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

BIOLOGY

ATAR course examination 2022

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

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

Question 31 **(20 marks)**

(a) (i) Approximately when did life first evolve on Earth? (1 mark)

Description	Marks
approximately 3.5 billion years ago (accept between 3 to 4 billion years ago)	1
Total	**1**

(ii) List **three** structural properties of an RNA molecule. (3 marks)

Description	Marks
Any three of	
• type of nucleic acid • contains ribose sugar • phosphate group • made up of nucleotides/nitrogenous bases/contains C, G, A and U bases • single stranded molecule	1–3
Total	**3**

(b) (i) Define the term ‘genetic code’. (1 mark)

Description	Marks
Any one of	
• set of rules that determine how genetic information/nucleotide sequences/codons in DNA/RNA is translated into amino acids/determines amino acids in a protein • how information in DNA/RNA is converted into a protein • base triplet code that determines amino acids in a protein	1
Total	**1**

(ii) Outline how the fact that all living organisms use essentially the same genetic code provides evidence for evolution. (2 marks)

Description	Marks
Organisms inherit genetic code from their ancestors.	1
All organisms can be traced back to a single ancestor.	1
Total	**2**

Question 31 (continued)

(c) State the role that each of the following plays in protein synthesis. (5 marks)

Description	Marks
RNA polymerase: (enzyme that) catalyses the synthesis of mRNA from DNA **or** adds nucleotides to mRNA molecule **or** binds to DNA (to initiate transcription) **or** unwinds DNA (to gain access to DNA sequence) **or** other specific action of RNA polymerase	1
Transcription: process of making a mRNA copy of a DNA/gene sequence	1
Anticodon: (three) nucleotides in tRNA that is complementary to codon in mRNA **or** (three) nucleotides in tRNA that bind to mRNA **or** that determine which amino acid tRNA carries	1
Ribosome: reads the mRNA/site of protein synthesis/performs translation/links amino acids (in correct order)	1
Amino acid: amino acids are the building blocks of protein/polypeptide **or** sequence of amino acids determine type of protein	1
Total	**5**

(d) (i) Define the term 'mutation'. (1 mark)

Description	Marks
A permanent change in DNA/a gene/a chromosome.	1
Total	**1**

(ii) List **three** distinctly different causes of mutation. (3 marks)

Description	Marks
Any three of	
• errors in DNA replication • errors in cell division • mutagens/environmental factors • physical mutagen/ chemical mutagen/or specific example of a mutagen • biological factors/viruses	1–3
Total	**3**

(e) Explain the role that mutation has played in diversifying life on Earth. (4 marks)

Description	Marks
Any four of	
• mutation is source of genetic variation or of all new alleles/new genes • these are the basis of differences among organisms • mutations have accumulated over time • differences among organisms/the diversity of organisms have increased over time • without mutation all organisms would be the same (except for environmental differences)	1–4
Total	**4**

Question 32 **(19 marks)**

(a) Outline **two** main ways in which rodents that live in deserts lose water to the environment. (4 marks)

Description	Marks
Any two of (2 x 2 marks)	
• breathing/exhaling/panting and evaporation of moisture from lungs • excretion/urination/expelling waste/defaecation and water is needed to excrete urea/urine or to expel faeces/waste • sweat glands/sweating and evaporation of water from skin	1–4
Total	**4**

(b) Calculate kidney mass as a percentage of body mass for *Peromyscus leucopus*. Show your workings. (4 marks)

Description	Marks
0.433	1
0.027 × 1000 (to convert kg to g) or 0.117 ÷ 1000 (to convert g to kg)	1
0.117 ÷ 27 or 0.000117 ÷ 0.027	1
0.0043 × 100 (to convert to percentage) or (0.117 ÷ 0.027) × (100 ÷ 1000) or (0.117 ÷ 0.027) × 0.1	1
Total	**4**

(c) Kidney mass as a percentage of body mass is often higher in rodents that live in deserts than in related species that live in moist environments. Explain why. (4 marks)

Description	Marks
Any four of	
• desert rodents need to minimise water loss **or** rodents in moist environments do not need to minimise water loss • the kidney is used to maintain salt-water balance/control the amount of water excreted/reabsorb water • (in desert rodents) large amounts of water are reabsorbed/recovered from urine **or** urine is highly concentrated • larger kidney size gives larger area for water reabsorption or the Loop of Henle is longer in (some) desert rodents • the Loop of Henle (is the part of the kidney that) recovers the water	1–4
Total	**4**

