oxidase* from working in mitochondria, thus preventing the production of ATP. The hydrogen cyanide acts as a non-competitive inhibitor.

In answering parts (a) and (b), use diagrams if you wish.

(a) Explain how hydrogen cyanide stops enzyme activity through non-competitive inhibition. (2 marks)

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

(b) Malonate stops enzyme activity in cellular respiration through competitive inhibition. Explain how malonate’s mode of action differs from that of hydrogen cyanide. (2 marks)

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

(c) Assuming that hydrogen cyanide and malonate have equal affinity for the enzyme (i.e. both bind to it with equal ease), explain why hydrogen cyanide would be faster in stopping enzyme activity than malonate. (2 marks)

.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
Question 7

The enzyme lactase digests lactose. Lactose + lactase → glucose + galactose.

In an experiment two test tubes were set up, and both kept at 15°C for 10 minutes. Test tube 1 contained 5 mL of lactose and 0.5 mL of lactase. Test tube 2 contained 5 mL of lactose and 0.25 mL of lactase. The result for test tube 1 is shown below.

(a) Draw a line on the above graph indicating the result you would expect for test tube 2 and justify your answer. (3 marks)

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

(b) Test tubes 3 and 4 were set up, both containing 5 mL of lactose and 0.5 mL of lactase. Test tube 3 was incubated at 37°C, whereas test tube 4 was incubated at 15°C. Both tubes were incubated for 10 minutes.

At the end of the 10 minutes, would the amount of glucose produced in test tube 4 when compared to test tube 3 be lower, the same or greater than the amount produced in test tube 3? Explain. (2 marks)

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

/5
Question 8

Two tubes were set up, each containing 20ml of a dilute glucose solution. A number of single-celled organisms were added to Tube A and the same number of a different single-celled organism added to Tube B. The tubes were bubbled with air, sealed and maintained under bright light. Small samples of solutions were extracted from each tube at 15-minute intervals for 3 hours, and tested for levels of dissolved oxygen (O$_2$) and carbon dioxide (CO$_2$). The lights were then turned off for the next 3 hours.

The measurements for the first 3 hours have been plotted below.

Graph A – Tube A

Graph B – Tube B

Question 8 continues opposite.
Question 8 (continued)

(a) What might be the colour of the organism in tube A? Explain. (1 mark)

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

(b) (i) Complete the two graphs to show what would happen to the dissolved oxygen $\text{O}_2$ and carbon dioxide $\text{CO}_2$ levels in the three hours after the light is turned off. (2 marks)

(ii) Explain your answers to part (i).

Graph A: (2 marks)

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

Graph B: (2 marks)

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

(c) Explain how, and why, the results would be different for both Tube A and Tube B if the tubes had not been sealed. (2 marks)

Tube A: ..............................................................................................................................
....................................................................................................................................
....................................................................................................................................
....................................................................................................................................
....................................................................................................................................

Tube B: ..............................................................................................................................
....................................................................................................................................
....................................................................................................................................
....................................................................................................................................
....................................................................................................................................
....................................................................................................................................
....................................................................................................................................
Tasmanian Certificate of Education

BIOLOGY

Senior Secondary

Subject Code: BIO315109

External Assessment

2012

Part 3

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the course statement:

Criterion 6 Demonstrate knowledge and understanding of cells.

Section Total

/33

Pages: 12
Questions: 5

© Copyright for part(s) of this examination may be held by individuals and/or organisations other than the Tasmanian Qualifications Authority.
BLANK PAGE
CANDIDATE INSTRUCTIONS

Candidates **MUST** ensure that they have addressed the externally assessed criterion on this examination paper.

Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

You should make sure you answer all parts within each question so that the criterion can be assessed.

This examination is 3 hours in length. It is recommended that you spend approximately 35 minutes in total answering the questions in this booklet.

The 2012 Biology Information Sheet can be used throughout the examination.

All written responses must be in English.
Question 9

A student investigated osmosis as follows:

Three equal-sized dialysis tubing bags were filled with salt solutions of different concentrations and their ends tied with thread. A fourth bag, of the same size, was filled with distilled water. Each filled bag had an initial mass of 20 g. The bags were placed in a beaker of distilled water, as shown in the diagram, and left for one hour. The bags were then re-weighed and the initial and final masses noted in the table shown below.

![Diagram of dialysis bags in a beaker of distilled water]

<table>
<thead>
<tr>
<th>Bag</th>
<th>Initial mass (g)</th>
<th>Final mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20.0</td>
<td>21.9</td>
</tr>
<tr>
<td>B</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>C</td>
<td>20.0</td>
<td>26.5</td>
</tr>
<tr>
<td>D</td>
<td>20.0</td>
<td>29.5</td>
</tr>
</tbody>
</table>

(a) Using the data in the table, which dialysis bag must have initially contained: (3 marks)

(i) distilled water?

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

(ii) the lowest concentration of salt?

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

(iii) the highest concentration of salt?

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

Question 9 continues opposite.
Question 9 (continued)

(b) Which substance was able to pass through the dialysis tubing and did this process require energy? Explain.  
.................................................................................................................................................  
.................................................................................................................................................  
.................................................................................................................................................

(c) What term is used to describe the property of the dialysis tubing that allows osmosis to take place?  
.................................................................................................................................................  
.................................................................................................................................................

(d) Explain what is happening in tube B.  
.................................................................................................................................................  
.................................................................................................................................................  
.................................................................................................................................................  
.................................................................................................................................................
Question 10

Potassium ions (K⁺) can move against a concentration gradient through the cell membrane and into the guard cells of plants. The diagram below shows a cross-section of the cell membrane from a guard cell:

(a) What is the cellular process by which potassium ions move into the guard cell against a concentration gradient? Give a reason for your answer. (1 mark)

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

(b) The movement of potassium ions is an important factor in the opening and closing of the stomata by guard cells. Explain the significance of the fact that guard cells contain chloroplasts. (2 marks)

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

(c) The turgor pressure inside guard cells is also an important factor in the opening and closing of the stomata by guard cells through a change in their shape. Explain how the movement of potassium ions into a guard cell will affect its turgor pressure. (2 marks)

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

/5
Question 11

Refer to the diagram on the right of a cell and some of its organelles.

(a) Is the cell prokaryotic or eukaryotic? Justify your answer. (1 mark)

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

(b) (i) What is the name and function of the organelle labelled Q? (1 mark)

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

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

(ii) Describe the internal structure of organelle Q and explain how its internal structure increases the organelle’s efficiency and effectiveness. (2 marks)

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

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

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

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

(c) Explain how the functioning of the organelles labelled N, P and W relies heavily on the function of organelle Q. (2 marks)

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

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

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

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

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

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

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

............................................................................................................................................
Question 12

Refer to the following electron photomicrograph, which shows part of a lactating (milk-producing) cell from a mammary gland. The white structures contain lipids and the black spots are proteins.

