Biology marking guide and response

External assessment 2023

Combination response (89 marks)

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

1. describe and explain biodiversity, ecosystem dynamics, DNA, genes and the continuity of life, and the continuity of life on Earth
2. apply understanding of biodiversity, ecosystem dynamics, DNA, genes and the continuity of life, and the continuity of life on Earth
3. analyse evidence about biodiversity, ecosystem dynamics, DNA, genes and the continuity of life, and the continuity of life on Earth to identify trends, patterns, relationships, limitations or uncertainty
4. interpret evidence about biodiversity, ecosystem dynamics, DNA, genes and the continuity of life, and the continuity of life on Earth to draw conclusions based on analysis.

Note: Objectives 5, 6 and 7 are not assessed in this instrument.

Queensland Government
Queensland Curriculum & Assessment Authority
For all Queensland schools

Purpose

This document consists of a marking guide and a sample response.

The marking guide:

- provides a tool for calibrating external assessment markers to ensure reliability of results
- indicates the correlation, for each question, between mark allocation and qualities at each level of the mark range
- informs schools and students about how marks are matched to qualities in student responses.

The sample response:

- demonstrates the qualities of a high-level response
- has been annotated using the marking guide.

Mark allocation

Where a response does not meet any of the descriptors for a question or a criterion, a mark of ‘0’ will be recorded.

Where no response to a question has been made, a mark of ‘N’ will be recorded.

Allow FT mark/s — refers to ‘follow through’, where an error in the prior section of working is used later in the response, a mark (or marks) for the rest of the response can still be awarded so long as it still demonstrates the correct conceptual understanding or skill in the rest of the response.

Marking guide

Multiple choice

Question	Response
1	D
2	C
3	B
4	C
5	D
6	A
7	D
8	C
9	B
10	A
11	B
12	C
13	C
14	D
15	A
16	A
17	B
18	A
19	B
20	D

Paper 1: Short response

Q	Sample response	The response:
21	1: hydrogen bonds 2: nitrogenous base 3: sugar 4: phosphate	• identifies 1 as hydrogen bonds **[1 mark]** • identifies 2 as nitrogenous base **[1 mark]** • identifies 3 as sugar **[1 mark]** • identifies 4 as phosphate **[1 mark]**
22	Heterotrophic bacteria break down dead remains and organic waste into CO_2, which is released into the atmosphere for use by plants in photosynthesis. Nitrogen-fixing bacteria convert atmospheric nitrogen into nitrates, which can be used by plants for protein synthesis.	• describes a way that bacteria assist matter to cycle through ecosystems **[1 mark]** • describes another way that bacteria assist matter to cycle through ecosystems **[1 mark]**
23a)	Parasitism	• identifies parasitism **[1 mark]**
23b)	Predatory relationships involve an organism capturing, killing and feeding on another organism. This relationship is parasitic because the eucalyptus tree is harmed, not killed.	• describes predation **[1 mark]** • explains how the relationship differs from predation **[1 mark]**
24a)	Advantageous. There was a rapid increase in the frequency of the new allele between 2004 and 2008 (0–84%). The frequency then continued to increase until 2022, when approximately 97% of the population had the allele. This indicates positive selection for the allele has occurred, suggesting the trait is advantageous.	• infers the allele is advantageous **[1 mark]** • justifies response using evidence from the graph **[1 mark]**

Q	Sample response	The response:
24b)	If mutations occur in coding regions of DNA, they may create new alleles. If new alleles occur in sex cells, they can be passed to the next generation and may become more common in the population (particularly if they're advantageous), causing changes to allele frequencies.	• explains that mutations can create new alleles **[1 mark]** • recognises the mutation must occur in sex cells **[1 mark]** • explains how mutations contribute to microevolutionary change **[1 mark]**
25a)	Species richness is higher in areas with low invasive species cover (seven different species compared to two).	• identifies species richness is higher in areas with low invasive species cover **[1 mark]**
25b)	The presence of the invasive species has a negative effect on biodiversity. While the same number of species were observed in the area when invasive species cover was 0–60% (7, as indicated by species richness), the SDI decreased from 0.83 to 0.3 as percentage cover increased. This indicates that overall, biodiversity decreased as percentage cover increased.	• identifies a relevant trend in the data **[1 mark]** • draws a valid conclusion about the effect of the invasive species **[1 mark]**
25c)	Species richness indicates the number of species that can coexist in the area; however, it doesn't account for the abundance of each species, so one or two species may be dominating. SDI considers the number of species and their relative abundance (evenness), but the number of species is not obvious from the index. Having both values is more informative because it allows the researcher to identify the number of species in the area (7) and infer evenness from the SDI. For example, the same number of species was present for 0–60% coverage (7), but the evenness was not the same, as the SDI decreased as % coverage got higher.	• recognises species richness is the total number of species present **[1 mark]** • recognises SDI considers species number and abundance/evenness **[1 mark]** • uses data to explain why data on species richness and SDI is more informative than a single measure **[1 mark]**
26a)	Approximately 550	• identifies carrying capacity **[1 mark]**
26b)	Natural disasters (such as bushfire) could remove trees from the ecosystem, affecting the availability of nesting sites. This would reduce the number of offspring the ecosystem could support.	• identifies an abiotic factor that could reduce the carrying capacity **[1 mark]** • explains how a change to this abiotic factor could reduce the carrying capacity **[1 mark]**