Question 32 (continued)

(d) The hornbill is a type of desert bird noted for having a very large beak with a rich supply of blood vessels. Explain how such a beak can aid the hornbill in regulating its body temperature. (4 marks)

Description	Marks
Any four of	
• heat transfer/loss with the environment can occur via the beak • (rich supply of blood vessels) so a lot of blood moves through the beak • (beak is large) so there is a large area in contact with the environment/air **or** there is a large area over which heat can be lost/transferred • blood vessels bring warm blood (from the core of the body) to the beak • heat is lost to the environment by convection/conduction/radiation (if the environment is cooler than the blood) • can constrict blood vessels to minimise blood flow/heat loss **or** can dilate blood vessels to maximise blood flow/heat loss	1–4
Total	**4**

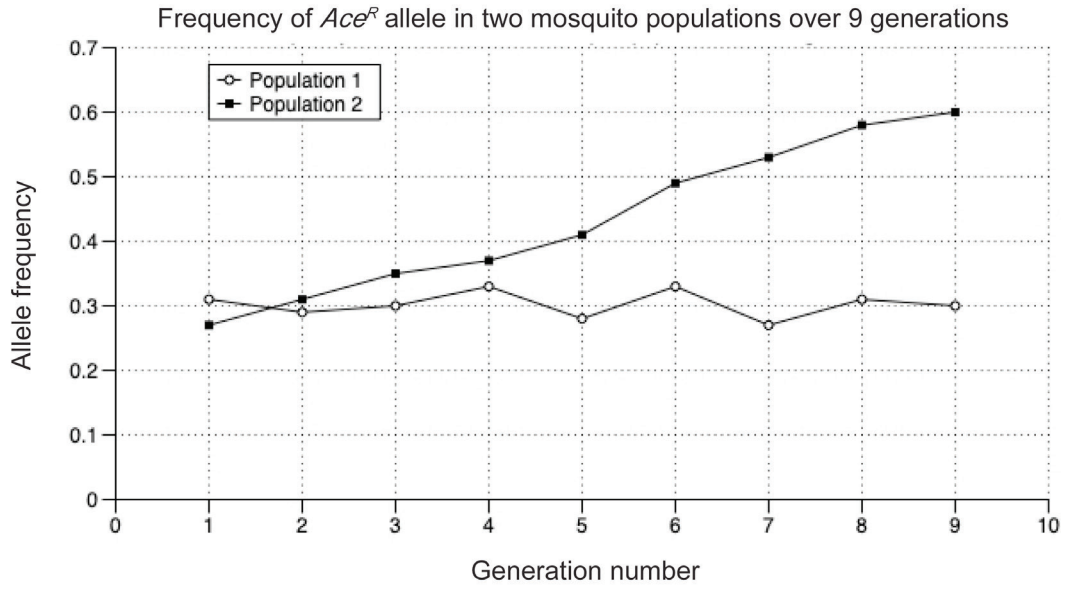
(e) The body temperature of desert birds is typically around 5 °C higher than that of desert rodents. This gives the birds an advantage over the rodents in losing heat to the environment via radiation. Explain why. (3 marks)

Description	Marks
Heat moves from a higher to a lower temperature **or** there is a net transfer of heat from a higher to a lower temperature.	1
(Birds/rodents/animals can lose heat to environment/air/surroundings) when their body temperature is higher than the environment/air/surroundings.	1
the birds can lose heat at a hotter temperature/over a broader range of temperatures than the rodents **or** the converse/at a faster rate.	1
Total	**3**

Question 33 **(20 marks)**

(a) Graph the frequency of the *Ace*^{R} allele for both Populations 1 and 2 against generation number. (6 marks)

Description	Marks
title must include both variables	1
data plotted separately for populations 1 and 2 including key	1
correct axes (X and Y)	1
appropriate scale	1
labelling – accurate labelling on both axes	1
plotting – data plotted accurately and joined (line graph)	1
Total	**6**



(b) (i) Define the term 'gene pool'. (1 mark)

Description	Marks
all of the genetic information/genes/alleles in a population/species	1
Total	**1**

(ii) Define the term 'allele'. (1 mark)

