Biology marking guide and response

External assessment 2021

Combination response (92 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.

Allowing for FT error — 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 be awarded so long as it still demonstrates the correct conceptual understanding or skill in the rest of the response.

Marking guide

Paper 1: Multiple choice

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

Paper 1: Short response

Q	Sample response	The response:	Notes
21	The features used to classify living things change as you go from the broader taxonomic level to the more specific. Kingdom is the most extensive, so the features encompass the widest variety of organisms, with features such as cell type and structure. Through the middle taxa, features become more specific, with an emphasis on minor shared similarities such as fur, body shape and leaf shape. At the species level, features such as teeth structure, body size, behaviour and distribution may be used, as well as the more recent use of biochemical similarities.	· states that the Linnaean system - starts with broad taxa that have major similarities **[1 mark]** - has lower taxa that become more specific, with minor similarities **[1 mark]** · provides a relevant example for broad taxa **[1 mark]** · provides a relevant example for mid **OR** narrow taxa **[1 mark]**	Students are not required to name the taxa in their description. If students refer to Linnaeus's three domains of animal, vegetable and mineral, accept this if the response aligns with the marking guide. Other *relevant examples* may include: - cell configuration (multicellular, unicellular) - modes of nutrient acquisition (e.g. autotrophic, heterotrophic) - reproduction (sexual, asexual) - or other suitable response consistent with a reasonable understanding.
22	Atmospheric carbon exists mainly as carbon dioxide, which is transformed from carbon dioxide gas to produce glucose (and other complex organic molecules) via photosynthesis. This also covers the transfer from atmosphere to plants by diffusion. Respiration transforms glucose into carbon dioxide.	· states 1 transformation **[1 mark]** · states another transformation **[1 mark]** · states 1 transfer **[1 mark]**	*Transformations* may include: - atmospheric carbon exists as CO_2 and during photosynthesis transforms atmospheric carbon into organic molecules, e.g. glucose - respiration transforms organic molecules into CO_2 - in an organism, carbon is changed into different molecules, e.g. proteins, fats or nucleic acids - or other suitable response consistent with a reasonable understanding. *Transfers* may include: - consumption of § autotrophs by heterotrophs § heterotrophs by other heterotrophs - transferring carbon in organic molecules from one organism to another - decomposers absorbing dead organisms, transferring carbon in organic molecules - or other suitable response consistent with a reasonable understanding.

Q	Sample response	The response:	Notes
23a)	Quadrats did not cover salt marsh area but transects were placed throughout the different strata. Quadrats sampled a smaller area of 40 m^2 compared to a larger area of 300 m^2 for transects. Bias was removed in quadrat sampling method by using random sampling, but it wasn't for transects.	· identifies first difference **[1 mark]** · identifies second difference **[1 mark]** · identifies third difference **[1 mark]**	Relevant *differences* may include: - quadrats did not cover all strata but transects crossed different strata - quadrats sampled smaller area compared to larger area of 300 m^2 for transects - bias was removed in quadrat sampling method by using random sampling, although not in a uniform environment - the belt transects provide more data, e.g. showing how abundance of species changes in its range - transects would have taken longer to complete than quadrats - or other suitable response consistent with a reasonable understanding.
23b)	The belt transect was most the most suitable method as it identified more species.	· concludes that the transect method was most suitable **[1 mark]** · gives a reason **[1 mark]**	*Reasons* may include that the transect method: - identified more species - gave better coverage of strata - or other suitable response consistent with a reasonable understanding.
24a)	Producers à Primary consumers 10% Primary à Secondary consumers 5% The ecosystem shows a drop in efficiency of transfer of biomass from 10% to 5%.	· provides - for producers to primary consumers, 10% **[1 mark]** - for primary to secondary consumers, 5% **[1 mark]** · contrasts efficiency **[1 mark]**	*Contrasts* may include: - 50% reduction in efficiency - an efficiency reduction of 5% - efficiency was halved - or other suitable response consistent with a reasonable understanding.
24b)	As you move through to higher tropic levels, a higher proportion of the energy is lost to respiration and heat, and to decomposers. Overall, a smaller percentage is passed on to the next trophic level.	· states that higher trophic levels lose a higher proportion of their energy due to other processes **[1 mark]** · states at least one process **[1 mark]**	*Processes* may include: - respiration - metabolic heat - waste (faeces, dead matter) - or other suitable response consistent with a reasonable understanding.