Q	Sample response	The response:
27	When homologous chromosomes pair up at metaphase 1 of meiosis, the orientation of maternal and paternal chromosomes is random, so each daughter cell (gamete) has a 50% chance of receiving the maternal homologue and a 50% chance of receiving the paternal homologue. This leads to 2^{24} possible chromosome combinations for each egg and sperm. In addition to this, any of the millions of sperm created by each male fish could fertilise an egg. This leads to a high number of possible chromosome combinations for the offspring, even before crossing over is considered.	• explains – the process of independent assortment **[1 mark]** – the process of random fertilisation **[1 mark]** – how independent assortment and random fertilisation contribute to genetic variation **[1 mark]**

Paper 2: Short response

Q	Sample response	The response:
1a)	Closed-forest	• classifies the ecosystem as closed-forest **[1 mark]**
1b)	Set up three transects in representative sections of the community. Walk along each transect line, recording data on the height and type of vegetation. Use randomly placed quadrats along each transect line to collect data on percentage foliage cover of the tallest plant layer. Use the data to construct a profile diagram and identify the height and dominant vegetation in the tallest strata. A random number generator could be used to determine the location of quadrats to minimise bias.	• describes an appropriate technique to collect data on height of tallest plant layer **[1 mark]** • describes an appropriate technique to collect data on percentage foliage cover of the tallest plant layer **[1 mark]** • identifies a strategy for minimising bias **[1 mark]**
1c)	If the logging event involved removing trees in the tallest plant layer, the percentage foliage cover and tallest plant layer could change. This would change the classification of the ecosystem. Specht's classification system would allow researchers to communicate information about changes in height and percentage cover of the tallest plant layer over time, so the progression back to closed-forest could be monitored.	• recognises that the logging could change the classification of the ecosystem **[1 mark]** • explains how Specht's classification system allows researchers to monitor recovery **[1 mark]**
2a)	Based on this food web, the dingo is a predator for kangaroos, echidnas, wombats, emus and lizards. If dingoes were removed, the populations of these species would flourish, adding increased strain on their prey and potentially increasing competition for grasses. This would have a significant effect on the community structure at each trophic level and therefore energy flow through the ecosystem.	• recognises the critical role of dingoes in maintaining the structure of the community **[1 mark]** • uses data from the food web to support response **[1 mark]**

<table>
<tr><th>Q</th><th>Sample response</th><th>The response:</th></tr>
<tr><td>2b)</td><td>A reduction in dingo numbers would cause termite numbers to decrease because kangaroos and wombats would lose a predator. This would cause numbers for both to increase, increasing competition with termites for grasses.</td><td>• predicts termite numbers would decrease [1 mark]
• justifies based on species interactions [1 mark]</td></tr>
<tr><td>3a)</td><td>3</td><td>• states 3 [1 mark]</td></tr>
<tr><td>3b)</td><td>Individual 4 has passed the trait on to all his daughters (who would inherit his X chromosome) but none of his sons (who would inherit his Y chromosome).
<table><tr><th></th><th>X^A</th><th>Y</th></tr><tr><td>X^a</td><td>X^AX^a</td><td>X^aY</td></tr><tr><td>X^a</td><td>X^AX^a</td><td>X^aY</td></tr></table>This shows that if an affected male (X^AY) mates with an unaffected female (X^aX^a), all of their daughters will be affected, but none of their sons.
This matches the chart, as individual 4 has six daughters with the trait, but none of his three sons have it.</td><td>• identifies appropriate evidence from the chart [1 mark]
• identifies appropriate genotypes for the Punnett square [1 mark]
• constructs a Punnett square [1 mark]
• uses the Punnett square to determine expected frequencies for offspring phenotypes [1 mark]</td></tr>
<tr><td>3c)</td><td>X^aY
Individual 6 is a male without the trait, so he must have inherited a recessive allele.</td><td>• infers X^aY [1 mark]
• provides appropriate reasoning [1 mark]</td></tr>
<tr><td>4a)</td><td>Convergent evolution</td><td>• identifies convergent evolution [1 mark]</td></tr>
<tr><td>4b)</td><td>As both species live in similar environments, they experience similar selection pressures, so natural selection will favour similar features. In this example, a longer beak/proboscis increases the chance of accessing food, and therefore survival, long enough to reproduce and pass on the trait. This results in the trait becoming more common in both populations over time.</td><td>• recognises the two species are exposed to similar selection pressures [1 mark]
• explains how natural selection favours similar features [1 mark]</td></tr>
</table>