(a) Milk is a complex mix of lipids and proteins. Identify and discuss the function of the organelles (not including the nucleus) involved in the synthesis, transport and packaging of the components that together produce milk, and its movement towards the cell membrane. (4 marks)

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

Question 12 continues opposite.
Question 12 (continued)

(b) Name the process by which milk leaves the cell and state whether or nor this process requires ATP. (1 mark)

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

The following question refers to the electron micrograph below.

(c) Is this electron micrograph a picture of an animal cell or a plant cell? Give a reason for your choice. (1 mark)

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

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

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

(d) The bar line to the right of the electron micrograph represents $2\mu m$ (two microns). What is the width of the vacuole, in microns, at the widest point? Show your working. (1 mark)

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

.............................................................................................................................................
**Question 13**

Grapevines in Tasmania are usually propagated from cuttings that have been removed from existing vines. It has been calculated that, in a young cell in the root tip of a plant, about $5\%$ of the total cell volume is occupied by *mitochondria*. The mitochondrial volume is however, only about $1\%$ in a mature cell in the root of the same plant.

(a) Briefly explain this difference in mitochondrial volume. (2 marks)

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

(b) What kind of cell division occurs when these grapevine cuttings start growing, and how is this significant to the grower? (2 marks)

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

A pair of homologous chromosomes involved in normal meiosis in an ovary carries the alleles shown.

(c) Look at the chromosomes below. Choose the letter that corresponds to the chromosome that could be found in any resultant eggs. Justify your choice. (1 mark)

Letter: .......... Reason: .............................................................................................................
...............................................................................................................................................

Question 13 continues opposite.
A cell with a diploid number of six is undergoing a type of cell division.

(d) Which one of the above diagrams could represent the arrangement of chromosomes in this cell at some stage of division? Explain how you arrived at your choice. (3 marks)

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
This question paper and any materials associated with this examination (including answer booklets, cover sheets, rough note paper, or information sheets) remain the property of the Tasmanian Qualifications Authority.
Tasmanian Certificate of Education

BIOLOGY

Senior Secondary

Subject Code: BIO315109

External Assessment

2012

Part 4

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the course statement:

**Criterion 7**  Demonstrate knowledge and understanding of organisms.

<table>
<thead>
<tr>
<th>Section Total</th>
<th>/33</th>
</tr>
</thead>
</table>

Pages: 12  
Questions: 5

© Copyright for part(s) of this examination may be held by individuals and/or organisations other than the Tasmanian Qualifications Authority.
**CANDIDATE INSTRUCTIONS**

Candidates **MUST** ensure that they have addressed the externally assessed criterion on this examination paper.

Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

You should make sure you answer all parts within each question so that the criterion can be assessed.

This examination is 3 hours in length. It is recommended that you spend approximately 35 minutes in total answering the questions in this booklet.

The 2012 Biology Information Sheet can be used throughout the examination.

All written responses must be in English.
Question 14

The diagram to the right shows a structure found in the body of a mammal.

(a) What is the name of this structure? (1 mark)
...............................................................................................................................................

(b) Which blood gas normally moves from the lung into the blood stream AND would the blood have the higher concentration of this gas at A or C? (1 mark)
...............................................................................................................................................

(c) What are TWO characteristics of the above structure that make it very efficient in carrying out its specialised task? (2 marks)
1. ........................................................................................................................................
...............................................................................................................................................
2. ........................................................................................................................................
...............................................................................................................................................

(d) Explain how an increase in the red blood cell count of an athlete could result in the athlete’s aerobic performance improving. (2 marks)
...............................................................................................................................................
...............................................................................................................................................
...............................................................................................................................................
...............................................................................................................................................
...............................................................................................................................................
...............................................................................................................................................
...............................................................................................................................................
...............................................................................................................................................
...............................................................................................................................................

**Question 15**

In desert regions of Australia a parasitic mistletoe, *Amyema nestor*, grows on the stems and branches of *Acacia grasbyi* which is a shrubby wattle. Haustoria (root-like projections) of the mistletoe penetrate the vascular tissues of the host plant.

The main differences between the photosynthetic structures of these two plants are:

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Leaf Structure</th>
</tr>
</thead>
</table>
| *Acacia grasbyi* (host) | needle-like, 2 mm in diameter  
 thickness of cuticle is 36 µm  
 stomata sunken in grooves beneath the leaf surface  
 leaf surface is hairy |
| *Amyema nestor* (parasite) | ovate, 12–25 mm in diameter  
 thickness of cuticle is 2 µm  
 stomata on leaf surface  
 leaf surface is smooth |

The carbon dioxide exchange rate and the transpiration rate for each plant was measured throughout 24 hours in the hot, dry season. The results are shown below.

**Question 15 continues opposite.**
Question 15 (continued)

(a) Use the information supplied to explain the differences in the transpiration rates of the two species of plants. (4 marks)

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

During the hot, dry season, the bright green foliage of the mistletoe stands out against the dull, whitish-green or yellow foliage of the *Acacia*.

(b) Taking into account the above statement, together with the data and information supplied in the table and graphs, which vascular tissue of the *Acacia* do you think the mistletoe has penetrated with its root-like projections, and for what purpose? (2 marks)

.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
Question 16

As the blood passes through the glomerulus in a nephron, certain blood components and other substances transported in the blood are filtered and finally removed as urine.

The table below shows the relative amounts of a range of substances in the blood, tubule and urine.

<table>
<thead>
<tr>
<th>Blood constituent</th>
<th>Amount filtered into kidney tubules (g)</th>
<th>Amount in renal veins (g)</th>
<th>Amount in urine (g)</th>
<th>Percentage reabsorbed from urine (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td>1002</td>
<td>971</td>
<td>31</td>
<td>97.0</td>
</tr>
<tr>
<td>chloride ions</td>
<td>370</td>
<td>353</td>
<td>17</td>
<td>95.4</td>
</tr>
<tr>
<td>glucose</td>
<td>70</td>
<td>70</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>urea</td>
<td>30</td>
<td>10</td>
<td>20</td>
<td>33.3</td>
</tr>
<tr>
<td>uric acid</td>
<td>4</td>
<td>3.5</td>
<td>0.5</td>
<td>87.5</td>
</tr>
<tr>
<td>calcium ions</td>
<td>10</td>
<td>9.6</td>
<td>0.4</td>
<td>96.1</td>
</tr>
</tbody>
</table>

(a) Which substance is removed from the blood most efficiently? Explain. (1 mark)

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

(b) The level of glucose in the blood varies little over a 24-hour period irrespective of changes in food intake and levels of activity. The hormones insulin and glucagon are involved in maintaining a normal range of glucose levels in the blood.

