Statistics

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<th>SA</th>
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General comments

The examination assessed the five topics listed in the *Biology Senior External Syllabus 2006*. Paper One assessed Cell structure and function, Continuity of life, and Evolution and diversity. Paper Two assessed Physiology of organisms and Organisms and ecosystems.

The general objectives of the syllabus were assessed across both papers. Questions assessing the *Understanding biology* and *Investigating biology* criteria required short responses; questions assessing the *Evaluating biological issues* criterion required extended responses.

The questions provided opportunities for candidates to demonstrate the syllabus objectives across the range of standards.

Understanding biology (UB)

Responses tended to be general and brief with a lack of biological terminology used across the papers. By correctly using appropriate biological terms, a response can still be brief and convey an understanding of the interrelationships between biological ideas. For example, when describing the impacts of introducing a new organism in an ecosystem, words such as ‘carrying capacity’, ‘competition’ and ‘limiting factors’ should be included in the response to indicate the relationships between all key factors of the particular habitat. These terms were missing from responses, demonstrating a superficial understanding of the biological impacts.

Responses in Paper One Part B: Continuity of life, highlighted a lack of understanding of the notation used to identify the genotype of an organism.
Investigating biology (IB)

In 2016, there was an improvement in recognising the importance of controls and variables when designing investigations. Most responses included a range for the variable to be tested with the inclusion of a valid control group. Graphing of data was generally appropriate, with titles missing but all other requirements met. The food web was generally well drawn. Interpretation of biological situations/data/graphs provided more difficulty, with general responses lacking depth of analysis.

Candidates did not always read questions thoroughly and did not respond to all that was being asked, e.g. in Paper One Part A: Question 5b a hypothesis was given without the required justification.

Evaluating biological issues (EBI)

Responses frequently focused on restating information brought into the examination room without using this information to support or refute the main points of the arguments. Many responses lacked structure. A good response clearly articulates a viewpoint with paragraphs to explain each argument or idea integrating the information gathered. This is followed by a summary that brings together the main points succinctly to reaffirm the decision.

Sample solutions

Sample solutions for 2016 are printed on the following pages to help teachers and candidates prepare for future Biology examinations.
Part A — Cell structure and function

Questions 1–7 assess *Understanding biology* (UB) and/or *Investigating biology* (IB). Attempt all questions. Write your responses in the spaces provided. Suggested time allocation: 35 minutes.

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**Question 1 (UB)**

State the cell theory.

- All living things are composed of cells.
- The cell is the basic unit of life.
- All cells come from pre-existing cells.

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**Question 2 (UB)**

Complete the table below by:

- stating the name of each cell component shown
- describing the main function of each component
- indicating if the component is found in plant and/or animal cells (tick in the appropriate box/boxes).

<table>
<thead>
<tr>
<th>Cell component</th>
<th>Name</th>
<th>Function</th>
<th>Present in</th>
<th>Animal cells</th>
<th>Plant cells</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mitochondria</td>
<td>Energy production (ATP)</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Chloroplast</td>
<td>Photosynthesis reactions</td>
<td>No</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Cell membrane</td>
<td>Controls movement of materials in an out of the cell.</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>
**Question 3 (UB)**

The diagram below shows the cell cycle.

![Cell Cycle Diagram](image)

Describe what is happening at each of the following stages of the cell cycle.

a. **Prophase**
   

b. **Metaphase**
   
   Chromosomes align at the equator.

c. **Anaphase**
   
   Chromosomes separate and move towards the poles.

**Question 4 (UB)**

Explain why the ratio of surface area to volume affects cell size.

A large surface area facilitates exchange of materials across the cell membrane. As cells become larger, the cell membrane does not increase proportionally to the volume. Therefore, the movement of materials across the membrane cannot keep up with the cell requirements which limits the size of the cell.
Question 5 (IB)

Beetroot cells contain a strongly coloured red pigment. A student conducted an experiment as follows:

- Four pieces of beetroot were collected.
- Each piece was placed in a different tube.
- Distilled water was added to each tube.
- Each tube was placed in a water bath at a different temperature.
- Each tube was left in its water bath for 30 minutes.
- The intensity of colour in each tube was recorded.

