Biology marking guide and response

External assessment 2024

Combination response (97 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.

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

Paper 1: Short response

Q	Sample response	The response:
21a)	$SDI = 1 - \left(\frac{(133 \times 132) + (96 \times 95) + (256 \times 255)}{485 \times 484} \right)$ $= 0.61$	• determines SDI as 0.61 **[1 mark]** • provides appropriate working **[1 mark]**
21b)	Species evenness decreased over the 10-year period. SDI considers both species richness and evenness — the greater the species richness and evenness, the higher the SDI value. As species richness was the same in both years but SDI decreased from 0.84 to 0.61, it can be inferred that species evenness was lower in 2024 than in 2014.	• infers that species evenness decreased over the 10-year period **[1 mark]** • justifies inference using SDI data **[1 mark]**
21c)	Quadrats could be randomly placed throughout the forest, and the number and type of plants observed in each quadrat recorded. This data could then be pooled and used to estimate the total number of each plant species at the site. The researchers could ensure that at least 10% of the site is sampled (by considering number and size of quadrats) and use a random-number generator to decide where to place the quadrats.	• describes an appropriate surveying technique **[1 mark]** • identifies one strategy to minimise bias **[1 mark]** • identifies a second strategy to minimise bias **[1 mark]**
22a)	Disruptive selection	• determines disruptive selection **[1 mark]**
22b)	The selection pressure provided a selective advantage to fish with body lengths around 13 cm and 21 cm. These fish had an increased chance of surviving to reproduce and pass on the trait, leading to an increase in these phenotypes from ~8% and ~4% before the selection pressure to ~16% after. Fish with intermediate phenotypes (~15–18 cm) were selected against, causing their relative frequencies to decrease over time.	• explains the observed trends, referring to – phenotypic variation **[1 mark]** – differential survival and reproduction **[1 mark]** – change over time **[1 mark]**

Q	Sample response	The response:
23	<table><tr><th></th><th>B</th><th>b</th></tr><tr><td>b</td><td>Bb</td><td>bb</td></tr><tr><td>b</td><td>Bb</td><td>bb</td></tr></table> 50% Bb: heterozygous black fur 50% bb: white fur 0.5 x 12 offspring = 6 white rabbits	• identifies parental genotypes **[1 mark]** • provides an appropriate Punnett square **[1 mark]** • predicts number of offspring with white fur **[1 mark]**
24a)	Crossing over	• identifies crossing over **[1 mark]**
24b)	Crossing over involves homologous chromosomes exchanging portions of their DNA. Because homologous chromosomes have the same genes but (usually) different alleles, this results in chromosomes with new combinations of genetic information/alleles.	• describes crossing over **[1 mark]** • explains how crossing over contributes to genetic variation **[1 mark]**
25	An interspecific hybrid is an offspring produced by the mating of individuals from two different species, e.g. a mule, which is the offspring of a horse and a donkey.	• describes interspecific hybrid **[1 mark]** • provides an example **[1 mark]**
26a)	Transfer efficiency = (1700/16 000) x 100% = 11%	• determines transfer efficiency **[1 mark]** • provides appropriate working **[1 mark]**
26b)	Energy lost to decomposers = 92 000 – (55 000 + 16 000) = 21 000 kJ m^{-2} $year^{-1}$	• determines 21 000 **[1 mark]** • provides appropriate working **[1 mark]**
26c)	Primary producers convert solar energy into chemical energy in the form of glucose through photosynthesis. At each level of the food chain some chemical energy is transformed into heat energy as organisms use it to drive their biochemical processes (respiration).	• describes one way energy is transformed **[1 mark]** • describes a second way energy is transformed **[1 mark]**

Q	Sample response	The response:
27	$N(\text{researcher I}) = \frac{M \times n}{m}$ $= \frac{160 \times 140}{80}$ $= 280$ $280 = \frac{100 \times 60}{m(\text{researcher II})}$ $m = \frac{100 \times 60}{280}$ $= 21 \text{ mice}$	• calculates *N* for researcher I **[1 mark]** • determines expected *m* for researcher II **[1 mark]**

Paper 2: Short response

Q	Sample response	The response:
1a)	Species A	• identifies species A **[1 mark]**
1b)	Backbone, bony skeleton, four limbs	• identifies backbone, bony skeleton and four limbs **[1 mark]**
1c)	Hair and amniotic egg	• identifies hair and amniotic egg **[1 mark]**
2a)	Carrying capacity is the size of the population that can be supported indefinitely on the available resources and services of an ecosystem.	• provides an appropriate definition **[1 mark]**
2b)	Availability of space Availability of nutrients	• identifies one factor that affects the carrying capacity of plant species in an ecosystem **[1 mark]** • identifies a second factor that affects the carrying capacity of plant species in an ecosystem **[1 mark]**
3	Population growth = (835 + 34) – (324 + 65) = 480 Growth rate = (480/4000) x 100% = 12% / year	• calculates population growth **[1 mark]** • calculates growth rate **[1 mark]**
4a)	Helicase unwinds the double helix and separates the strands. Polymerase adds nucleotides to the new strand.	• describes the role of helicase **[1 mark]** • describes the role of DNA polymerase **[1 mark]**
4b)	The weak nature of hydrogen bonds makes it easy for helicase to separate strands. Complementary base pairing allows DNA polymerase to be guided by the template strand.	• explains one way the structure of DNA aids replication **[1 mark]** • explains a second way the structure of DNA aids replication **[1 mark]**

