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Government of **Western Australia**
School Curriculum and Standards Authority

BIOLOGY

ATAR course examination 2024

Marking key

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

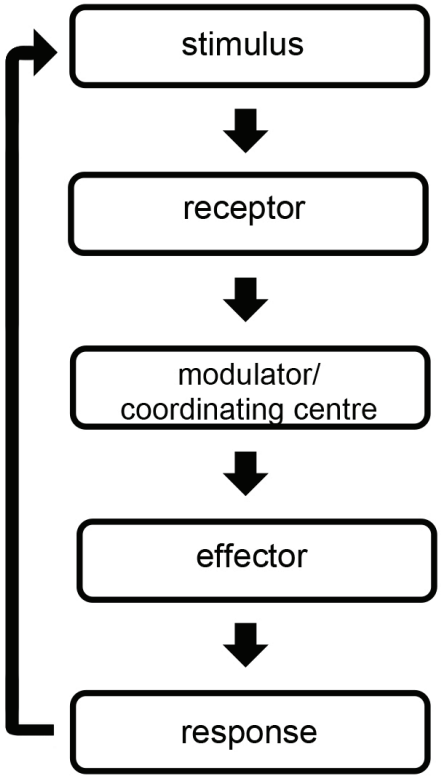
Section One: Multiple-choice **30% (30 Marks)**

Question	Answer
1	a
2	c
3	a
4	b
5	d
6	c
7	a
8	b
9	d
10	d
11	b
12	a
13	b
14	c
15	b
16	c
17	d
18	a
19	b
20	c
21	d
22	a
23	b
24	c
25	d
26	c
27	a
28	b
29	d
30	c

Section Two: Short answer **50% (100 Marks)**

Question 31 **(22 marks)**

(a) (i) A negative feedback loop has **five** main components. Construct a diagram that shows these components. Use arrows to show the flow of information among the components. (6 marks)



Description	Marks
stimulus	1
receptor	1
modulator/coordinating centre/processor/control	1
effector	1
response	1
correct flow of information (must include link between response and stimulus)	1
Total	**6**

(ii) State the defining feature of a negative feedback loop. (1 mark)

Description	Marks
response reduces stimulus	1
Total	**1**

Question 31 (continued)

(b) State the name of an infectious disease that disrupts homeostasis in the host, and identify the aspect of homeostasis that is disrupted by this disease. (2 marks)

Description	Marks
Any one of (1 x 2 marks)	
• chytridiomycosis/chytrid fungus disease salt-water balance or gas exchange • *Phytophthora*/jarrah dieback salt-water balance • influenza/malaria thermoregulation (must state a homeostatic mechanism, not just fever)	1–2
Total	**2**
Accept other relevant answers.	

(c) (i) State the type of nitrogenous waste excreted by penguins. (1 mark)

Description	Marks
uric acid	1
Total	**1**

(ii) State **one** advantage to penguins of excreting this type of nitrogenous waste. (1 mark)

Description	Marks
Any one of	
• uric acid requires little water to excrete • uric acid is insoluble in water or can be stored in eggs or can be stored for a long time	1
Total	**1**

(iii) State **one** disadvantage to penguins of excreting this type of nitrogenous waste. (1 mark)

Description	Marks
uric acid requires more energy to produce	1
Total	**1**

(d) Describe the main features of a counter-current heat exchange system. (5 marks)

Description	Marks
Any five of	
• warm blood in arteries flows to feet/extremities • cold blood from feet/extremities flows into body • arteries and veins are close together • heat is transferred from arteries to vein • heat is transferred by conduction • prevents warm blood entering feet/extremities	1–5
Total	**5**
Accept other relevant answers.	

(e) Explain how allopatric speciation could result in the evolution of a new penguin species on a new island. (5 marks)

Description	Marks
Any five of	
• some penguins colonise and breed on a new island • gene flow/migration between this and other islands is limited by distance or by large stretches of water or by geographical barrier • selection pressures or the environment differs between the new and other islands • there may be a founder effect if the new island is colonised by a small number of individuals or novel mutations/changes due to genetic drift may occur on the new island • genetic differences accumulate between the population on the new island and other islands • (eventually) penguins on the new island can no longer interbreed and produce fertile offspring with penguins on the other islands	1–5
Total	**5**
Accept other relevant answers.	