Q	Sample response	The response:
4c)	The hummingbird hawkmoth and tube-shaped flowers place selection pressures on each other, resulting in complementary characteristics (the proboscis length matches the flower depth). This gives the hawkmoth an advantage over species with shorter proboscises (access to food) and advantages the flower because the hawkmoth is more likely to distribute pollen to other flowers of the same species. Coevolution has most likely resulted in longer proboscises and deeper flowers.	• explains that – the two species impose selection pressures on each other **[1 mark]** – this results in complementary characteristics **[1 mark]**
5a)	Conserved sequences are assumed to accumulate mutations at a constant rate over time, so time since divergence can be predicted by the amount of genetic difference. Greater genetic difference means more time since divergence.	• explains that mutations occur at a constant rate in conserved sequences **[1 mark]** • recognises that greater genetic difference corresponds to more time since divergence **[1 mark]**
5b)	I: *B. bartonus* II: *B. reidus* III: *B. watsonii* IV: *B. deakinii*	• infers species II–IV **[1 mark]**
6	Twin studies involve collecting data on the rate of concordance/discordance in monozygotic twin pairs. Because identical twins form from a single egg, they share the same DNA, so any differences in phenotype can be attributed to the environment. By comparing the rate of discordance in monozygotic twin pairs, scientists can quantify the degree to which the environment influences gene expression and look for differences in the epigenome that may explain the observed differences.	• describes a twin methodology **[1 mark]** • recognises that monozygotic twins have the same genome **[1 mark]** • explains how data can be used to investigate the effect of the environment on gene expression **[1 mark]**
7a)	Primary succession. The image depicts the colonisation of a barren landscape.	• identifies primary succession **[1 mark]** • provides appropriate reasoning **[1 mark]**
7b)	Two key features of a pioneer species are that they can tolerate extreme conditions and photosynthesise. Their role is to make the area more habitable for the next colonisers.	• infers a key feature **[1 mark]** • infers another key feature **[1 mark]** • describes the role of pioneer species in ecological succession **[1 mark]**

Q	Sample response	The response:
8	Temporal isolation occurs when populations differ in their periods of reproductive activity, so genes are no longer exchanged. This disruption to gene flow can result in two populations evolving independently to the point that they are no longer able to interbreed.	• explains that temporal isolation occurs when populations differ in their periods of reproductive activity **[1 mark]** • identifies that this disrupts gene flow **[1 mark]** • explains how disruption to gene flow can lead to speciation **[1 mark]**
9a)	70 cells/mL	• identifies 70 **[1 mark]**
9b)	*P. aurelia* follows a similar growth pattern when grown separately and together with *P. caudatum*, exhibiting exponential growth from day 1–4 and then continuing to increase in population density up until day 14, when the number of cells/mL starts to decrease. The difference is, when grown with *P. caudatum*, the maximum number of cells only reaches ~225 cells/mL, as opposed to ~273 when grown separately. This indicates that *P. aurelia* is still able to grow effectively in the presence of *P. caudatum*, but does experience some inhibition.	• identifies a similarity **[1 mark]** • identifies a difference **[1 mark]** • states the significance **[1 mark]**
9c)	The competitive exclusion principle states that two species cannot coexist indefinitely if they occupy the same niche, because they will compete for identical resources. This competition will eventually lead to exclusion of the weaker species unless they evolve to have a more distinct niche. This principle is demonstrated in the experiment because both *P. aurelia* and *P. caudatum* grow well individually, but when they are grown together, *P. aurelia* outcompetes the *P. caudatum*, causing its population to die out by day 16.	• explains the competitive exclusion principle **[1 mark]** • identifies that both species grow well individually **[1 mark]** • identifies that *P. aurelia* outcompetes *P. caudatum* when grown together **[1 mark]**