<table>
<thead>
<tr>
<th>Tube</th>
<th>Temperature</th>
<th>Intensity of colour (0–10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>18 °C</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>30 °C</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>40 °C</td>
<td>5</td>
</tr>
<tr>
<td>D</td>
<td>60 °C</td>
<td>10</td>
</tr>
</tbody>
</table>

Note: 0 = no colour 10 = strong colour

a. What hypothesis was this experiment designed to test? Justify why this is a valid hypothesis.

Temperature affects the rate of diffusion, the greater the temperature the greater the diffusion. OR

If the temperature is increased, the porosity of the cell wall and membrane is increased.

These are valid as there is more pigment in the water (darker colour) at greater temperatures.

b. Evaluate the design of the experiment. What additional information would you require to be confident about the adequacy of the data? Propose refinements.

The experiment was designed well, although to ensure a fair test:

Size of beetroot isn’t specified, they need to all be the same.

The amount of water in tube is to be the same.

Use repeat trials, more samples are required, e.g. 5 test tubes at each temperature.

Control variables:

The measurement of colour would be more objective using a colorimeter rather than a 1 - 10 scale...
Question 6 (UB)

The browning of peeled apples on exposure to air is catalysed by the enzyme phenol oxidase.

Using your knowledge of enzyme action, explain why boiling apples as soon as they are peeled can prevent the browning process.

Enzymes are a protein which can be denatured (destroyed) by heating. The enzyme phenol oxidase will be destroyed by the boiling, so the browning process will not occur.

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Question 7 (UB and IB)

A scientist collected 50 marine worms, which normally live in seawater. Groups of 10 worms were weighed and each group placed in a different salt concentration. After 12 hours, each group was reweighed and the change in mass calculated as a percentage. The results are shown in the table below.

<table>
<thead>
<tr>
<th>Salt concentration (%)</th>
<th>Change in mass of worms (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>-15</td>
</tr>
<tr>
<td>5</td>
<td>-40</td>
</tr>
</tbody>
</table>

a. Use the data above to plot the information on a graph.

[Graph showing change in mass of marine worms in different salt concentrations]

b. On the graph above, draw a line of best fit to compare the change in salt concentration and the change in the worms’ mass.
c. Explain what has occurred to the worms placed in the 5% salt solution.

These worms have shrivelled and lost water, due to osmosis. The concentration of water inside the cell is greater than the concentration outside, therefore there is movement from an area of high concentration to an area of low concentration.

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

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

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

d. Worms placed in distilled water would die. Explain what would cause this.

Water moves into the cells by osmosis, as the distilled water has a 0% salt concentration. The cells swell and probably burst.

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

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

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

e. Determine the salt concentration in the worms’ normal habitat. Explain your response.

3 - 3.5% .................................................................

This is where there is no change in mass. .................................................................

internal salt concentration = external salt concentration .................................................................

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

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

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

End of Part A
Part B — Continuity of life

Questions 1–7 assess Understanding biology (UB).
Question 8 assesses Evaluating biological issues (EBI).

Attempt all questions. Write your responses in the spaces provided.

Suggested time allocation: 65 minutes.

Question 1 (UB)

Meiosis is the process by which gametes are produced. Gametes can fuse together to form zygotes.

a. How do these two processes lead to a wide variety of offspring being produced?

During gamete formation in meiosis, crossing over occurs between the arms of homologous chromosomes, leading to a mixing of genes. Random assortment occurs in the second stage of meiosis, so there is a chance of mixing of chromatid combinations in the gamete.

During zygote formation (fertilisation) there is a random pairing of gametes.

b. What are the advantages of producing a variety of offspring?

Variation in offspring creates an evolutionary advantage for a species. If environmental conditions change, then the chances of a favourable adaptation being present in the population is increased and the population is more likely to survive.
Question 2 (UB)

In garden peas, purple flower colour is dominant over white. A heterozygous purple-flowered plant is crossed with a white-flowered plant. Give the genotypic and phenotypic ratios of the offspring.

\[
\begin{array}{c|ccc}
 & P^- & p^- & \text{Ratio} \\
\hline
P^- & \frac{1}{2}Pp & \frac{1}{2}pp & \frac{1}{2} \text{ Purple} \\
p^- & \frac{1}{2}Pp & \frac{1}{2}pp & \frac{1}{2} \text{ White} \\
\end{array}
\]