Explain how the two hormones interact with the liver to maintain a normal range of glucose levels in the blood. (4 marks)

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

Question 16 continues opposite.
**Question 16 (continued)**

Harry has diabetes and measures his blood glucose level using a monitor (see below). Before each meal, Harry measures his blood glucose level. He then injects himself with a measured dose of insulin, that depends on his blood glucose reading. When the glucose reading is high, Harry injects a higher dose of insulin.

Harry records his blood glucose levels in a diary. He is supposed to keep his blood glucose levels within the normal range (4.0 – 6.0 mmol/L).

The table below shows a section from Harry’s diary over a three-day period.

<table>
<thead>
<tr>
<th>Date</th>
<th>before breakfast</th>
<th>two hours after breakfast</th>
<th>before midday meal</th>
<th>two hours after midday meal</th>
<th>before evening meal</th>
<th>two hours after evening meal</th>
<th>before bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 July 2012</td>
<td>7.0</td>
<td>9.1</td>
<td>6.8</td>
<td>4.3</td>
<td>14.2</td>
<td>12.9</td>
<td></td>
</tr>
<tr>
<td>14 July 2012</td>
<td>9.0</td>
<td>7.5</td>
<td>7.1</td>
<td>6.2</td>
<td></td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>15 July 2012</td>
<td>5.3</td>
<td>7.4</td>
<td>2.9</td>
<td>8.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(c) Suggest a reason for:

(i) the high reading two hours after the evening meal on 13 July.

(ii) the low reading before the evening meal on 15 July.

(d) Suggest why Harry always measures his blood glucose **before bedtime**.
Insects show an adaptive relationship between their diet and the types of digestive enzymes in their gut. The table below shows the types of digestive enzymes present in the alimentary canal of five different insects, labelled A to E.

<table>
<thead>
<tr>
<th>Insect</th>
<th>Protease</th>
<th>Lipase</th>
<th>Amylase</th>
<th>Sucrase</th>
<th>Maltase</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>D</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

+ = present  0 = absent

The insects from which this data were obtained were:

A blood-sucking insect;

A blow-fly larva feeding on decaying meat;

A wood-chewing beetle;

An aphid sucking the sap from the phloem vessel of a plant; and

An unknown species of wasp found feeding on plant and animal matter in a garden.

(a) Using the information given above in the table and the text, write the letter that best identifies the: (5 marks)

blood-sucking insect ...........................................

blow-fly larva ..................................................

wood-chewing beetle ..........................................

aphid-sucking sap ...........................................

unknown species of wasp .................................

(b) Some species of thrips (type of insect) feed only on nectar produced by flowers. This nectar is made up almost entirely of a glucose solution. Giving your reasons, explain whether you think that thrips would have a complex or a simple digestive tract. (2 marks)

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

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

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

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

............................................................................................................................................
Question 18

Kirsty and John have a daughter, Anne, with cystic fibrosis. They went to see a genetic counsellor who drew up the following family tree.

![Family Tree Diagram]

The allele for cystic fibrosis \( n \) is recessive to the normal allele \( N \).

(a) On the basis of this pedigree explain why it is not possible for cystic fibrosis to be inherited through a sex-linked allele. (2 mark)

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

(b) Using the letters \( n \) and \( N \), state the genotype(s) of:

Kirsty: .............................................. John: ..............................................
Anne: .............................................. Number 8: ..............................................

(c) Kirsty and John are thinking of having more children, so they seek advice from a genetic counsellor on the risk (probability) of having more children with the disease. Discuss the advice they most likely received from the genetic counsellor. (2 marks)

.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
Tasmanian Certificate of Education

BIOLOGY

Senior Secondary

Subject Code: BIO315109

External Assessment

2012

Part 5

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the course statement:

Criterion 8 Demonstrate knowledge and understanding of the interaction of organisms with their environment.

| Section Total | /33 |

Pages: 12
Questions: 5

© Copyright for part(s) of this examination may be held by individuals and/or organisations other than the Tasmanian Qualifications Authority.
CANDIDATE INSTRUCTIONS

Candidates **MUST** ensure that they have addressed the externally assessed criterion on this examination paper.

Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

You should make sure you answer all parts within each question so that the criterion can be assessed.

This examination is 3 hours in length. It is recommended that you spend approximately 35 minutes in total answering the questions in this booklet.

The 2012 Biology Information Sheet can be used throughout the examination.

All written responses must be in English.
Question 19

The diagram below is a simplified food web showing some of the feeding relationships in a typical Tasmanian dry sclerophyll forest. Use the information from the food web to answer the questions below.

Question 19 continues opposite.
Question 19 (continued)

(a) Identify the autotrophic organisms in the food web. (2 marks)
.............................................................................................................................................

(b) Identify TWO organisms that occupy both the third and fourth trophic levels. (1 mark)
1. ...................................................................................................................... 2. ...........................................................

The introduced European Red Fox is a top-order predator that eats reptiles and mammals, and has caused the extinction of several native species of mammals. One example is the extinction of the Tasmanian Bettong (Bettongia gaimardi) on the mainland.

(c) If the fox were to become established in Tasmania, predict its likely impact on the food web shown opposite. (4 marks)
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................

(d) Bettongs are considered to be ‘ecosystem engineers’. Their foraging activities create up to 3000 diggings per hectare, which has positive effects on the soil, water and nutrients. The extensive diggings of Bettongs contribute to ecosystem health by increasing the soil’s capacity to capture and absorb water. Bettongs also disperse the spores of the fungi on which they feed. These fungi enable plants, such as eucalyptus and acacia trees, to extract nutrients from the soil.

Using the Tasmanian Bettong as an example, explain what is meant by the term ‘ecological niche’. (3 marks)
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................
.............................................................................................................................................

/10
**Question 20**

The Bettong (*Bettongia gaimardi*) is extinct on the mainland. It has not been sighted in the Australian Capital Territory (ACT) for 80 years. In 2011, a number of Bettongs were brought from Tasmania to Tidbinbilla Nature Reserve in the ACT to establish a captive breeding or founder colony.

In late May 2012, another 24 Bettongs were captured from different sites in Tasmania and brought to the ACT. They were divided between the Tidbinbilla breeding colony and the Mulligans Flat Woodland Sanctuary (a 485 ha area enclosed by a predator-proof fence).

The map shows the approximate areas of eastern Tasmania occupied by the Bettong.

(a) Explain the genetic importance of sourcing the ACT individuals from different populations scattered throughout eastern Tasmania.  