<table>
<tr><th>Q</th><th>Sample response</th><th>The response:</th><th>Notes</th></tr>
<tr><td>25</td><td>The genotypes of the parents are I^Ai and I^Bi

Potential crosses<table><tr><td></td><td>I^A</td><td>i</td></tr><tr><td>I^B</td><td>I^AI^B</td><td>I^Bi</td></tr><tr><td>i</td><td>I^Ai</td><td>ii</td></tr></table>¼ type AB, ¼ type A, ¼ type B,
¼ type O</td><td>· identifies parents as I^Ai and I^Bi [1 mark]
· shows appropriate working [1 mark]
· states a consequentially correct frequency for each blood type [1 mark]</td><td>Appropriate working may be a Punnett square or other suitable combination method.
For frequency of each blood type:
- allow FT error from incorrect genotypes
- answers expressed as
§ common fractions, e.g. ¼
§ decimal fractions, e.g. 0.25
§ percentages, 25%
§ or other suitable response.</td></tr>
<tr><td>26a)</td><td>Phosphate, deoxyribose sugar and a nitrogenous base.</td><td>· states phosphate, sugar and a base [1 mark]</td><td>Students must provide all 3 components for 1 mark.</td></tr>
<tr><td>26b)</td><td>DNA samples are taken from two or more individuals and short sequences/STRs are identified and separated.
The short fragments of DNA are then amplified using polymerase chain reaction (PCR).
Results are compared by gel electrophoresis, so DNA similarities and differences between the samples and/or a known DNA profile can be determined.</td><td>· describes
- one step [1 mark]
- a second step [1 mark]
- a third step [1 mark]</td><td>For the steps, accept:
- DNA is taken from two or more individuals
- PCR is used for amplification
- gel electrophoresis is used for comparison
- or a suitable response consistent with a reasonable understanding.</td></tr>
<tr><td>27</td><td>The phylogenetic tree is correct. In order of percentage differences compared to A, D is 10% different across the three gene regions, C is 13% different and B is 24% different.</td><td>· determines that the tree is correct [1 mark]
· describes the order of percentage differences between species [1 mark]
· provides relevant data from the table [1 mark]</td><td>Relevant data includes determining percentage differences of other species to A.</td></tr>
<tr><td>28</td><td>Phase A: Population is low and resources are plentiful; maximum growth rate is observed; births consistently outnumber deaths.
Phase B: Birth and death rates become balanced as population reaches carrying capacity.</td><td>· refers to a feature of
- Phase A [1 mark]
- Phase B [1 mark]
- determines population growth model as logistic [1 mark]</td><td>Features of the curve are:
- at Phase A, maximum growth rate
- at Phase B, low or no population growth.</td></tr>
</table>

Q	Sample response	The response:	Notes
	Population growth model: logistic		For the *population growth model*, accept *logistic growth model* or *S-curve*.

Paper 2: Short response

Q	Sample response	The response:	Notes
1	An abiotic factor that would affect population would be temperature, because warmer water will evaporate faster, reducing the carrying capacity by limiting space. A biotic factor that would affect population would be food availability, because more food (e.g. algae or plankton) would result in a larger population of mosquito larvae.	· states a - relevant abiotic factor **[1 mark]** - relevant biotic factor **[1 mark]** · explains the effect of the identified - relevant abiotic factor **[1 mark]** - relevant biotic factor **[1 mark]**	*Abiotic factors* may include: - temperature - depth - oxygen availability - or other suitable response consistent with a reasonable understanding. *Biotic factors* may include: - food availability - competitors for food or space - or other suitable response consistent with a reasonable understanding. *Explanations* must identify how the relevant factors would increase or decrease the population.
2a)	Exons are sequences of coding DNA, which is transcribed into mRNA and then translated into proteins. Introns are sequences of non-coding DNA and have a variety of other functions. They are spliced out of the mRNA prior to translation.	· states that exons are coding DNA and introns are non-coding DNA **[1 mark]** · explains that exons are transcribed into mRNA and then translated into proteins**,** whereas introns are spliced out of mRNA and have other functions **[1 mark]**	For the *explanation*, accept other suitable responses consistent with a reasonable understanding.
2b)	Telomeres protect the ends of chromosomes from being degraded, prolonging their life.	· states a function of telomeres **[1 mark]**	*Functions of telomeres* are to: - protect the ends of chromosomes from being degraded - protect the ends of chromosomes from sticking to each other - lengthen the life of DNA by protecting chromosomes - or other suitable response consistent with a reasonable understanding.