Question 3 (UB)

In humans, the ABO blood grouping system is brought about by three different alleles: \(I^A\), \(I^B\), and \(i\). The genotypes for the blood groups are:

<table>
<thead>
<tr>
<th>Blood type</th>
<th>Genotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(I^AI^A) or (I^AI^i)</td>
</tr>
<tr>
<td>B</td>
<td>(I^BI^B) or (I^Bi)</td>
</tr>
<tr>
<td>AB</td>
<td>(I^AI^B)</td>
</tr>
<tr>
<td>O</td>
<td>(ii)</td>
</tr>
</tbody>
</table>

In a family that has four biological children, each child has a different blood group. What are the phenotypes of the parents? Explain your reasoning, showing all working.

"4 blood groups in children must have in parents \(I^A, I^B, i\)"

Genotypes of children:
- A: \(I^A(i\ or\ I^B,i)\)
- B: \(I^B(i\ or\ I^B, i)\)
- AB: \(I^AI^B\)
- O: \(i i\)

To achieve this:

\[
\begin{array}{c|ccc}
 & I^A & I^B & i \\
\hline
I^A & I^A+i & I^A+i & I^A+i \\
I^B & I^B+i & I^B+i & I^B+i \\
i & i+i & i+i & i+i \\
\end{array}
\]
**Question 4 (UB)**

Entire ovaries can be transplanted from one animal to another and remain functional.

The following transplant was carried out:

![Diagram showing ovaries removal and transplantation](image)

The following mating then took place:

![Diagram showing mating and offspring](image)

**a.** What is the genotype of Rabbit 3 for fur colour?

dd

**b.** What is the most likely genotype of Rabbit 2 for fur colour?

Dd

**c.** Explain why rabbits 1 and 3, who both have light fur, were able to produce offspring with dark fur. Rabbit 1 had ovaries which were transplanted from rabbit 2 (dark fur), which contain the gene for…… dark coloured fur.

**d.** It has been suggested that if the offspring of rabbits 1 and 3 were allowed to interbreed, then all of the next generation would have dark fur. Do you agree or disagree with this suggestion? Explain.

No. There would probably be both light and dark fur in the next generation. Each of the offspring…… have the genotype, Dd, as they have received the gene for the light fur from rabbit 3. A cross between Dd and Dd will result in 75% dark fur, and 25% light fur.
Question 5 (UB)

In mice, black coat (B) is dominant to brown coat (b) and an unspotted coat (T) is dominant to white spotted coat (t).

A number of black mice with white spots were crossed with brown unspotted mice. All the offspring (F1) had black unspotted coats. If one of these F1 mice with black unspotted coats was crossed with a brown-coated mouse that was heterozygous unspotted, what is the chance of getting a brown mouse with white spots? Show all working.

\[
\begin{array}{c|c|c|c|c}
B \times T & B & T & b & t \\
B & BBTT & BbTT & BbT & bbT \\
T & BbTT & BbT & bbTT & bbTT \\
b & BbTT & BbT & bbTT & bbTT \\
t & BBTT & BbTT & bbT & bbT \\
\end{array}
\]

Chance of brown with white spots is \( \frac{1}{8} \)
**Question 6 (UB)**

The family tree below shows the pattern of inheritance of a genetic disease caused by a single gene.

![Family Tree Diagram](image)

**Key**
- □ Normal male
- ■ Affected male
- ○ Normal female
- ● Affected female

a. What features of the pedigree suggest that the disease is sex-linked?

The trait is only in males. A cross between a normal male and a normal female produces affected... males only.

b. Assuming sex-linkage is involved, what are the genotypes of individuals I, II, III and V?

(Use X and Y for the sex chromosomes and N or n for the alleles).

I - Normal male - XNY

II - Normal female with affected offspring - XNXn

III - Affected male - XnY

V - Normal female with affected father and offspring - XNXn

c. What might individual IV’s genotype be? Explain your response.

The possible genotype for individual IV is XNXN, as no males have been affected. If IV carried the... gene, there is a 50% chance that her male offspring would have the disease, and this isn’t the case. In the family tree...
**Question 7 (UB)**

The diagram below represents how proteins are made under instructions from DNA.