Description	Marks
a form/version of a gene	1
Total	**1**

(iii) State whether the allele frequency changes in the mosquito populations are an example of macroevolution. Provide a reason to support your answer. (3 marks)

Description	Marks
Clearly states no.	1
Macroevolution refers to large scale changes or changes above the species level.	1
The changes (in the mosquito populations) are small scale or occurring below the species level or the (mosquito) populations are undergoing microevolution (not macroevolution).	1
Total	**3**

Question 33 (continued)

(c) Propose an explanation for the increase in the frequency of the *Ace*^{R} allele in Population 2 during the study. (5 marks)

Description	Marks
Natural selection/selective pressure of insecticide	1
Subtotal	**1**
Any four of	
Either • the *Ace*^{R} allele gives resistance to the insecticide • individuals with *Ace*^{R} allele survive/reproduce/are fitter/produce more offspring • the *Ace*^{R} allele is passed to offspring/inherited • more individuals in the next generation have *Ace*^{R} allele • process is repeated over multiple/10 generations leading to progressive increase in frequency of the *Ace*^{R} allele or • progressive increase in frequency of the *Ace*^{R} allele, which is characteristics of natural selection • unlikely to be due to genetic drift because the frequency of the *Ace*^{R} allele does not change at random • unlikely to be to due mutation because the frequency *Ace*^{R} allele does not change at random • because the allele frequency change is too fast/large to be explained by mutation (which changes allele frequencies slowly) • could only be gene flow if individuals were coming from a population with a high frequency *Ace*^{R} allele	1–4
Subtotal	**4**
Total	**5**

(d) The Australian Government's biosecurity agency deploys insect traps around airports and other ports of entry into Australia. Explain why. (4 marks)

Description	Marks
To detect/capture exotic/non-native insects or mosquitos.	1
Subtotal	**1**
Any three of	
• before they have a chance to spread/become established (in Australia) • (if not stopped) insects/mosquitoes could introduce new disease or contribute to the spread of existing diseases • could damage crops or some insects are crop pests • could displace native species or disrupt natural ecosystems or become an invasive species	1–3
Subtotal	**3**
Total	**4**

Question 34 **(20 marks)**

(a) (i) Distinguish between a dominant and a recessive allele. (2 marks)

Description	Marks
dominant – only one copy of allele is needed for an individual to show phenotype or heterozygote will show phenotype	1
recessive – two copies of allele are needed for an individual to show phenotype or only recessive homozygote will show phenotype or can be masked by a dominant allele	1
Total	**2**

(ii) Distinguish between autosomal and sex-linked alleles. (2 marks)

Description	Marks
autosomal – alleles are on autosomal chromosomes or alleles are not on sex chromosomes or two alleles are present in both males and females	1
sex linked – alleles are on sex chromosomes or X/Y chromosome or two alleles are present in females and only one is present in males	1
Total	**2**

Two white sheep are mated. They produce offspring with white fleece and with black fleece.

(b) Calculate the probability of these sheep producing an offspring with black fleece. Explain your answer. (5 marks)

Description	Marks
0.25/25%/1 in 4	1
Both parents must be heterozygotes or *Tt* (to produce black sheep) or both will produce gametes with *T* and with *t* allele (in equal proportions)	1
Must use specified notation for alleles (T,t).	1
Black offspring must have *tt* genotype (because black fleece is recessive).	1
Only one in four offspring will have *tt* genotype or three in four offspring will have one copy of *T*/dominant allele.	1
Total	**5**
Can use a fully annotated punnett square.	

Question 34 (continued)

(c) Spider lamb syndrome (SLS) is an inherited condition in sheep. Affected animals have abnormal spines and long, often splayed (spread out) legs. SLS is caused by a recessive SLS allele at an autosomal gene. Outline an approach that can be used to determine whether an unaffected individual has the SLS allele without breeding the sheep. (5 marks)

Description	Marks
DNA sequencing or (comparative) genomics	1
determine nucleotide sequence	1
compare genomes/DNA sequences of affected and unaffected sheep	1
Subtotal	**3**
Any two of	
• take samples from affected and unaffected sheep • extract DNA • use PCR/restriction enzymes/gel electrophoresis	1–2
Subtotal	**2**
Total	**5**

(d) Body size in sheep is a polygenic trait. Explain what a polygenic trait is. (3 marks)