Question 32 **(20 marks)**

(a) Compare the banding patterns of snakes between mainland and island sites. Include a specific data quote in your answer. (4 marks)

Description	Marks
banded snakes are common at mainland sites or are rare on islands	1
unbanded snakes are common on islands or are rare at mainland sites	1
intermediate snakes are also common on islands or are also rare at mainland sites	1
data quote (must include type of snake, site and percentage) e.g. 100% of snakes at mainland site 1 were banded	1
Total	**4**
Accept other relevant answers.	

(b) (i) State **one** similarity between natural selection and genetic drift. (1 mark)

Description	Marks
both change allele frequencies or are micro-evolutionary forces	1
Total	**1**

(ii) Identify **two** differences between natural selection and genetic drift. (4 marks)

Description	Marks
Difference one	
natural selection causes adaptive changes	1
genetic drift causes random changes	1
Subtotal	**2**
Difference two	
genetic drift is more important in small populations	1
natural selection is more important in large populations or is important in both small and large populations	1
Subtotal	**2**
Total	**4**
Accept other relevant answers.	

(c) (i) Define 'gene flow'. (1 mark)

Description	Marks
exchange of genes/alleles/genetic information between two populations or the introduction of genes/alleles/genetic information from one population to another	1
Total	**1**

(ii) State how gene flow influences allele frequencies within a population. (1 mark)

Description	Marks
introduces new alleles (within a population) or increases diversity or decreases frequency of pre-existing alleles	1
Total	**1**

(iii) State how gene flow influences allele frequencies between populations. (1 mark)

Description	Marks
reduces genetic differences between populations (exchanging genes) or makes allele frequencies in different populations similar	1
Total	**1**

(d) Explain how a founder effect could contribute to the allele frequency differences between a mainland and an island population of this snake. (4 marks)

Description	Marks
small number of individuals colonise an island	1
allele frequencies in these individuals are not representative of mainland/original population	1
because the number of individuals is small or due to random/chance deviations	1
allele frequencies in the island population reflect those of founders (rather than those of mainland)	1
Total	**4**

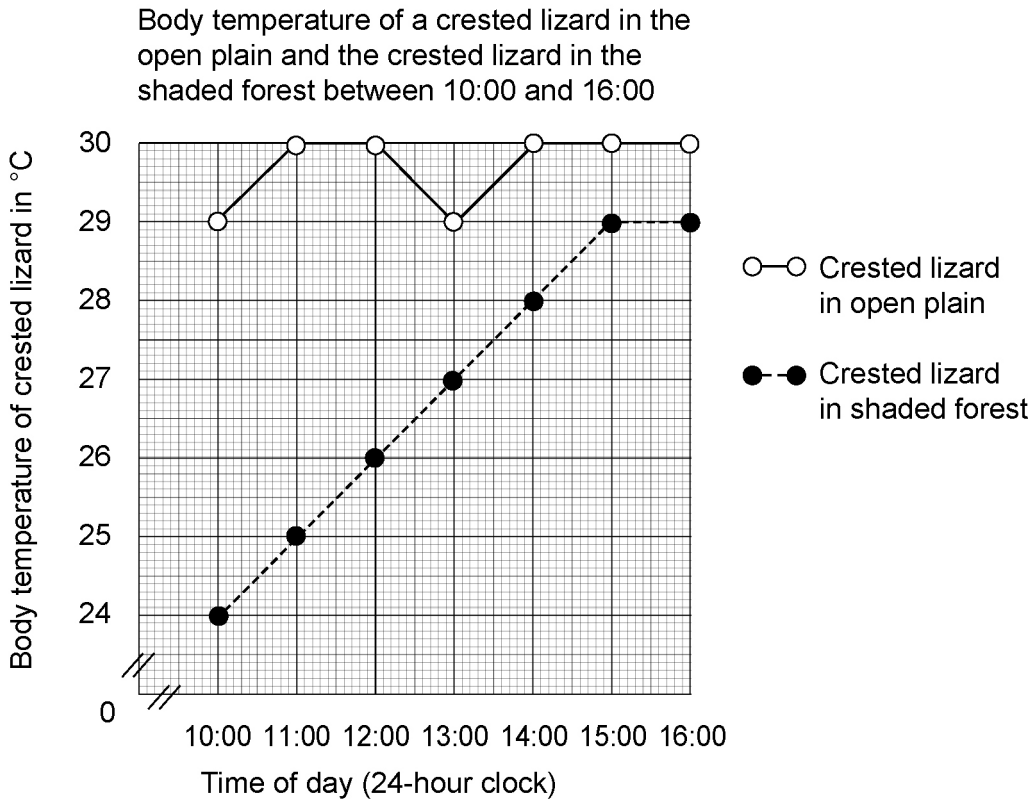
(e) Describe how biotechnology could be used to determine the amount of genetic diversity in a population. (4 marks)