![Diagram of protein synthesis](image)

**a.** Name processes 1 and 2.

Process 1: Transcription

Process 2: Translation

**b.** Explain how protein synthesis occurs. Include the two processes shown in the structures above in your explanation.

Transcription: DNA helix partially unwinds so that a portion of DNA can be transcribed. An enzyme - RNA polymerase - helps line up nucleotides to create a complementary strand of messenger-RNA (mRNA) which takes the information to the cytoplasm, then ribosome.

Translation: mRNA is sent to the cytoplasm, where it bonds with ribosomes, the sites of protein synthesis. Once the mRNA is in place, transfer-RNA (tRNA) molecules, each with a specific amino acid attached, binds to the ribosome in a sequence determined by the mRNA. The tRNA molecule whose anticodon is complementary to the mRNA forms a temporary base pair with the mRNA. A peptide bond is formed between adjacent amino acids. The process continues until the stop codon.

At that point, the protein chain is released.

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Queensland Curriculum & Assessment Authority
March 2017
Question 8 assesses *Evaluating biological issues* (EBI). Write an extended response below. Your response MUST refer to biological principles, concepts and ideas.

**Question 8 (EBI)**

Insects can be both useful and harmful to crop plants such as maize. Corn borers are insects that eat maize plants. The bacterium *Bacillus thuringiensis* produces a toxin that kills insects. Scientists have been growing this bacterium and collecting the toxins to spray over maize crops to kill corn borers.

An agricultural company has developed genetically modified (GM) maize plants containing a gene from *Bacillus thuringiensis* so that the plants produce this toxin.

Would you advise farmers to grow GM maize plants? Justify your decision by providing biological advantages and disadvantages of growing GM maize plants.

State decision whether agree or disagree.

Each paragraph should have a fact (positive or negative) supported by evidence.

For example

Positive

- transgenic chemicals are digested in the gut
- transfer of genes occurs in natural populations
- reduction of pesticides in the environment

Negative

- pest species have a biological role, but could become extinct
- impact on food web
- long term effects of GM are unknown

Conclusion - restate decision with reference to the information that supports the decision.
End of Part B
**Part C — Evolution and diversity**

Questions 1–4 assess **Understanding biology** (UB) or **Investigating biology** (IB).

Question 5 assesses **Evaluating biological issues** (EBI).

Attempt all questions. Write your responses in the spaces provided.

Suggested time allocation: **50 minutes**.

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**Question 1 (UB)**

Explain why soft-bodied organisms are less likely to be fossilised than organisms that have some hard parts such as shell or bone.

*The soft, fleshy body parts of organisms are readily decayed by decomposer organisms. Shell and bone are relatively hard and take much longer to decompose. They can remain intact long enough to be buried until fossilisation occurs.*

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**Question 2 (UB)**

Study the diagram below, which illustrates the stages of embryological development for different kinds of organisms.

![Embryological Development Diagram]

**a.** Explain how comparative embryology is used to support the theory of evolution. Refer to the diagram in your response.

*Comparative embryology of the vertebrates shown clearly indicates similarities between the different organisms in the early stages of development. Such similarities suggest an evolutionary relationship between the organisms such that at some point in their history they shared a common ancestor.*
b. Select two of the following areas of study and, using specific examples, briefly explain how they support the theory of evolution.

i. Palaeontology

ii. Biogeography

iii. Comparative anatomy

iv. Biochemistry.

TWO REQUIRED ONLY

**Palaeontology**: study of fossils from different geological eras suggests that organisms have changed over time, one form giving rise to another.

**Biogeography**: the distribution of different but related organisms on landmasses that are isolated form one another suggests that the organisms had a common ancestor at a time when the land masses were joined.

**Comparative anatomy**: the similarities shared by many different groups of organisms is evidence that they are related and share a common ancestor.

**Biochemistry**: analysis of molecular structure, such as, DNA and proteins between species, provides further evidence of evolutionary relationships. The greater similarity, the more closely related.
Question 3 (UB)

Study the evolutionary tree below, which shows examples of extinct and present-day Australian fauna.

![Evolutionary Tree]

a. Use the theory of natural selection to explain the evolution of the two different species of wombat in the diagram. Include the following in your response:

- natural variation
- different environmental pressures
- adaptations to different environments.