Description	Marks
controlled/influenced by the alleles at many genes/by many genes	1
also influenced by the environment	1
trait shows many different phenotypes in a population or trait shows continuous variation/a normal distribution in a population	1
Total	**3**

(e) A group of biologists want to produce a line of sheep with increased resistance to fleece rot. They could do this either by artificial selection or by transgenesis. Outline **one** advantage and **one** disadvantage of producing this line of sheep by artificial selection rather than transgenesis. (4 marks)

Description	Marks
Advantage	
• (breeding sheep is a) natural process • can be done on farm/does not require specialist equipment/less controversial	1–2
Subtotal	**2**
Disadvantage	
Either • artificial selection changes allele/gene frequencies gradually • slower process or will take many generations to produce desired line or • artificial selection relies on alleles/genes/variation already present in sheep • less effective than using a (targeted) gene from another type of organism.	1–2
Subtotal	**2**
Total	**4**

Question 35 **(20 marks)**

(a) (i) State the type of pathogen that causes chytridiomycosis. (1 mark)

Description	Marks
(Chytrid) fungus/*Batrachochytrium*	1
Total	**1**

(ii) Chytridiomycosis disrupts homeostasis in the frog host. Define 'homeostasis'. (1 mark)

Description	Marks
The process organisms use to maintain constant internal conditions or ability to maintain stable internal conditions/state.	1
Total	**1**

(iii) State the aspect of homeostasis in the frog host that is disrupted by chytridiomycosis. (1 mark)

Description	Marks
salt-water balance/water balance/salt balance/osmosis/ gas exchange	1
Total	**1**

(b) Outline how chytridiomycosis is transmitted between frogs. (3 marks)

Description	Marks
Any three of	
• pathogen/fungi/zoosporangia release spores/zoospores (into environment/water) • spores/zoospores are motile/swim/transported by water to new frog • by direct/skin contact between frogs • (spore/zoospores) invade skin/epidermal cells of new frog.	1–3
Total	**3**

Question 35 (continued)

(c) (i) State a hypothesis for the experiment. (1 mark)

Description	Marks
The survival rate is the same/different for the two frog species after inoculation with/exposure to the (chytridiomycosis) pathogen.	1
Total	**1**
Hypothesis must be written as statement, not a prediction.	

(ii) On the basis of the results of the experiment, which frog species is most susceptible to chytridiomycosis? Justify your answer. (4 marks)

Description	Marks
Litoria aurea/*L. aurea*	1
Any three of	
• individuals of *L. aurea* that were exposed to the pathogen/in the treatment tanks did not survive • (most) individuals of *L. aurea* that were not exposed to the pathogen/in the control tanks did survive • individuals of *L. peroni* (usually) survived whether they were exposed to pathogen/in control or treatment tanks • accurate quote of data – must include species, treatment and percentage alive	1–3
Total	**4**

(d) (i) Distinguish between the reliability and validity of an experiment. (2 marks)

Description	Marks
Reliability is the chances of getting the same/similar result (if the experiment was to be repeated).	1
Validity is when the experiment tests the hypothesis/what is intended to be tested.	1
Total	**2**

(ii) List **three** distinctly different factors in the frog-chytridiomycosis experiment on page 23 that would be needed to ensure that the results were valid. (3 marks)

Description	Marks
Any three of	
• tanks – same environment/conditions/temperature/size/lighting • food – same type/amount/timing • frogs – same size/age/number/condition/prior environment • fungus – same amount/type/method of inoculation between species • handling – frogs in control inoculated with saline solution/handled the same way as frogs in treatment • experimental design – same/similar number of treatment and control tanks	1–3
Total	**3**
Accept other relevant answer.	

(e) Population size is declining in some frog species due to reasons other than disease. Explain how knowledge of the reproductive behaviour of a frog species can assist with conservation planning to minimise population decline. (4 marks)

Description	Marks
Any two of (2 x 2 marks)	
Either • reproductive behaviour influences reproductive success • can use information to predict/understand how it will change population size/population dynamics or • document (preferred) time/location of reproduction • can add extra protections at that time/place or • document courtship/mating behaviour • can add protections to minimise disruptions to behaviour or can manipulate behaviour/population sex ratios or can ensure species can behave normally in captive breeding or • document nesting sites • can protect nesting sites/add suitable/artificial nesting sites or • document differences/similarities in behaviour among populations (of a species) • can ensure behaviours are compatible before moving individuals from one population to another	1–4
Total	**4**