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

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

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

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

(b) From a community biodiversity point of view, identify one advantage and one disadvantage of re-introducing the Bettong into an area such as the Mulligans Flat Woodland Sanctuary.  

Advantage: ................................................................................................................................

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

Disadvantage: .........................................................................................................................

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

/4
Question 21

Dioxins are among the most poisonous and persistent of the chemicals known as organochlorines. They are so toxic that exposure standards are set at extremely low levels. Dioxins are released into the atmosphere by industry and car emissions, and are generally not taken up or absorbed by plants. Instead, they tend to settle on the surface of leaves or accumulate on the soil surface and leaf litter. They enter the terrestrial food chain when plant matter is eaten by animals.

Below is a table showing the concentration of dioxin in an ecosystem.

<table>
<thead>
<tr>
<th>Concentration of Dioxin [parts per quadrillion (ppq)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>atmosphere</td>
</tr>
<tr>
<td>plant leaves</td>
</tr>
<tr>
<td>grasshoppers</td>
</tr>
<tr>
<td>wild ducks</td>
</tr>
<tr>
<td>humans</td>
</tr>
</tbody>
</table>

(a) Name the process whereby certain chemicals such as dioxin can increase in concentration as they move up the trophic levels of a food chain and explain how the process occurs. (3 marks)

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

(b) Draw and label a pyramid of biomass for the food chain included in the above table and explain why it is shaped like a pyramid. (3 marks)

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

Question 21 continues over the page.
Question 21 (continued)

Examine the diagram below, which represents the nitrogen cycle.

(c) Which letters indicate the process of nitrogen fixation? (1 mark)
   .............................................................................................................................................

(d) What process is indicated by the letter V? (1 mark)
   .............................................................................................................................................
Question 22

A group of scientists investigated two species of mammals living in their natural habitat. The scientists recorded the ways in which the mammals gained and lost water.

The scientists’ findings are summarised in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Mammal Species A</th>
<th>Mammal Species B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water gain</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking</td>
<td>0 mL/day</td>
<td>1500 mL/day</td>
</tr>
<tr>
<td>Eating</td>
<td>6 mL/day</td>
<td>750 mL/day</td>
</tr>
<tr>
<td>Metabolism</td>
<td>54 mL/day</td>
<td>250 mL/day</td>
</tr>
<tr>
<td><strong>Water loss</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporation</td>
<td>43.9%</td>
<td>36%</td>
</tr>
<tr>
<td>Urine</td>
<td>13.5%</td>
<td>60%</td>
</tr>
<tr>
<td>Faeces</td>
<td>2.6%</td>
<td>4%</td>
</tr>
</tbody>
</table>

What conclusions can be drawn about the type of environment in which each of these species of mammal normally lives? Support your answer with evidence from the table. (5 marks)
Question 23

A particular gene locus in the mosquito has two alleles. These show incomplete dominance resulting in three genotypes with corresponding phenotypes. In this case homozygous $R^R R^R$ is resistant, homozygous $R^S R^S$ is very sensitive and heterozygous $R^R R^S$ is sensitive to DDT. The graphs below show the number of mosquitoes of the three phenotypes (and genotypes) from 1965, when DDT was first used, through to 1970, two years after the spraying of DDT stopped.

Using your knowledge of Darwin’s Theory of Natural Selection, explain the changes in the frequency of the three genotypes (phenotypes) from 1965 and 1968, AND the change in the relative frequencies of the three genotypes after 1968 when DDT was no longer being sprayed for control of mosquitoes. (6 marks)
This question paper and any materials associated with this examination (including answer booklets, cover sheets, rough note paper, or information sheets) remain the property of the Tasmanian Qualifications Authority.
SOME COMMON TERMS EXPLAINED:

- **Analyse**: interpret data to reach a conclusion
- **Calculate**: to find the answer using mathematics
- **Compare**: give an account of similarities and difference between two factors
- **Construct**: represent information in a graphical form
- **Deduce**: reach a conclusion from the information given
- **Describe**: give a detailed account including all relevant information
- **Design**: produce a plan
- **Discuss**: give an account including a range of arguments, assessment of the importance of various factors or a comparison of alternatives
- **Distinguish**: give the difference between two or more different items
- **Draw**: represent by means of pencil lines – include labels (unless told not to)
- **Estimate**: find an approximate value
- **Evaluate**: assess the limitations and implications
- **Explain**: give a clear account including causes and reasons
- **List**: give a sequence of names or brief answers
- **Identify**: find and answer for a quantity
- **Measure**: find a value for a quantity. Always include the units of the number (value)
- **Outline**: give a brief account or summary
- **Predict**: give an expected result
Criterion 2 – Design & evaluate experiments

Formulating a Hypothesis
Your hypothesis should
1. be feasible (i.e. be sensible and based on scientific concepts)
2. be a statement (not a question)
3. be based on observations
4. involve one independent and one dependent variable in a cause-and-effect relationship
5. be testable and measurable in a way that demonstrates cause and effect

Experimental Design
State the hypothesis to be tested (unless already stated)
1. State the independent variable and how it is manipulated
2. State the dependent variable and how it is measured
3. Describe the procedure clearly in a step-by-step fashion which could be easily followed in a laboratory or the field.
   ▪ Indicate sample sizes, quantities of materials and time involved. Indicate how many replicas there are (if needed).
   ▪ Describe which variables are controlled and how. Say why fixed variables are needed. Include factors relevant for the organism – biotic and abiotic relevant in the environment
   ▪ What is the control group in the experiment and why is it needed.
4. How are the results analysed.
5. Indicate any repetitions of the experiment

If required:
6. State what results would support the hypothesis and what results would not support the hypothesis
7. Discuss any foreseeable problems in conducting the experiment.
   ▪ variables difficult to control, sample size issues, ethical issues, animal vs human experimentation/environmental impacts etc.

“Cause”

DEPENDENT VARIABLE (IV)
the thing that the experimenter measures

“Effect”

INDEPENDENT VARIABLE (IV)
the thing that the experimenter deliberately varies

Designing Experiments with Humans
Designing experiments with humans as subjects is not straightforward because there are a number of areas over which the experimenter has no control.

The impact of these unfixed/uncontrolled variables can be reduced by a number of factors including:

- use of placebos and double blind experiments / trials

Also ethical aspects need to be considered.

Trial experiments conducted in a confined situation (laboratory/greenhouse) need to precede field investigations.