The northern hairy-nosed wombat and the southern hairy-nosed wombat shared a common ancestor. Variation existed within the population of that ancestral group. Movement of different populations saw them inhabit different localities with different environmental pressures.

Populations in different areas would have become geographically and therefore, reproductively isolated from one another over a long period of time. Different environmental pressures would have favoured different forms of the same characteristic in the two groups. Individuals within each group that had the characteristic most suited to their particular environments would have had the best chance of surviving and passing on their characteristics to their offspring, while those individuals without the favourable characteristics would have died out.

In this way, the most favourable characteristics in each group became more common and subsequent generations became more and more adapted to their particular environments. Over time, the two populations became so different from one another that they no longer reproduced and were two different species.
b. Explain two reasons that could account for the disappearance of diprotodon.

Climate change - environmental conditions may have become warmer and drier, changing the ecosystem to which the diprotodon was adapted.  
Arrival of humans - hunting may have contributed to the extinction.  

Any 2 reasonable.  

Question 4 (IB)

In 1926, a British scientist fed leaves covered with soot to 20 larvae from a female peppered moth that had a light-coloured body and wings. The 20 larvae went through a normal life cycle.

Eventually they became light-coloured adult moths that in turn produced another generation of offspring. When the scientist examined the offspring, he reported that 8% had a dark-coloured body and wings. He claimed that the diet of soot had caused mutation to the dark colour.

a. Evaluate the design of the experiment. What are two faults in the design and what are the implications of these?

TWO REQUIRED ONLY.  
No control group (larvae fed leaves without soot), as a result there was nothing to compared the results to. Too few larvae were used and may not have represented the entire moth population. The genetic history of original moths. The female may have had dark moths as ancestors, the male may have been dark. The experiment was not repeated.

b. Were the claims made by the scientist valid? Explain your response.

No. The experiment was not controlled and too many assumptions were made.


c. Propose three improvements to the original design of the experiment.

Run the experiment for more generations.  
Isolate pure breeding moths and feed their larvea soot/ no soot.  
Collect moths from a wider area.  
Control all other variables.
Question 5 assesses \textit{Evaluating biological issues} (EBI). Write an extended response below. Your response MUST refer to biological principles, concepts and ideas.

\textbf{Question 5 (EBI)}

Earth has had five mass extinctions, which is defined as when more than 75\% of species disappeared each time. Biologists suspect we are living through the sixth mass extinction.

‘The cause of the sixth extinction is well-known: human selection is replacing natural selection as the engine of evolution ... The net effect is global biologic homogenisation and ecosystem simplification — the end of the wild.’


Outline the possible future consequences of ‘the sixth mass extinction’. In your response, make reference to the theory of evolution, past extinctions and consequences for the future.

The best guide as to the effect of a sixth mass extinction is to look at the past and the effect.

Compare alternatives and predictions relevant in the past, present and future contexts.

Decrease in diversity and variation leads to further mass extinction in the case of a catastrophic event. (Reduction of variation for selection pressures; e.g. all same food supply: disaster ... famine as alternatives ... aren’t available)

Creation of new combinations of genes due to selective breeding gives new species.
End of Part C

End of Paper One
Part A — Physiology of organisms

Questions 1–9 assess *Understanding biology* (UB) or *Investigating biology* (IB).

*Attempt all questions. Write your responses in the spaces provided.*

*Suggested time allocation: 60 minutes.*

**Question 1 (UB)**

The diagram below shows the parts of a crocodile involved in breathing.

![Diagram of crocodile](image)

Crocodiles have lungs and breathe air but they lack a diaphragm. Crocodiles breathe in by expanding the ribs and contracting muscles attaching the liver to the hip bones. This pulls the liver back and causes air to enter the lungs. Breathing out occurs when the ribs are pushed inwards and contraction of the abdominal muscles moves the liver forward.

*Explain the similarities and differences between crocodile and human respiratory systems.*

Both crocodiles and humans breathe air. Both use the contraction of muscles to change the air pressure in the chest to result in breathing in.

Change in chest cavity volume is brought about in different ways in humans and crocodiles. Crocodiles do not use intercostal muscles and lack a diaphragm. Change is brought about by contracting muscles attached to the liver and hip and moving the liver to create space.