Description	Marks
Any four of	
• DNA profiling/DNA sequencing • collect snake samples or extract DNA from snake samples • use PCR/STRs/gel electrophoresis/restriction enzymes • compare profiles/fragments of multiple individuals • estimate number of alleles/genetic variants or amount of genetic differences/variation (this point must give some indication of what constitutes genetic diversity)	1–4
Total	**4**
Accept other relevant answers.	

Question 33 **(21 marks)**

(a) Graph the relationship between time of day and the body temperature of the crested lizard in the shaded forest and the crested lizard in the open plain. (6 marks)

Description	Marks
title, must include comment on body temperature, environment and time	1
data plotted separately for forest and plain, with key	1
correct axes (X and Y)	1
accurate labelling of both axes, with units	1
appropriate scale	1
data accurately plotted and joined	1
Total	**6**



(b) (i) Calculate the mean body temperature of the crested lizard in the shaded forest during the study. (1 mark)

Description	Marks
26.86 °C or 26.9 °C or 27 °C (must include units)	1
Total	**1**

(ii) Calculate the median body temperature of the crested lizard in the open plain during the study. (1 mark)

Description	Marks
30 °C (must include units)	1
Total	**1**

(iii) State the range in body temperature of the crested lizard in the shaded forest during the study. (1 mark)

Description	Marks
24 °C to 29 °C *(*must include units)	1
Total	**1**
Note: student response must include both temperatures; do not accept 5 °C on its own.	

(iv) State the time/s with the greatest temperature difference between the two lizards. (1 mark)

Description	Marks
10:00 and 11:00 (must include both)	1
Total	**1**

(c) State whether you can use the graph to accurately estimate the body temperature of the crested lizard in the open plain at time 24:00. Justify your answer. (3 marks)

Description	Marks
no	1
this is an extrapolation/there is too much time outside the graph	1
the graph does not show environmental temperature/weather changes with time/during a day or 24:00 is at night and there is no sun	1
Total	**3**

(d) Explain why the body temperature of the crested lizard in the open plain is consistently higher than the crested lizard in the shaded forest. (4 marks)

Description	Marks
lizards are ectothermic	1
rely on external heat sources (rather than metabolic heat)	1
in open plain, lizards have opportunity to bask in sun/lie on ground warmed by sun	1
in shaded forest, reduced chances of finding sunny area/ground warmed by sun	1
Total	**4**
Accept other relevant answers.	

(e) Explain why it would be an improvement to measure more than one lizard at each location. (4 marks)

Description	Marks
improve reliability	1
reduce the chance of random event/outlier influencing results	1
measured lizard may be atypical	1
lizards vary in age/size/condition/behaviour/physiology/factors that influence the results	1
Total	**4**
Accept other relevant answers.	

Question 34 **(17 marks)**

(a) (i) Identify a male in the pedigree that shows the disorder. (1 mark)

Description	Marks
II-3 or II-8 or III-7 or IV-4	1
Total	**1**

(ii) Identify a female in the pedigree that is not a descendant of individual I-2. (1 mark)

Description	Marks
I-1 or III-8	1
Total	**1**

(b) State whether the disorder is caused by a recessive or dominant allele. Justify your answer, with reference to specific individuals in the pedigree. (3 marks)

Description	Marks
recessive	1
individuals I-1 and I-2 do not have disease	1
two of their offspring (II-3 and II-8) have the disease	1
Total	**3**
Accept other relevant example.	