Distinction between a few terms:

A replica is multiple identical groups within the one experiment.
A repeat is doing the experiment again at a future time.
A follow up experiment is one which builds on the original experiment in some way.
**Biological Molecules**

**A. Carbohydrates**
- contain carbon, hydrogen, oxygen
- general formula: \( \text{CH}_2\text{O} \)
  - e.g. glucose = \( \text{C}_6\text{H}_{12}\text{O}_6 \)
- main function - energy source
- some used in growth/repair - to build new cell components etc.
- excess carbohydrates are stored in the body as:
  - starch (in plants)
  - glycogen (in animals) - in liver, muscles

**Types:**
(i) *Monosaccharides*
- "single sugar" - e.g. glucose, fructose
- 3-6 C atoms, small – can fit through pores in cell membrane.
- soluble in water
(ii) *Disaccharides*
- "double sugars" - e.g. sucrose (cane sugar), lactose (milk sugar)
- too large to fit through cell membranes
(iii) *Polysaccharides*
- "many sugars", large number (1,000’s) of monosaccharide (monomer) units joined together – form a polymer.
- too large to fit through cell membranes
- insoluble in water (mostly)
  - e.g. starch, glycogen, cellulose

**B. Proteins**
- contain carbon, hydrogen, oxygen and nitrogen (sometimes sulphur)
- large, complex
- are polymers - made up of a large number of individual units (monomers) called amino acids (AA)

  - single AA - (20 different types of AAs)
  - dipeptide - 2 amino acids joined
  - polypeptide - many amino acids
  - protein - one or more polypeptide chains, folded up to produce a specific shape

- different proteins have different AA sequences, and therefore fold up to produce different shapes.
- proteins in the diet need to be broken down (digested) into individual AAs so they can be absorbed into the blood. Inside cells (at the ribosomes) these AA’s are synthesised into new proteins.
- These proteins may be:
  - structural proteins – skin, muscles, hair
  - specialised proteins – have specific functions: e.g. haemoglobin – in red blood cells, enzymes, hormones (e.g. adrenalin, insulin), antibodies.
- Main function of proteins - to provide "building blocks"/raw materials for tissue growth, repair, function and metabolism.

- Need all 20 kinds of amino acids in order to make all the proteins needed by the body.
  - Of the 20 different AA’s, 9 (8 in adults and 1 extra in infants) AA’s are called essential amino acids. These must be included in the diet, as they cannot be made by the body.
  - If non-essential AA’s are missing in the diet, they can be made by the liver, from glucose and nitrogen-containing compounds.
- Excess amino acids cannot be stored in the body.

**C. Lipids**
- fats, oils
- contain carbon, hydrogen, oxygen (less O than C)
- consist of a glycerol molecule and usually 3 fatty acid molecules

- Same in **ALL** lipids
- The number and type of these determine the type of lipid

  - Animal lipids
    - contain saturated fatty acids.

  - Plant lipids
    - contain unsaturated fatty acids.

**Main function of lipids** – high energy source
- (also used to build structural components - e.g. cell membranes)
**D. NUCLEIC ACIDS**

- e.g. DNA (deoxyribonucleic acid)
- RNA (ribonucleic acid)

---

### CELL REACTIONS

**(a) Decomposition /catabolic reactions**

- Breaking large molecules into smaller ones
- Produces/releases energy

- e.g. cell respiration

**(b) Synthesis /anabolic reactions**

- Joining together small molecules to make larger ones
- Needs energy to occur

- e.g. photosynthesis, DNA replication, protein synthesis

---

**CELL RESPIRATION**

An energy-releasing process

**(a) AEROBIC RESPIRATION**

- Uses/requires $O_2$
- Occurs in mitochondria

*Overall Equation:*

\[
\text{glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water} + \text{energy}
\]

\[C_6H_{12}O_6 + 6O_2 \rightarrow \text{ENERGY} + 6CO_2 + 6H_2O\]

When 1 molecule of glucose is aerobically respired $\rightarrow$ 36 molecules of ATP

**ATP** - Adenosine triphosphate

“High energy” molecule – “like a charged battery”

**ADP** - Adenosine diphosphate

“Low energy” molecule – “like a flat battery”

- Storing Energy: $\text{ADP} + \text{energy} (+ \text{phosphate}) \rightarrow \text{ATP}$

- Releasing Energy: $\text{ATP} \rightarrow \text{energy} + \text{ADP} (+ \text{phosphate})$

**(b) ANAEROBIC RESPIRATION**

- Occurs without $O_2$
- Occurs in cytoplasm

*Overall Equation:*

\[C_6H_{12}O_6 \rightarrow \text{ENERGY} + C_3H_6O_3\] - in animal cells

\[C_6H_{12}O_6 \rightarrow \text{ENERGY} + C_2H_5OH + CO_2\] - in plant & yeast cells

When 1 molecule of glucose is anaerobically respired $\rightarrow$ 2 molecules of ATP

**Brief pathway of glucose in cellular respiration**

- Glucose
  - Glycolysis takes place in cytoplasm

- Pyruvic acid (cytoplasm)

- Acetyl Coenzyme A (mitochondria)
  - This reaction takes place in the mitochondria of cells, only if $O_2$ is present and releases large amounts of ATP

- Carbon dioxide and water
PHOTOSYNTHESIS (P/S)

an energy-storing process

- light energy is stored as “chemical” energy
  molecules of glucose

**Overall Equation:**

\[ 6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 \]

- Stored as starch
- Respired to release energy
- Used to build new tissue (= growth)

Comparison of respiration and photosynthesis in plants and animals

<table>
<thead>
<tr>
<th></th>
<th>DARK</th>
<th>LIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANT (autotroph)</td>
<td>respiration</td>
<td>respiration &amp; photosynthesis</td>
</tr>
<tr>
<td>ANIMAL (heterotroph)</td>
<td>respiration</td>
<td>respiration</td>
</tr>
</tbody>
</table>

**Factors affecting the rate of photosynthesis**

- Temperature
- Concentration of CO₂
- Light intensity
- Wavelength/colour of light

**Compensation Point**: the light intensity at which the rate of photosynthesis equals the rate of respiration.

ROLE OF ENZYMES

**Enzymes** are proteins which speed up (catalyse) the chemical reactions which occur in organisms. They are “biological catalysts”.

**Types of enzymes**

Enzymes fall into two types of categories:

1) **Intracellular enzymes**: these occur inside cells and catalyse metabolic reactions
2) **Extracellular enzymes**: these occur outside cells and catalyse reactions involved in digestion

Enzymes are also classified according to the type of substance on which they act.

**Naming Enzymes**

- most end in -ASE
- first part relates to the substrate the enzyme works on:
  e.g. **Lactase** is the enzyme which works on the substrate **Lactose**

**Coenzyme** — a non-protein molecule that has to be present before an enzyme can stimulate its specific chemical reaction. The coenzyme takes part in the reaction and is changed by it. Examples include vitamins and ATP.