In humans, the diaphragm contracts and intercostal muscles lift the ribs, up and out.

...
Question 2 (UB)

The diagram below is of the human heart.

![Heart Diagram]

a. Use the letter/s on the diagram to indicate which vessel/s carry oxygenated blood.

C, D

b. If the muscular wall of the left ventricle thickens, the ventricle becomes stiff and is no longer able to pump the same amount of blood as it did under normal circumstances. This could lead to a heart attack.

Explain the effect on the blood pressure in:

i. the main artery of the arm.

As the left ventricle becomes stiff, less blood than normal is pumped with each heartbeat, which would decrease the blood pressure.

ii. vessel D.

The blood pressure would be higher than normal, as the blood is coming from the lungs, and is not being pumped out of the heart effectively causing blood to "back up" in vessel D.
Question 3 (UB)

The diagram below shows the major structures of a section of the digestive system.

![Diagram of digestive system]

**a.** Choose two of the structures shown in the diagram. Link each structure to its function in the digestive system.

---

**TWO ONLY**

Villi - increase the surface area for absorption of digestive products.

Muscle layers - help to move food along by peristaltic contractions.

Blood vessels in close contact - allow for the products of digestion to be transported.

Single layer of cells - small diffusion distance.

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**b.** Ingesting certain bacteria can lead to severe diarrhoea (watery faeces). Using your knowledge of how the digestive system functions:

* identify the organ being affected by the bacteria
* explain your reasoning.

Large intestine.

The increase in water in the waste product (i.e., diarrhoea) indicates that water is not being absorbed into the bloodstream. Water reabsorption mainly occurs in the large intestine so this must be the area most affected.
Question 4 (IB)

The table below gives information about four species of birds in winter.

<table>
<thead>
<tr>
<th>Bird species</th>
<th>Body mass (g)</th>
<th>Energy needed per day (kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>21</td>
<td>84.2</td>
</tr>
<tr>
<td>X</td>
<td>12</td>
<td>62.4</td>
</tr>
<tr>
<td>Y</td>
<td>9</td>
<td>49.5</td>
</tr>
<tr>
<td>Z</td>
<td>7</td>
<td>42.0</td>
</tr>
</tbody>
</table>

Interpret and analyse the data to draw a conclusion for the energy needed per day per gram of body mass. Use the data in your response.

Energy needed per gram body mass for each species:

- W: 4.0 kJ/g
- X: 5.2 kJ/g
- Y: 5.5 kJ/g
- Z: 6.0 kJ/g

As body mass decreases, the amount of energy needed to sustain the bird increases proportionally.

Bird W is almost twice the size of Bird X and the relative amount of energy required per gram is not significantly more 4.0 vs 5.2 kJ/g.

Bird Y is 3/4 the size of Bird X and uses 5.5 vs 5.2 kJ/g.

The data may indicate that Bird Z is most active, eating less energy dense foods, requiring it to do more work each day for its body weight. Species W is the most energy efficient, despite its large body mass (21g).

Smaller birds have a larger SA:V and loose heat at a higher rate, therefore they require more energy.
**Question 5 (UB)**

Consider the stimulus-response pathway that enables the body’s nervous system to detect and respond to changes in temperature.

```
Stimulus
↓
Receptor
↓
Control centre
↓
Effector
↓
Response
```

Use the terms in the stimulus-response pathway to explain how the body detects and responds to a decrease in environmental temperature.

The decrease in environmental temperature is the **stimulus**.----------------------------------------

Temperature **receptors** in the skin detect the decrease and send a nerve message to the **control centre**. The brain. Another nerve message is relayed from the brain to **effectors** in the skin. Several effectors may be stimulated resulting in a number of responses, for example:

- muscles (effectors) below the skin contract, causing hair to stand up, trapping a layer of air for insulation;
- muscles (effectors) contract and relax in rapid succession (shivering) - the increased cellular activity... generates heat;
- surface blood vessels (effectors) contract, reducing heat loss.