Q	Sample response	The response:
4c)	Mutations occur when DNA polymerase makes an error by inserting, removing or adding an incorrect nucleotide. Substitution reactions involve A, T, C or G being swapped for a different nucleotide, and result in point mutations. Because of the way that codons work, these mutations will only affect one amino acid. Additions or deletions cause frameshift mutations, where all codons after the mutation will be affected.	• explains how errors in DNA replication cause point mutations **[1 mark]** • explains how errors in DNA replication cause frameshift mutations **[1 mark]**
5a)	A population bottleneck is an event that drastically reduces the size of a population.	• describes a population bottleneck **[1 mark]**
5b)	A population bottleneck may lead to lower genetic variation because individuals who survive usually do so by chance. Allele frequencies of the remaining population may not reflect the original population, and some (potentially fitter) alleles may be lost altogether. Lower genetic diversity means a population is less likely to have favourable alleles that allow them to respond effectively to environmental changes, increasing the risk of extinction.	• recognises population bottlenecks reduce genetic diversity **[1 mark]** • explains why lower genetic diversity increases the risk of extinction **[1 mark]**
6a)	$\text{Frequency (a)} = \frac{(2 \times 23) + 540}{2 \times (830 + 540 + 23)}$ $= 0.21$	• calculates frequency of allele a **[1 mark]** • provides appropriate working **[1 mark]**
6b)	Frequencies of the sickle-cell anaemia allele are high (1–20%) in the middle of the continent, where malaria is present, but low (<1%) in other areas. This suggests positive selection for the allele has occurred in these areas, causing it to become more prevalent. This is characteristic of an allele that is advantageous.	• identifies appropriate evidence **[1 mark]** • explains their reasoning **[1 mark]**

Q	Sample response	The response:
7a)	Habitat fragmentation can lead to geographic isolation, where populations that were previously able to interbreed can no longer reach each other to do so. This disruption to gene flow can result in two populations evolving independently to the point that they are too genetically dissimilar to interbreed.	• recognises that habitat fragmentation can cause populations to become isolated **[1 mark]** • identifies that this disrupts gene flow **[1 mark]** • explains how disruption to gene flow can lead to speciation **[1 mark]**
7b)	Allopatric speciation	• identifies allopatric speciation **[1 mark]**
8a)	Species richness is five times higher in zone D than zone A. Zone A has two different species, whereas zone D has 10.	• identifies species richness is higher in zone D **[1 mark]** • provides appropriate data **[1 mark]**
8b)	As organic matter increased from 1% to 30%, the pH decreased from 8.4 to 6. This suggests that organic matter lowers soil pH.	• infers that organic matter lowers soil pH **[1 mark]** • justifies response using data **[1 mark]**
8c)	Zone D. Zone D is the oldest dune and has the highest species richness. This suggests it may be further along in succession. The number of K-selected species tends to increase as succession progresses.	• predicts zone D **[1 mark]** • provides appropriate reasoning **[1 mark]**
9a)	I. RNA polymerase II. mRNA III. polypeptide	• identifies I as RNA polymerase **[1 mark]** • identifies II as mRNA **[1 mark]** • identifies III as polypeptide **[1 mark]**
9b)	The role of tRNA is to transport amino acids from the cytoplasm to the ribosome in the order specified by the mRNA. Each tRNA carries a specific amino acid, based on its anticodon sequence. The anticodon recognises and binds to its complementary sequence on the mRNA molecule. This allows amino acids to be connected in the order specified by the mRNA sequence.	• describes – the role of tRNA **[1 mark]** – the role of anticodons **[1 mark]** – tRNA-amino acid specificity **[1 mark]**

Q	Sample response	The response:
9c)	Transcription factors bind to sections of DNA near the gene being expressed and either promote or inhibit the binding of RNA polymerase. Epigenetic tags affect the degree of DNA coiling. Genes in sections of DNA that are tightly bound are usually not expressed because the enzymes involved in transciption can't access them.	• describes one way gene expression is regulated **[1 mark]** • describes a second way gene expression is regulated **[1 mark]**
9d)	Mutations may occur in non-coding sections of DNA (introns), meaning the resulting polypeptide will not be affected. Point mutations may not change the amino acid the triplet codes for, meaning the resulting polypeptide is unaffected (silent mutation).	• provides one reason **[1 mark]** • provides a second reason **[1 mark]**
10a)	Vertebrate biodiversity has increased over geological time. While the number of different classes has remained about the same in each era (7), the number of families has gradually increased from ~110 at the end of the Palaeozoic era to ~220 at the end of the Mesozoic era and ~610 in the Cenozoic era.	• identifies an appropriate trend **[1 mark]** • provides data to support response **[1 mark]**
10b)	Classes C and D became extinct during the Palaeozoic era.	• identifies C and D **[1 mark]** • identifies Palaeozoic era **[1 mark]**
10c)	Class G	• identifies G **[1 mark]**
11a)	Pioneer species will move into an area and either create or improve the soil by adding organic material through their own death and decay. This makes the landscape more hospitable, allowing new species to colonise the area, changing the community composition. The community composition continues to change over time until a climax community is established.	• describes – the role of pioneer species **[1 mark]** – changes in community composition **[1 mark]** – establishment of a climax community **[1 mark]**
11b)	Primary succession occurs in an environment with no previous life/soil, whereas secondary succession occurs in an area that has previously been inhabited but experienced a disturbance.	• identifies a distinguishing feature of primary and secondary succession **[1 mark]**

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