**Cofactor** — is a mineral ion of some kind that has to be present to help activate the enzyme. Cofactors influence reactions, but do not take part in them, nor are they changed. Examples include Mg²⁺ and K⁺.

**Inhibitors** — poisons such as heavy metals and insecticides can prevent enzymes functioning by slowing down or stopping enzyme action by competing for or changing the shape of the active site.
Factors affecting enzyme activity

- Concentration of substrate
- Sensitivity to temperature changes
- Sensitivity to pH environments
- Presence of cofactors and coenzymes are required by some enzymes
- Chemical energy in the form of ATP is required by a variety of enzymes before they can act.

PROTEIN SYNTHESIS

Process of making proteins in the cell

Transcription – the synthesis of a mRNA (messenger RNA) molecule from a template strand of DNA in the nucleus.

A tRNA (transfer RNA) molecule

Translation - involves the reading of the mRNA molecule by the ribosomes and the ordered sequential joining of the amino acids to form a protein.

Codon - A group of three nucleotides (or triplet) of DNA or RNA. A codon codes for a specific amino acid.

Anticodon - A sequence of three nucleotides on a molecule of tRNA that is complementary to the base sequence on a codon of mRNA.

Mutations – A change in the sequence of nucleotide bases of the genetic material (DNA or RNA)

Changes may be:
- spontaneous (no discernible reason) - "base" mutation rate = 1 gene in every 100,000 per generation
  or
- induced - caused by mutagens (e.g. radiation, chemicals, high temperature)

Point (gene) mutation - a mutation in the nucleotide sequence of a gene in which only one base is altered.

bases may be: added (inserted) deleted substituted

Some of these changes may result in overall change to the protein being produced.
Criterion 6 – Cells

STRUCTURE

Organelles visible with a light microscope:
- Nucleus and nuclear membrane
- Nucleolus
- Cell membrane
- Chloroplasts
- Vacuoles

1 mm = 1000 µm

Length of cell = \( \frac{\text{Field of View}}{\text{Number of times cell fits across}} \)

ANIMAL CELL VIEWED WITH ELECTRON MICROSCOPE

PROKARYOTIC CELLS
- no definite nucleus – DNA spread through cytoplasm.
- no membrane-bound organelles
- eg bacteria, blue-green bacteria

EUKARYOTIC CELLS
- distinct nucleus surrounded by a membrane
- have organelles that are surrounded by a membrane (e.g. mitochondria, ER, lysosomes)
- e.g. cells of most plants and animals

EXCHANGE OF MATERIALS

Diffusion - movement of solute (solid)
Osmosis - movement of water from an area of lower concentration (“weak” solution) to an area of higher concentration (“strong” solution), through a semi-permeable membrane
Active transport - movement of solute from an area of lower concentration to any area of higher concentration with the use of energy
Endocytosis - movement of LARGE substances (too large to fit through pores in cell membrane) INTO a cell. e.g. phagocytosis – engulfing solid particles; pinocytosis – engulfing liquid droplets
Exocytosis - movement of LARGE substances OUT OF a cell. e.g. secretion of useful substances made in the cell (e.g. enzymes); excretion of wastes.
Diffusion and osmosis illustrated

Factors affecting the rate of diffusion
- concentration gradient (conc. difference)
- temperature
- SA : Vol ratio
- medium of transport

Surface area: Volume ratio (SA : Vol ratio)
Important for cell functioning. Relates to cell size and shape.

Adaptation to changing salinity
Organisms that live in environments where the concentration changes (e.g. estuaries) respond to these changes in two main ways:

Osmoconformers - allow changes internal concentration to change

Osmoregulators - maintain a relatively constant internal environment

Relative Sizes of Molecules
The cell membrane has pores of a particular size. Only molecules which are small enough can pass through these pores (i.e. the cell membrane is semi-permeable).

<table>
<thead>
<tr>
<th>SMALL ENOUGH</th>
<th>TOO LARGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen (O₂)</td>
<td>Cell organelles</td>
</tr>
<tr>
<td>Carbon dioxide (CO₂)</td>
<td></td>
</tr>
<tr>
<td>Other dissolved gases:</td>
<td></td>
</tr>
<tr>
<td>e.g. N₂</td>
<td></td>
</tr>
<tr>
<td>Amino acids</td>
<td>Proteins</td>
</tr>
<tr>
<td>Urea, ammonia</td>
<td></td>
</tr>
<tr>
<td>CARBOHYDRATES</td>
<td>CARBOHYDRATES</td>
</tr>
<tr>
<td>Monosaccharides</td>
<td>Disaccharides</td>
</tr>
<tr>
<td>e.g. glucose</td>
<td>e.g. sucrose, lactose,</td>
</tr>
<tr>
<td></td>
<td>maltose</td>
</tr>
<tr>
<td></td>
<td>Polysaccharides</td>
</tr>
<tr>
<td></td>
<td>e.g. starch, glycogen,</td>
</tr>
<tr>
<td></td>
<td>cellulose</td>
</tr>
<tr>
<td>Glycerol</td>
<td>Lipids</td>
</tr>
<tr>
<td>Fatty acids</td>
<td>e.g. fats, oils</td>
</tr>
<tr>
<td>Dissolved ions</td>
<td></td>
</tr>
<tr>
<td>e.g. Ca²⁺, Na⁺, Cl⁻</td>
<td></td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td></td>
</tr>
</tbody>
</table>

Contractile vacuoles can be used to maintain equilibrium in some protists

Plasmolysis - contraction of cytoplasm of a plant cell as a result of osmosis out of the cell.
CELL DIVISION

There are two types of division:

**Mitosis** – process of cell division in which daughter cells are identical to parent cells. Process used in growth, repair and replacement of cells.

**Meiosis** – process of gamete (egg and sperm) production in most organisms. Gametes contain half the number of chromosomes as parent cells.

**Mitosis**

- The chromosomes become visible.
- Chromatids
- Centromere
- Each chromosome produces a replica of itself.
- The chromosomes line up across the middle of the cell.
- The chromatids separate and move to opposite ends of the cell and the cell starts to split into two.
- Daughter cells

**Meiosis**

- The cell has finished splitting.
- Homologous chromosomes come together and arrange themselves across the middle of the cell.
- Homologous chromosomes part company and move to opposite ends of the cell which starts to split into two.
- The cell has finished splitting, and the chromosomes arrange themselves across the middle of the two daughter cells.
- The chromatids now separate from each other and the two cells start to split.
- The chromatids become the chromosomes of the two daughter cells; the cell has finished splitting, and we now have two cells each of which contains the same number of chromosomes as the parent cell.