(c) State whether the disorder is more likely to be caused by alleles at an X linked or autosomal gene. Justify your answer. (2 marks)

Description	Marks
Any one of (1 x 2 marks)	
• X linked only males are affected/more common in males • impossible to tell from pedigree all outcomes in pedigree are possible for both an X linked and autosomal recessive disorder	1–2
Total	**2**

(d) Two roan coloured Cocker Spaniels are crossed and the offspring include white, black and roan puppies. State the probability of producing a roan puppy. Use an annotated Punnett square to show your workings. (6 marks)

Description	Marks
0.50 or 50%	1
Punnett square with appropriate key	1
Shows genotypes of both parents	1
Shows gametes of both parents	1
Shows genotypes of four offspring	1
Shows phenotypes of four offspring	1
Total	**6**

B1 = black allele
B2 = white allele

Both parents are heterozygotes B1B2

	B1	B2
B1	B1B1 (black)	B1B2 (roan)
B2	B2B1 (roan)	B2B2 (white)

Note: Accept other allele labelling.

(e) Identify **three** characteristics of a 'polygenic trait' and state a specific example of a polygenic trait. (4 marks)

Description	Marks
trait controlled by many genes	1
also influenced by the environment	1
many different phenotypes	1
height/weight/other relevant example	1
Total	**4**

Question 35 **(20 marks)**

(a) (i) State the major group of organisms to which the *Phytophthora* dieback pathogen belongs. (1 mark)

Description	Marks
Protista/Oomycota	1
Total	**1**

(ii) Identify **two** major structural characteristics of the pathogen that causes *Phytophthora* dieback. (2 marks)

Description	Marks
Any two of	
• eukaryotic cells or has nucleus or has mitochondria or has membrane-bound organelles • cellulose cell wall • fine filaments or hyphae (without cross walls)	1–2
Total	**2**

(b) (i) List **two** symptoms of *Phytophthora* dieback. (2 marks)

Description	Marks
Any two of	
• plant wilts • leaves drop or discolour or curl • root rot • cankers on stem • branches die or plant dies • stunted growth	1–2
Total	**2**
Accept other relevant answers.	

(ii) Describe how the *Phytophthora* dieback pathogen causes disease. (3 marks)

Description	Marks
Any three of	
• pathogen invades plant cells • draws nutrients from plant cells • kills plant cells • stops transport of water/sugar or blocks/damages vascular tissue	1–3
Total	**3**

(c) Explain how humans spread *Phytophthora* dieback disease. (4 marks)

Description	Marks
• transmitted via (mobile) spores/zoospores found in soil • human activity e.g. humans drive in an area and collect soil/spores on vehicle tyres or humans walk in area and collect soil/spores on shoes/clothes or other relevant example • the soil/spores are then taken to another area • potentially transport via infected plants	1–4
Total	**4**

(d) State the treatment code numbers corresponding to the **two** controls and describe the function of each control. (4 marks)

Description	Marks
Control one	
Treatment code 1	1
measures mortality/survivorship of seedlings in the absence of pathogen and chemicals	1
Subtotal	**2**
Control two	
Treatment code 2	1
measures mortality/survivorship of seedlings when they are infected with pathogen but not treated with any chemical	1
Subtotal	**2**
Total	**4**

(e) (i) Based on the experimental results, recommend a treatment for the *Phytophthora* dieback pathogen in avocados and justify your answer with reference to the data. (2 marks)

Description	Marks
Treatment code 6/oxathiapiprolin	1
92% (46) seedlings survived for one month, more than any other treatment/similar to the uninfected control	1
Total	**2**

(ii) State whether the treatment you recommended for *Phytophthora* dieback in avocado orchards would also be suitable for natural ecosystems. Justify your answer. (2 marks)

Description	Marks
No or extrapolates beyond data	1
would need to conduct trials with native species/natural ecosystem to know if it was suitable	1
Total	**2**

Section Three: Extended answer **20% (40 Marks)**

Unit 3

Question 36 **(20 marks)**

(a) Describe the roles of DNA, messenger RNA (mRNA) and transfer RNA (tRNA) in protein synthesis. (10 marks)