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

Unit 3

Question 36 **(20 marks)**

(a) Describe how new species can arise via allopatric speciation. (10 marks)

Description	Marks
Any ten of	
• (allopatric speciation is where) new species arise in geographic isolation/different places • ancestral species/population is subdivided by a barrier • example of a barrier (e.g. change in course of river/formation of desert/breakup of continent/other relevant example) • creates two subpopulations/populations • gene flow/migration between two subpopulations/populations is not possible (because of barrier) • subpopulations/populations evolve independently or evolve different allele/gene frequencies (because there is no gene flow) • natural selection causes adaptive differences • because subpopulations/populations are in different environments • mutation/genetic drift may cause random differences • genetic differences increase through time • eventually individuals in different subpopulations/populations will be unable to reproduce (and produce fertile offspring) or individuals in different subpopulations/populations will be genetically/reproductively incompatible • regarded as new species when individuals can no longer reproduce with each other	1–10
Total	**10**

(b) Explain how structural proteins are essential to cellular structure **and** how enzymes are essential for cellular functioning. Include specific examples in your answer. (10 marks)

Description	Marks
Histone proteins combine with DNA to form chromatin/chromosomes or spindle/microtubules move chromosomes during cell division or other specific example that states a type of structural protein and its function	1
Subtotal	**1**
Structural proteins: Any four of	
• contribute to structure of organelles/cell membranes • form spindles/microtubules • give the cell its shape/form cytoskeleton • organise location of organelles in cells/chromosomes in nucleus • move chromosome during cell division/mitosis/meiosis • combine with DNA to form chromosomes/chromatin (Do not accept duplicates from description above.)	1–4
Subtotal	**4**
DNA polymerase catalyses DNA synthesis or other specific example with named enzyme and process.	1
Subtotal	**1**
Enzymes: Any four of	
• act as catalysts or speed up rate of biochemical reactions • lower the activation energy (in biochemical reactions) • required for all biochemical reactions/photosynthesis/respiration/protein synthesis • needed for building new molecules/anabolism • needed for breakdown of large/toxic molecules/catabolism	1–4
Subtotal	**4**
Total	**10**

Question 37 **(20 marks)**

(a) Describe how a DNA molecule replicates itself **and** the process of mitosis. (10 marks)

Description	Marks
DNA replication	
Two strands of the DNA molecule separate/unwind/unzip.	1
(Weak) hydrogen bonds between (nitrogenous) bases are broken.	1
Each strand acts as a template for synthesis of the other strand **or** DNA replication is semiconservative **or** each DNA strand is copied.	1
Base pairing ensures that the new strand is complimentary to the template or A and T, and G and C are paired on template and new strands.	1
Subtotal	**4**
Mitosis	
Chromosomes condense or nuclear membrane breaks down.	1
Chromosomes line up in centre of cell/on metaphase plate/at centre of spindle.	1
Sister chromatids/one chromatid of each chromosome moves to opposites poles/opposite ends of the cell*.	1
Spindle/microtubules move chromosomes to centre of cell or move chromatids/chromosomes to opposite ends of cell.	1
Subtotal	**4**
Any two of	
• divided into four stages or divided into prophase, metaphase, anaphase, and telophase • (at end of mitosis) cell divides/cytokinesis takes place or chromosomes decondense or nuclear membrane reforms • DNA replication occurs before mitosis begins or at start of mitosis chromosomes consist of two chromatids or two identical DNA molecules • results in two genetically identical daughter cells or results in two daughter cells with a copy of each chromosome or results in two cells that are identical to/have same number of chromosomes as parent cell	1–2
Subtotal	**2**
Total	**10**
*Must be clear that it is sister chromatids or chromatids that are part of same chromosome that separate. Homologous pairs do not synapse or segregate in mitosis.	