**Diploid** 2n - Full number of chromosomes in the nuclei

**Haploid** n - Half the number of chromosomes in the nuclei. Usually found in the gametes.
**DIGESTION SYSTEM IN HUMANS**

- Nasal cavity
- Soft palate
- Pharynx
- Epiglottis
- Mouth
- Stomach
- Pancreas
- Esophagus
- Diaphragm
- Gall bladder
- Liver
- Duodenum
- Large intestine
- Cecum
- Appendix
- Anus
- Rectum

**Cross section through villi**

**Stages in acquisition of nutrients**

- Mouthparts (physical digestion)
- Hydrolysing enzymes (chemical digestion)
- Peristaltic (physical digestion)
- Movement of food
- Small, simple, soluble molecules absorbed
- Used in metabolism (respiration and production of complex organic molecules)
- Water absorbed

Large complex insoluble organic molecules of food

**RESPIRATORY SYSTEM IN HUMANS**

Gas exchange at the alveoli

**TRANSPORT SYSTEM IN HUMANS**

- Superior Vena Cava
- Pulmonary Artery
- Right Atrium
- Mitral Valve
- Left Ventricle
- Aortic Valve
- Inferior Vena Cava
EXCRETION IN HUMANS

Urinary system of a female

Vertical section through a kidney

Cross section of the three vessels

Components of blood
Plasma (55%)
- Water
- Dissolved substances
- Plasma proteins
Cells (45%)
- Red blood cells
- Lymphocytes
- Phagocytes
- Platelets

Structure of a nephron
Fate of excess amino acids

- Carbohydrate → Energy, or stored as fat
- amino acids → Ammonia → Urea → Uric acid

Comparison of nitrogenous waste products

<table>
<thead>
<tr>
<th>Solubility</th>
<th>Ammonia</th>
<th>Urea</th>
<th>Uric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxicity</td>
<td>Soluble</td>
<td>Soluble</td>
<td>Insoluble</td>
</tr>
<tr>
<td>Energy required for conversion</td>
<td>None</td>
<td>Some</td>
<td>Most energy demanding</td>
</tr>
</tbody>
</table>

PLANT TRANSPORT SYSTEM

Transpiration – Loss of water vapour by a plant through xylem and stomata in the leaves.

Translocation – the transfer of soluble food materials (eg sugars, vitamins etc) from the leaves where they are made by photosynthesis down and up through the phloem.

VASCULAR BUNDLES

- xylem and phloem tissue occur together and form vascular bundles.
- vascular bundles in leaves form veins → branch into finer units → no cell is far from a vascular bundle
- in herbaceous dicotyledons, vascular bundles are arranged around edge of stem/root (xylem is on inside)

HOMEOSTASIS

Negative feedback – a change which reverses a particular trend

Positive feedback – a change in some variable triggers variables which amplify the change

Comparison of control systems

<table>
<thead>
<tr>
<th></th>
<th>Nervous</th>
<th>Endocrine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of message</td>
<td>Electrochemical impulses</td>
<td>Chemical compounds (hormones)</td>
</tr>
<tr>
<td>Route of message</td>
<td>Specific nerve cells</td>
<td>General blood system</td>
</tr>
<tr>
<td>Types of effects</td>
<td>Rapid, but usually short term</td>
<td>Usually slower, but generally longer lasting</td>
</tr>
</tbody>
</table>
**Xylem vessels**

- Cell contents die, leaving an empty tube.
- The end walls of the cells wither away and water can pass from one cell to another.
- The cell walls are toughened with lignin which is laid down in various patterns.

**Phloem vessels**

- SIEVE PLATE: the end wall of the sieve tube, so called because it has holes in it which allow sugars to pass from one cell to the next.
- SIEVE TUBE: made of a long line of cells joined end to end. Sieve tubes carry the sugar. The living cells which form them have thin cytoplasm and no nuclei.
- COMPANION CELLS have thick cytoplasm and large nuclei. They do not carry sugar, but are thought to help the sieve tubes to do so.

**Surface view of stomata**

**Internal section of a leaf**
Transpiration system

The path of water from soil across the root to the xylem and into the leaf.

ASEXUAL AND SEXUAL REPRODUCTION

1. **ASEXUAL REPRODUCTION**
   - production of daughter cells (offspring) which are genetically identical to the parent cell.

2. **SEXUAL REPRODUCTION**
   - involves **fertilization** – the joining together of 2 **gametes** (sex cells – sperm and ovum) to produce a **zygote**.

   ovum + sperm → zygote

**Fertilisation** requires moisture.
- may be external (e.g. fish, frog)
  - or internal (e.g. mammals, birds)
- May involve separate “male” and “female” individuals (cross fertilisation)
  - or “male” and “female” parts of the same individual (self-fertilisation)
  - [hermaphrodites – have both ♀ and ♂ reproductive organs – e.g. snails, earthworms → can self- or cross-fertilise]
GENETICS

Gene - the basic unit of inheritance for a given characteristic

Allele - Alternate forms of the same gene responsible for determining contrasting characteristics (T or t)

Homozygous - individuals have identical alleles for a particular characteristic – e.g. TT or tt

Heterozygous - individuals have different alleles for a particular characteristic – e.g. Tt

Phenotype - The physical or chemical expression of a characteristic

Genotype - The genetic expression of a characteristic

Monohybrid cross - A cross where only one gene or characteristic is being considered

Dominant allele - If present, hides the effect of the recessive allele. e.g. T is dominant over t → a Tt individual will have the characteristic which T stands for

Recessive allele - Only expressed in the phenotype if no dominant allele present. e.g. must be tt to be dwarf

F₁ generation - the generation produced by crossing two parental stocks.

F₂ generation - the generation produced by crossing two F₁ organisms

Incomplete (Partial) dominance - The condition where the alleles do not fully express themselves when in the heterozygous genotype and the offspring may be an “average” of the two characteristics

Co dominance – the condition where both alleles express themselves in the heterozygous genotype. Usually expressed as Cᵣ Cʷ

Pedigree - chart showing the family history of a particular condition

Types of chromosomes

Autosome
Chromosome not associated with sex. In humans there are 22 autosomes

Sex linked
Chromosome that determines the sex of an individual

Types of inheritance

- Autosomal Dominant

- Autosomal Recessive

- X-linked Dominant

- X-linked Recessive
Ecology
The study of living organisms in the natural environment. How they interact with one another and how the interact with their nonliving environment.

Ecosystem
Community + Abiotic environment, interacting

Community
All the populations of the different species living and interacting in the same ecosystem.

Species
A group of organisms that can breed to produce fully fertile offspring.

Population
A group of organism of the same species that live in the same habitat at the same time where they can freely interbreed.