Description	Marks
Any ten of	
• DNA contains genes or genetic code or genetic information • mRNA is produced from DNA • genetic information/code is transferred to mRNA • using complementary base pairing • conversion of DNA to mRNA is called transcription • mRNA molecule transfers genetic information/code (from nucleus) to cytoplasm • mRNA forms complex with ribosomes • tRNA carries amino acids to ribosome/mRNA • tRNA ensures correct amino acid is added to growing protein chain • one end of tRNA molecule carries a specific amino acid (determined by anticodon) • other end of the tRNA molecule (anticodon) binds with complementary mRNA codon • amino acid on the tRNA is transferred to protein chain • different tRNAs add different amino acids • the conversion of mRNA to a protein is called translation	1–10
Total	**10**

(b) Describe **four** characteristics of the oldest known life forms and explain how the fossil record and comparative genomics have helped to determine the characteristics of early life forms. (10 marks)

Description	Marks
Characteristics: any four of	
• a type of bacteria/archaea/cyanobacteria • consists of single cells • prokaryotes or without nucleus/membrane-bound organelles • anaerobic/lived without oxygen • aquatic/marine habitats • ancient/3.5 billion years old	1–4
Subtotal	**4**
Fossil record: any three of	
• preserved remains/traces of organisms • show morphological characteristics (of organisms) • obtain evidence of age/habitat • from type/location of rock	1–3
Subtotal	**3**
Comparative genomics: any three of	
• comparison of genomes/DNA/genes of different species • collect DNA/genes/molecular data from a broad range of organisms/bacteria/micro-organisms/fossils • identify conserved sequences/genes/parts of the genome • use conserved sequences to determine genetic characteristics of early life forms • construct phylogenetic tree • use tree to identify early life forms/close relatives of early life forms • assume early life forms have similar characteristics to closest living relatives	1–3
Subtotal	**3**
Total	**10**

Question 37 **(20 marks)**

(a) Describe how artificial selection can be used to produce a crop variety with desirable characteristics and **three** advantages and **three** disadvantages of using artificial selection to produce a new crop variety. (10 marks)

Description	Marks
Process of artificial selection: any four of	
• selective breeding/intentional reproduction of individuals with desired characteristic/desired traits selected by humans • individuals pass alleles/genes (for characteristic) to offspring • frequency of alleles/genes producing desired trait increases in the next generation • process repeated over many generations • alleles/genes/characteristics become common or eventually all individuals show characteristics	1–4
Subtotal	**4**
Advantages: any three of	
• natural process/mimics natural selection/ only use alleles/genes already present in species • low risk of unexpected environmental impacts or low risk of producing superweed or impacting non-target organisms • does not require (much) specialist equipment/knowledge • long history so well understood/socially acceptable	1–3
Subtotal	**3**
Disadvantages: any three of	
• response/change may be limited because only using genes/alleles already present in species • can take a long time/many generations to bring about change • can increase inbreeding or decrease genetic diversity • can result in undesirable changes in other characteristics	1–3
Subtotal	**3**
Total	**10**
Accept other relevant answers.	
Note: advantages and disadvantages should refer to the process and not the outcome.	

(b) Explain the **two** main ways in which the process of meiosis results in variation in genotypes. (10 marks)

Description	Marks
Crossing-over: any five of	
• crossing-over • exchange of alleles/DNA • between non-sister chromatids • in a homologous pair • occurs during meiosis I/prophase I • results in chromosomes with new combinations of alleles	1–5
Subtotal	**5**
Independent assortment: any five of	
• random/independent assortment • occurs during meiosis I/metaphase I/anaphase I • when homologous chromosomes randomly orientate during metaphase I/in centre of cell or when homologous chromosomes randomly segregate/separate • maternal and paternal chromosomes in a set move to different poles at random • different sets of homologous chromosomes move independently of each other • each pole/gamete ends up with a novel combination of maternal and paternal chromosomes	1–5
Subtotal	**5**
Total	**10**

Question 38 **(20 marks)**

(a) Explain why plants lose water to the environment during gas exchange and **three** distinctly different ways in which xerophytic plants minimise water loss from gas exchange. (10 marks)