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Question 6 (UB)

Plants adapted to conditions of high temperatures and low water availability often have stomata sunken into pits on stems and leaves. The stomata remain closed during the hottest part of the day.

a. Describe the role of stomata in relation to gas exchange and water movement in plants.
   When stomates are open, gases can diffuse into and out of the leaf according to the concentration of gradients of the gases. CO₂ can diffuse into the leaf and become available for photosynthesis. Oxygen needed for respiration also enters through the stomata. Water vapour that has evaporated from the surfaces of cells within the leaf moves about the intercellular spaces and eventually diffuses out of the leaf though the stomata.

b. Explain the role of stomata in water conservation for the plants during the hottest part of the day.
   During the hottest part of the day, plants adapted to conditions of high temperature have their stomata closed to reduce water loss.

   

c. How would the closure of stomata affect the rate of photosynthesis and plant growth? Explain your response.
   The closure of stomata during the hottest part of the day also reduces the availability of CO₂ for photosynthesis, so the rate of photosynthesis is reduced. With less carbohydrates being produced by plants, growth can be expected to be slow.

Question 7 (UB)

The following data was obtained by experiments measuring the transpiration from leaves and water absorption by the roots from soil in 100 plants over 2-hour periods starting from 12 noon. The plants were located in a glasshouse where humidity and temperature were maintained at constant levels.

<table>
<thead>
<tr>
<th>Process</th>
<th>Time (2-hour period ending at)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 pm</td>
</tr>
<tr>
<td>Transpiration from leaves (ml of water)</td>
<td>34</td>
</tr>
<tr>
<td>Absorption of water by roots (ml of water)</td>
<td>20</td>
</tr>
</tbody>
</table>
a. On the same set of axes, use the data to plot two graphs: one for transpiration, the other for absorption.

b. Interpret and analyse the results to draw a conclusion about the relationship between transpiration and absorption. In your response:
   i. describe and explain the pattern for transpiration and absorption.
   ii. explain why transpiration and absorption of water follows these patterns. Use theory in your explanation.
   iii. draw a conclusion about the relationship.

   Both transpiration and absorption rates increase and decrease during the afternoon as heat decreases and stomata opens. Transpiration increases until 8pm when the cooler temperature affects the rate of transpiration. Absorption rate is dependent on the rate of transpiration, which is why the same pattern occurs but at a later time. Transpiration creates a 'pull' of water through the plant. As water is lost through the leaves, water is drawn through the xylem, drawing water up from the roots (absorbing water from the soil) to the leaves.

   Conclusion: As the amount of transpiration increases, so too does the absorption.
Question 8 (UB)

An athlete can run a marathon in 2 hours 15 minutes on a dry day in temperatures of up to 35 °C.

The athlete notices:
- if the air is dry, their body will not overheat
- in humid conditions, if the outside temperature is over 18 °C, their body will overheat.

Explain why the athlete overheats in humid conditions.

The evaporation of sweat from the skin has a cooling effect, keeping the body temperature constant.

Humid conditions reduces the rate of evaporation from the skin, thus reducing the evaporative cooling effect and the body overheats.

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**Question 9 (IB)**

Gardening books advise against growing broad beans and onions alongside each other as the growth of both crops is reduced.

You have a supply of onion root extract. Design an experiment to test the hypothesis that the extract is responsible for inhibiting the growth of the broad bean plants. In your design:

- provide methodology
- address variables
- plan replicate treatments
- identify data to be collected.

Randomly assign 100 broad bean seeds to 5 groups. (If seedlings are used, they should be the same size and age). .................................................................

Plant all seeds and grow under conditions so the following can be kept constant for all plants: soil, ...........

fertiliser, watering, temperatures, humidity, light intensity and length of exposure to light ...........

The control group would have no onion root extract added. .................................................................

The remaining groups would each have a set amount of onion root extract added at regular intervals, ....

increasing in concentration. (Independent variable = concentration of root extract). ........................

As the plants mature, measure the height of the plants. (Dependent variable = height). ...........

If the control group showed greater growth than some or all of the other groups then the hypothesis would be supported. ........................................................................................................

The experiment should be repeated. ........................................................................................................

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Part B — Organisms and ecosystems

Questions 1–4 assess Understanding biology (UB) and/or Investigating biology (IB).
Question 5 assesses Evaluating biological issues (EBI).

Attempt all questions. Write your responses in the spaces provided.
Suggested time allocation: 60 minutes.