Q	Sample response	The response:	Notes
3	Features that make these plants effective colonisers of dunes are that they grow rapidly, their seeds are dispersed by the wind and they are tolerant of the extreme heat and dryness of the environment.	· identifies first feature **[1 mark]** · identifies second feature **[1 mark]** · identifies third feature **[1 mark]**	*Features* include that the species: - photosynthesises - may be wind-pollinated and wind-dispersed (seeds) - produces many seeds - spreads through runners/asexually - can handle the environment, e.g. grass shoots that are flattened by wind, rain or animals are able to grow upright again Features only need to be identified, not explained.
4	Polymerase chain reaction is used to amplify (i.e. make many copies) of a DNA template because usually only a small amount of DNA is available for analysis. For example, crime scene DNA is sometimes found only at trace levels. PCR amplifies this small amount to allow analysis to be carried out.	· explains purpose of PCR as amplifying a DNA sample for further analysis **[1 mark]** · provides an example **[1 mark]**	*Examples* of PCR application may include: - crime scene analysis - diagnosis of infectious diseases - genetic testing - forensic research - or other suitable response consistent with a reasonable understanding.
5	Crossing over: When segments of maternal and paternal chromosomes are exchanged during the process of meiosis, resulting in chromosomes containing DNA from each parent — new genetic combinations are produced at the chromosome level. Independent assortment: Maternal and paternal chromosomes do not separate together; instead, each haploid gamete cell will contain a mixture of chromosomes from each parent, providing new genetic combinations.	· for crossing over - provides the name of the process **[1 mark]** - describes the process **[1 mark]** - states how the process contributes to genetic variation in gametes **[1 mark]** · for independent assortment - provides the name of the process **[1 mark]** - describes the process **[1 mark]** - states how the process contributes to genetic variation in gametes **[1 mark]**	For *crossing over*, accept: - crossing over and recombination - homologous recombination. A description of *crossing over* must include: - chromosomes are from parents - there is swapping of different sections of chromosomes/alleles/alternate genes - the newly recombined chromosomes now carry different allele combinations, e.g. carried AB and now carries aB or BA - these new combinations now go into the same gamete.

Q	Sample response	The response:	Notes
6	Two limitations are: 1. Sometimes only fossil evidence is available, so a species may be differentiated based on physiological and morphological features. 2. In some areas, hybridisation of plants and animals occurs, yet they are different species.	· states a limitation **[1 mark]** · states another limitation **[1 mark]**	*Limitations* may include: - species that reproduce asexually (e.g. bacteria) or through self-fertilisation - 'ring' species, where most interbreed, but not all with each other - ecology, behaviour, life cycle, sexual behaviour and genetic make-up can all contribute to the species concept - or other suitable response consistent with a reasonable understanding.
7	High genetic diversity may allow for some members of the population to survive diseases and later reproduce and pass on their resistance to increase the survivability of the population. However, inbreeding creates low genetic diversity, which makes koalas vulnerable to extinction due to disease.	· explains how genetic diversity can prevent extinction during rapid environmental change, e.g. disease **[1 mark]** · describes why koalas have low genetic diversity (inbreeding) **[1 mark]** · states that koalas are more vulnerable to extinction due to low genetic diversity **[1 mark]**	
8	This is allopatric speciation, where populations of the same species are separated by barriers (island-like distribution, exclusion by competitors, geographical barriers) meaning that no exchange of genetic material is possible and gene flow is halted. Over many generations, mutation, natural selection and genetic drift result in genetic and phenotypic divergence until a new species is formed.	· identifies the mode as allopatric speciation **[1 mark]** · describes two elements of allopatric speciation - cessation of gene flow due to a barrier between population groups **[1 mark]** - genetic drift over time until divergence **[1 mark]**	
9	Initial allelic frequencies were B 0.55 and b 0.45. Allelic frequencies after 20 generations were B 0.3 and b 0.7. B decreased (from 0.55 to 0.3) and b increased (from 0.45 to 0.7). This selection pressure was in favour of white rabbits as both genotype and allelic frequencies shifted toward the white phenotype and the white allele.	· provides the correct initial and final allele frequencies **[1 mark]** · identifies consequentially correct change in allele frequency **[1 mark]** · states a consequentially valid conclusion **[1 mark]**	Allow for FT error to contrast the change in allele frequency. Accept frequency calculations shown as decimals, percentages or fractions.