Biodiversity
The total number of different species in an ecosystem and their relative abundance.

Habitat
The characteristics of the type environment where an organism normally lives. (e.g. a stony stream, a temperate woodland)

Niche
Habitat + role + tolerance limits to all limiting factors

Energy and organisms

Autotrophs / Producers
Organisms which can synthesise their own complex, energy rich, organic molecules from simple inorganic molecules (e.g. green plants synthesis sugars from CO₂ and H₂O)

Heterotrophs / Consumers
Organisms who must obtain complex, energy rich, organic compounds form the bodies of other organisms (dead or alive).

Detritivores
Heterotrophic organisms who ingest dead organic matter. (e.g. earthworms, woodlice, millipedes) but do not decompose it into inorganic matter

Decomposers
Heterotrophic organisms who secrete digestive enzymes onto dead organism matter and absorb the digested material. (e.g. fungi, bacteria) completely breakdown the organic molecules into inorganic molecules → make matter available to producers - i.e. responsible for the recycling of matter in the ecosystem

FOOD WEBS

(i) First Order (Primary) Consumers –
(ii) Second Order (Secondary) Consumers
(iii) Third Order (Tertiary) Consumers –
(iv) Top Consumer/Carnivore – not usually eaten by other organisms

Trophic level 4 – carnivore (tertiary consumer)
Trophic level 3 – carnivore (secondary consumers)
Trophic level 2 – herbivore (primary consumers)
Trophic level 1 – producer

ECOLOGICAL PYRAMIDS
As you go up a food chain, the number of individuals at each level (usually) decreases. Due to energy losses at each level, each individual needs to consume a large number of the individuals below.

Pyramid of Biomass uses total weight (dry mass) of organisms at each level and takes into account both numbers and mass

Pyramid of Energy considers total energy at each level

Each level must be no more than 10% of previous
BIOLOGICAL MAGNIFICATION

Some poisons (those that are not biodegradable) are not completely broken down and excreted by organisms → instead; they accumulate in tissues and are passed along a food chain

INTERACTIONS AMONGST ORGANISMS

<table>
<thead>
<tr>
<th>Type of interaction</th>
<th>Species A</th>
<th>Species B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predator Prey</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Herbivory</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Mutualism</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Commensalism</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Competition</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Parastism</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

Key
+ benefits , - harmed (may not mean death) 0 not affected

ENERGY FLOW
- is a one-way flow
- energy can’t be created or destroyed, it can only be changed to a different form
- source sun → light energy

BIOGEOCHEMICAL CYCLES

- cannot create/destroy atoms → there is a finite (fixed) amount of matter in our biosphere. (assume that Earth is a closed system – with no losses/gains of matter)
- recycling of matter by decomposers
- nutrient matter cycles

ENERGY FLOW

- Carbon cycle
  - atmospheric CO₂ (0.04% of air volume)
  - photosynthesis
  - respiration
  - combustion

- Nitrogen cycle
  - atmospheric nitrogen (78% of air volume)
  - fixation
  - lightning
  - death or excretion
  - bacteria

Carbon cycle

Nitrogen cycle

BIOGEOCHEMICAL CYCLES

- Carbon cycle
  - CO₂ → plants → animals → decomposition → CO₂

- Nitrogen cycle
  - nitrogen → plants → animals → decomposition → nitrate ions → aerobic soils → nitrifying bacteria → ammonia → aerobic soils

97% reflected

Energy lost as heat and respiration

10%

1st ORDER CONSUMERS

2nd ORDER CONSUMERS

Energy lost as heat and respiration

10%
POPULATION
measured as a rate – e.g. no. per 100,000
\[ r = (b - d) + (i - e) \]
growth rate  \( \downarrow \) birth rate  \( \downarrow \) death rate  \( \downarrow \) immigration rate  \( \downarrow \) emigration rate  \( \downarrow \)

In Ideal conditions – J curve
- a “doubling” of numbers in a set time period e.g. bacteria, human world population.
- not sustainable in the long term - population either “crashes” OR external factors regulate the growth rate

In reality – S curve

FACTORS WHICH AFFECT CARRYING CAPACITY / POPULATION SIZE

ABIOTIC FACTORS – DENSITY INDEPENDENT
e.g. temperature, humidity, rainfall, light intensity, sunlight hours, size of area, presence of trace elements, soil type may have a direct effect on the population – e.g. sunlight hours effects amount of P/S and \( \therefore \) plant growth
OR
an indirect effect – e.g. sunlight hours \( \rightarrow \) P/S \( \rightarrow \) plant growth \( \rightarrow \) kangaroo population

BIOTIC FACTORS – DENSITY DEPENDENT
The impact of other organisms can be identified in two types of competition:

- INTRASPECIFIC COMPETITION –
  competition between members of the same species

- INTERSPECIFIC INTERACTIONS –
  competition between members of different species

Carrying capacity - maximum no. of individuals which can be supported by the environment

Environmental resistance
Abiotic and biotic factors acting to limit population growth.
NATURAL SELECTION AND SPECIATION

A species is a population of organisms that can potentially interbreed under natural conditions to provide fertile offspring.

An extension of the species concept is a cline. Clines are gradual change in the structures among members of a species due to ecological or geographical distribution. E.g. in the Snow Gum the length of leaves is shorter at high altitude than at low altitude. Usually the trees next to each other are capable of interbreeding even though they look different and a common gene pool exists in the cline.

Hybrids are offspring produced from parents of different species. They are sterile (can’t reproduce). Examples include zebroids (zebra and horse), mules (donkey and horse).

Speciation begins when gene flow is prevented between populations of a species. Thereafter, mutation, natural selection, and genetic drift operate independently in each population and lead to irreversible genetic divergence of one from the other.

- Individuals remain members of the same species even if they are geographically isolated provided that gene flow still occurs
- Gene flow is the physical movement of alleles into and out of a population. These alleles counter the differences in populations that may occur through mutation, natural selection and genetic drift.

Isolating mechanisms:

1. Geographical Isolation
   - a single population is split into two separate populations by a physical barrier such as a river or mountain range. This prevents the organisms from mating and therefore each new population may develop large genetic differences and become separate species

2. Reproductive Isolation
   - Behavioural Isolation – the mating rituals of many species stops interbreeding e.g. female frogs will only respond to the correct call of the male of their species
   - Mechanical Incompatibility – the reproductive parts of the organism simply won’t “fit” together
   - Seasonal Isolation – interbreeding cannot occur if mating happens at different times of the year
   - Developmental Isolation – fertilisation may occur but the embryo does not survive

To produce a new species, evolution must generate large enough genetic changes between populations so that mating cannot occur or the offspring produced are sterile.