Question 1 (IB)

At the seashore, the tide comes in and goes out twice each day. Some students investigated whether two different species of seaweed — bladder wrack and sea lettuce — could live only at certain positions on a rocky shore. Seaweeds are plant-like organisms that make their food by photosynthesis.

The students:
1. placed a 50-metre tape measure on the rocks at right angles to the sea.
2. placed a 1 m x 1 m quadrat next to the tape measure.
3. recorded whether each species was present or not.
4. repeated steps 2 and 3 every metre down the shore.

The section of the seashore and the results are shown below.

![Diagram showing the section of seashore with a transect line and bladder wrack and sea lettuce distribution]

**a.** The students placed the quadrat at regular intervals along the transect line rather than placing the quadrat at random positions anywhere on the rocky shore. Explain why this is a better method.

This provides data on the position of the seaweed and provides a more consistent picture of the distribution and will include any transition zones along the transect. If such a zone is small, random testing may miss it and not give a reliable indication of species present.

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b. Analyse the data to draw a conclusion about the distribution of bladder wrack and sea lettuce. Use the data in your response.

The bladder wrack is better adapted than the sea lettuce to survive in dry conditions.

Both species are found within the high tide zone. Sea lettuce must be covered in water at all times, as it is found below low tide level and in the pools of seawater. Bladder wrack can tolerate some time out of the water.

c. How could the students have improved their investigation?

Repeat the investigation several times elsewhere along the shore.

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The bladder wrack has many air bladders to help it float upwards when the sea covers it. Formulate and justify a hypothesis to explain how this helps the bladder wrack survive in this environment.

The air bladders allow the bladder wrack to absorb more light for photosynthesis as they are near the surface at all times, but still in the water.

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Question 2 (UB)

Locust plagues are common in some inland areas of Australia following seasons of good rainfall. Locusts feed on a variety of crops and pastures, invading previously uninfested areas.

a. Describe the short-term effect/s the locust plague would have on the ecosystem.

Many plants will be destroyed and damaged. The food supply of other first order consumers will be reduced. Habitats and nesting sites may be destroyed. There will be an increase in insectivore numbers in response to the increase in food availability.

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b. Explain the long-term effect/s on the ecosystem.

In the long term, the ecosystem will probably recover and the populations of organisms return to their original numbers. Locust populations can't be sustained in high numbers due to food shortages and will move on or die. Ecosystems will recover.
Question 3 (UB)

Define the following and give an example for each.

a. Parasitism

A relationship between two species of organisms in which one organism benefits and the other is harmed.

b. Mutualism

A relationship between two species of organisms in which both benefit from the association.

Question 4 (UB and IB)

a. Draw a food web for the ecosystem described below.

In a particular forest ecosystem, leaf-eating insects feed on the leaves of Eucalyptus trees, while sap-sucking insects feed on the sap of these trees. Starlings eat both types of insects, and these birds are in turn preyed upon by goshawks. Spiders that live in the trees feed on wasps and the leaf-eating and sap-sucking insects. Wasps are sometimes observed eating the sap-sucking insects.

b. Add a decomposer organism to your food web, including appropriate arrows.
Question 5 assesses *Evaluating biological issues* (EBI). Write an extended response below. Your response MUST refer to biological principles, concepts and ideas.

**Question 5 (EBI)**

Australia’s biodiversity has been under threat ever since European settlement with 24 mammals becoming extinct since the late 18th century. Feral cats are one of the major causes of extinctions. They are found across Australia and kill tens of millions of native animals every night. A long-term sustainable solution is needed.

 Decide if dingoes should be introduced into areas to keep feral cat numbers down. In your response, explain the:

- effects of feral cats on the ecosystem.
- advantages and disadvantages of introducing dingoes.

Justify your decision by referring to the advantages and disadvantages discussed.

State decision - agree or disagree.

Each paragraph should provide a fact supported by evidence. Biological terms should be used, e.g. predators, food chains, food webs, communities, biological control, pests, ecosystems, introduced species etc.

Conclusion - restate decision with reference to the information that supports the decision.

Possible points:

- timeliness of effect
- past attempts at biological controls
- dingo an additional predator in the environment
- predator/prey vs competitors for food
- success as predator - do dingoes kill as many prey, especially if they are eating cats?
End of Part B

End of Paper Two