Q	Sample response	The response:	Notes
10	In eukaryotes, DNA occurs bound to histone proteins in chromosomes in the nucleus of eukaryotes or as unbound circular DNA in the mitochondria. It can also occur as unbound circular DNA in the cytosol of prokaryotic cells.	· describes one way DNA occurs in cells **[1 mark]** · describes a second way DNA occurs in cells **[1 mark]** · describes a third way DNA occurs in cells **[1 mark]**	*Ways DNA occurs in eukaryotes* are: - bound to histone proteins in chromosomes - in the membrane-bound nucleus - as unbound circular DNA in mitochondria - as unbound circular DNA in chloroplasts. *Ways DNA occurs in prokaryotes* are: - as unbound (exception being those species in the domain Archaea) circular DNA in the cytosol or linear or circular unbound chromosomes in the cytosol - supercoiled - mostly as a single chromosome, or single copy of the DNA. Both prokaryotes and eukaryotes contain double-stranded DNA.
11	Transcription factors either increase (activator) or decrease (repressor) the rate of transcription of a particular gene. For example, transcription factor A increases transcription for the intermediate cells to form, whereas it reduces the rate of or prevents compact bone formation.	· states that transcription factors can both increase and decrease transcription rates **[1 mark]** · provides a suitable example from the table **[1 mark]**	A *suitable example* demonstrates that transcription factors can both increase and decrease transcription rate, e.g. transcription factor B activates cartilage formation, whereas transcription factor C represses cartilage formation.

Q	Sample response	The response:	Notes
12a)	SDI = $1 - (\frac{7(7-1)+3(3-1)+88(88-1)}{98(98-1)})$ = 0.19	· shows substitution correctly performed **[1 mark]** · determines SDI = 0.19 **[1 mark]**	Accept *substitution* as: SDI = $1 - \left(\frac{7704}{98(98-1)}\right)$ or SDI = $1 - (\frac{7704}{9506})$
12b)	Area 2 has lower SDI than Area 1. While the communities' total populations are similar (94 to 98), Area 2 has a species that is dominant (Yellow mangroves) which causes the SDI in Area 2 to be much lower than Area 1.	· states a relevant similarity **[1 mark]** · states a relevant difference **[1 mark]** · states the significance of the identified differences **[1 mark]**	Allow FT error from Question 12a). *Relevant similarities* may include: - total population of the mangroves in each area - all 3 mangroves were present. - or other suitable response consistent with a reasonable understanding. *Relevant differences* may include: - Area 2 has lower SDI than Area 1 - Area 1 has a greater species evenness whereas Area 2 has a dominant species (Yellow Mangrove) - or other suitable response consistent with a reasonable understanding. *Relevant significances* may include: - the dominance of a species or lack of species evenness in Area 2 will reduce SDI - the difference in SDI between the two areas results in Area 1 having greater biodiversity - or other suitable response consistent with a reasonable understanding.

Q	Sample response	The response:	Notes
13	It is likely that no further ecological succession would occur — this appears to be a climax community as there is levelling in the biomass and biodiversity, a range of shrubs, trees and grasses with mature trees making up a large proportion of the community and the dominant species are K-selected (mature trees).	· predicts no further succession **[1 mark]** · provides a relevant reason **[1 mark]** · provides another relevant reason **[1 mark]**	*Reasons* are evidence of a climax community and may include: - no recent change in biomass - no recent change in species diversity - abundance of mature trees - K-selected species (i.e. mature trees) are becoming dominant - or other suitable response consistent with a reasonable understanding.