(b) Explain why genetic diversity is reduced in small populations **and** why populations with reduced genetic diversity face an increased risk of extinction. (10 marks)

Description	Marks
Reduced genetic diversity: Any four of	
• because of genetic drift • causes random/chance changes in allele frequencies • results in loss of alleles/genes/variation from populations • loss happen quicker in smaller populations • because random/chance events are magnified in smaller populations	1–4
Subtotal	**4**
Increased risk of extinction: Any six of	
• populations need genetic variation to evolve/change/respond to changes or reduced diversity means populations cannot adapt/adjust to environmental change • advantageous alleles may have been lost (due to genetic drift) • individuals in population are genetically the same/similar • individuals may have decreased disease resistance • inbreeding/inbreeding depression is more likely in small populations • fitness of individuals may be reduced • because individuals are more likely to inherit two deleterious recessive alleles or are more likely to be homozygotes or are less likely to be heterozygotes	1–6
Subtotal	**6**
Total	**10**

Unit 4

Question 38 **(20 marks)**

(a) Distinguish between the structural characteristics of bacteria and fungi. (10 marks)

Description	Marks
Any five of following showing differences (5 x 2 marks):	
• bacteria: unicellular/surge cell, fungi: (usually) multicellular/filamentous • bacteria: microscopic/small, fungi: (usually) macroscopic/large • bacteria: prokaryote/nucleus is absent, fungi: eukaryote/nucleus present • bacteria: membrane bound, organelles absent, fungi: membrane bound organelles present • bacteria: cell wall made of protein and carbohydrate/peptidoglycan, fungi: cell wall made of chitin • bacteria: single/circular chromosomes, fungi: paired/linear/multiple chromosomes • bacteria: flagella/pilli present, fungi: flagella absent (except for some spores)	1–10
Total	**10**

(b) Explain how shallow branching roots with a high salt content and opening stomata only at night can help a plant to survive in an arid environment. (10 marks)

Description	Marks
Roots: Any five of	
• branching increases root surface area/surface area to volume ratio • increases the chances of roots contacting water • shallow means that roots are close to surface • where the water is/to take advantage of surface water/rainfall before evaporation • water uptake is via osmosis • high salt means that there is (much) more salt in roots than in soil or a steep concentration • this increases the rate of water uptake/osmosis	1–5
Subtotal	**5**
Stomata: Any five of	
• stomata must be open sometimes (for gas exchange) • water is lost through open stomata • water is lost via evaporation/transpiration • rate of evaporation is lower if environment is cooler/more humid or higher if environment is warmer/drier • environment is likely to be cooler/more humid at night **or** warmer/drier during the day • plants will lose less water if they open stomata at night **or** plants would lose more water if they opened stomata during the day	1–5
Subtotal	**5**
Total	**10**

Question 39 **(20 marks)**

(a) Explain how ectotherms obtain body heat. Include a specific example in your answer. (10 marks)

Description	Marks
Ectotherms predominantly rely on external sources for heat (unlike endotherms).	1
Specific example, e.g. honeybees vibrate flight muscles to generate metabolic heat before flying or other relevant example.	1
Subtotal	**2**
Any eight of	
• metabolism produces heat • animals can increase activity to increase metabolism/heat output • radiation/solar radiation (is the main source of heat) • animals bask in sun to obtain heat • some are black/dark coloured to increase heat absorption • may orient body/body parts to sun or occupy locations with high exposure (to solar radiation, when they want to warm) • rocks/ground/objects absorb solar radiation • become warmer than air/animal • animals lie on these warm rocks/ground/objects to obtain heat • via conduction • which is heat transfer between objects in direct contact with other	1–8
Subtotal	**8**
Total	**10**

(b) Discuss how quarantine and immunisation are used to control the spread of influenza on a pig farm. (10 marks)

Description	Marks
Quarantine: Any five of	
• infected pigs or pigs suspected of being infected would need to be separated from healthy pigs • influenza is spread by close contact/aerosols/infected surfaces • separated pigs would need to be far enough apart to prevent close contact or spread via aerosols/would need to decrease population density • equipment/clothing/objects would need to be disinfected before moving from quarantine to non-quarantine area • will not be effective unless all infected pigs are identified/separated • new arrivals should be placed in quarantine for a precautionary period	1–5
Subtotal	**5**
Immunisation: Any five of	
• give pigs (influenza) vaccine • to induce immunity or to stimulate pigs' immune system • all/most of herd will need to be vaccinated/need to create herd immunity • to reduce chances of an infected pig contacting an unvaccinated pig • immunity may not be lifelong, regular vaccination may be required • immunisation may prevent illness but not stop infection/transmission or may not be effective against some influenza strains	1–5
Subtotal	**5**
Total	**10**

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