Description	Marks
Water loss during gas exchange	
gas exchange occurs through (open) stomata or plants release oxygen/take in carbon dioxide through (open) stomata	1
stomata are pores in the leaf (that are surrounded by guard cells)	1
water/water vapour is lost from plant when stomata are open	1
via transpiration or evaporation	1
Subtotal	**4**
Minimising water loss: any three of (3 x 2 marks)	
Either • fewer stomata or reduced size of stomata • fewer openings/smaller area to lose water through or • sunken stomata or hairs in stomatal pit or leaves are rolled • increases humidity around stomatal pore or creates humid microclimate or • stomata open at night or stomata close during the day • stomata are open when temperatures are lower or are closed when temperatures are higher or • less stomata on upper surface or more stomata on lower surface or leaves are rolled • protects stomata from environment/wind/direct sunlight	1–6
Subtotal	**6**
Total	**10**

(b) Using influenza as an example, explain why urban areas are susceptible to epidemics and how vaccination and **three** other healthcare provisions can reduce disease transmission. (10 marks)

Description	Marks
Urban areas: any four of	
• influenza is easily spread or transmitted via direct contact or airborne particles • urban areas have high population density • increases disease/influenza transmission • uninfected people are more likely to come into contact with an infected person • increased travel/migration to urban areas increases the chance of introducing a new strain (little resistance in population)	1–4
Subtotal	**4**
Vaccinations	
vaccines give people immunity (without catching the disease)	1
reduces the chances of an individual catching the disease (even if they are in contact with an infected individual)	1
spread of disease will slow/transmission will be reduced if a large proportion of the population are vaccinated/immune/with herd immunity	1
Subtotal	**3**
Other healthcare provisions: any three of	
• education/advice about good hygiene/mask wearing/hand washing • can implement isolation/quarantine of infected people • antiviral medication to reduce severity/duration of symptoms • monitoring/reporting can result in early detection/early implementation of control measures	3
Subtotal	**3**
Total	**10**

Question 39 **(20 marks)**

(a) For crown gall disease, explain how the pathogen invades the host and causes disease, and **two** distinctly different management strategies to prevent the spread of the disease. (10 marks)

Description	Marks
How the pathogen invades the host and causes disease	
• bacterium/pathogen invades the plant through a wound • inserts plasmid into host genome • causes rapid division of host cells • causes galls (where the roots join the trunk, on the roots, or on the main stem or branches) • galls disrupt water transport • reduces ability of plants to resist stressful conditions such as drought	1–6
Subtotal	**6**
Management strategies: any two of (2 x 2 marks)	
Either • do not damage the plants or clean tools/equipment • to stop the transfer of bacteria/pathogen from one plant to another or • destroy infected plants or apply chemical/biological controls • to kill/reduce the number of bacteria in the soil/environment or • apply biosecurity measures at borders or inspect any imported plants/soil or quarantine infected plants/soils • to contain the disease to a certain area or stop the introduction of disease to a new area or • educate people/increase public awareness • so people can recognise disease and act quickly or know about control measures	1–4
Subtotal	**4**
Total	**10**

(b) Explain what would happen to a desert mammal if it drank saltwater and explain **one** physiological and **one** behavioural adaptation that desert mammals use to maintain water-salt balance. State which adaption is physiological and which is behavioural.

(10 marks)

Description	Marks
Effects of drinking salt water: any four of	
• disrupts homeostasis/osmoregulation/osmosis • body fluids will have too much salt/hypertonic to cells or cells will be hypotonic to body fluids • cells will lose water to body fluids (by osmosis) • cells will shrink/wrinkle/dehydrate • lack of water/high concentration of solutes will disrupt metabolic processes	1–4
Subtotal	**4**
Explanation of physiological adaptations:	
States a physiological adaptation	1
Either • gains water from food metabolism • breakdown of fat/carbohydrates produces water or • produce hormone/vasopressin/antidiuretic • promotes reabsorption of water by kidney	1–2
Subtotal	**3**
Explanation of behavioural adaptations:	
States a behavioural adaptation	1
Either • nocturnal/active at night • when temperatures are lower to minimise water loss by evaporation or • burrow • creates humid microclimate or allows animal to avoid very high temperatures to minimise water loss by evaporation	1–2
Subtotal	**3**
Total	**10**
Accept other relevant answers.	

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