CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



MARK SCHEME

17 SELECTION AND EVOLUTION

SCORE	PERCENTAGE
/	%

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Paper 1 Multiple Choice Answers: Selection and Evolution

Question	Paper	Q. No.	Answer
1615	9700_w15_qp_12	38	C
1616	9700_w15_qp_13	38	D

242. 9700_w15_ms_21 Q: 6

(a) (i) grass **;** [1]

(ii) rabbit(s) / grasshopper(s) **;** [1]

(iii) fox(es) **;** [1]

(b) denitrification **;**
nitrification **;**
nitrogen fixation **; A** Haber process [3]

[Total: 6]

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243. 9700_s16_ms_22 Q: 3

(a) (i) 1179 **;;**

one mark *if not to the whole person e.g. 1179.24 / 1179.2* **or**
if calculation correct but answer incorrect
e.g. 1.39 × 848.38 **or** 1.39 × (84 838 000/100 000) **or**
if no calculation to check but answer given as 1180 **[2]**

(ii) **1** provides information about / AW, proportion / percentage, (of population) affected / AW **;**
2 to, make (valid) comparisons / compare **;** *between countries / in one country over time*
3 provides information about severity of disease **;** AW

4 population size, taken into account / different for different countries / changes over time in a country **;**
do not need 'size' if 'use of 'population' is in correct context

5 *idea that* countries with larger populations will usually have more cases / higher number of cases may just mean larger population of country**;**

6 AVP **;** gives guidance about whether the disease is, spreading / becoming an epidemic / dying out (in one country) *in context of over time*
idea that number of cases per 100 000 are, standardised / normalised, values
7 use of data to support **;** *only two of Chad, Eritrea or Ethiopia where comparisons between countries stated* **I** *ref. to* other countries

(2009) actual cases and standardised cases

comparison (2009) to support mp 5 population size and actual cases

stated values of similar number of cases per 100 000 and populations of different sizes

countries compared, number of cases per 100 000 for any stated year, with comment about severity

number of cases per 100 000 for one country over time, with comment about severity / spreading / dying out / control / AW **[max 3]**

(b) *can give values of percentage vaccinated to describe 'increasing / decreasing' percentage vaccination*

support

1 Gambia high percentage vaccinated (throughout) and low number of cases **;**
A Eritrea

2 data to support **;** *e.g. a percentage vaccination for a year <u>and</u> number of cases (same, or following, year after vaccination) or a range given for percentage vaccinations over the whole, or stated, number of years or a compilation of the two*

partial / weak, support

3 Central African Republic decreasing vaccination and number of cases in 2011, higher / 15.31 **;**

4 Chad (from 2008) increasing percentage vaccination and, low / stated, number of cases,
2009 / 2010 / 2012 **;**
1.45 1.66 0.96

do not support

5 Niger / Ethiopia / Chad, (generally) increasing percentage vaccinated and number of cases, fluctuates / increase and decrease (ora) / AW **;**
A stated correct data *to show increase and decrease*
A for Chad if mp 4 given and ref. to increase / 71.6 in 2011

6 (generally) increasing percentage vaccinated and number of cases, increases / goes from 2.34–4.67, in 2011 in Niger **or**
increases / goes from 1.39–4.86, in 2010 in Ethiopia **or**
increases / goes from 1.66–71.6, in 2011 in Chad **A** 1.45–1.66 in 2010 **;**

7 Central African Republic decreasing vaccination and low number of cases in, 2009 / 2010 / 2012 **;**

8 / 9 AVP **;;** e.g.

- *idea that* most values for number of cases are low irrespective of vaccination percentage
- *ref.to* needs, high / 90%, vaccination to be effective
  A < 80% / low, vaccination ineffective
- *idea that* generally Gambia / Eritrea, have higher percentage vaccinated and have lower number of cases than, (three of) Ethiopia, Chad, Central African Republic, Niger / the other countries
- *ref. to* Chad / Central African Republic, in 2011 and, epidemics / inability to keep number of cases down / ineffectiveness of vaccination programme **I** *ref. to* 71.6 (Chad) or 15.31 (Central African Republic)
- Eritrea 2012 high vaccination but, increase in / 3.16, cases
- *ref. to* increasing percentage of vaccination in Niger and decrease in cases, 2009–2010 from 5.23 to 2.34 / 2011–2012 from 4.67–1.59
  A 2009–2012 from 5.23 to1.59 **[max 4]**

(c) *points refer to smallpox, look for points written as ora*
any two from

1 high, percentage / proportion, immunised / vaccinated **;** AW
A mass vaccination

2 no boosters required / one dose enough / immunity very long-lived **;**
A *idea of* long-lasting effect of vaccine

3 same, vaccine / antigens, used (throughout) **;**
treat as neutral ref. to, low mutation rate / stability, of smallpox virus

4 heat stable / thermostable / freeze-dried / lyophilised, vaccine **; I** frozen
A no need to refrigerate / AW
A *idea of* longer shelf-life

5 ease of, administering vaccine / training people to give vaccine **;**

6 ring vaccination / described, e.g. contact tracing **;**

7 easy to identify infected people / AW, (to begin ring vaccination) **;**

8 lower percentage cover required for smallpox than measles / lower herd immunity required **;**

9 AVP **;** smallpox less infectious (so lower percentage cover required)
idea of less, civil unrest / war / movement of populations (so easier to implement)
suggestion that smallpox live vaccine (and measles not live) **[max 2]**

(d) active artificial / artificial active **;** *treat as neutral* acquired **[1]**

(e) *can be from point of view of country programme or WHO programme cost*

1 preparing / manufacturing / purchasing, vaccine **; A** cost to provide vaccine free to developing countries

2 disposables / equipment to administer (vaccine) **;**
e.g. syringes / needles / (protective) gloves

3 storage **;** e.g. space, security

4 refrigeration / maintaining cold chain **;**

5 transport (of, vaccine / health care workers) **;**

6 wages / training, of staff involved **;** e.g. wages for, health care workers administering vaccine / staff involved in training health care workers

7 record keeping / contact tracing **;**

8 advertising / informing / marketing / education **;**

9 research / development **;**

10 setting up vaccination / immunisation, camps (for remote / epidemic, areas) **;**
I building, hospitals / clinics **[max 2]**

[Total: 14]

Q1.

Question 4

(a) *Use **one** of the following schemes **1, 2 or 3.***

1 named example e.g. sickle cell anaemia / PKU
change base ;
may change amino acid ;
change folding / shape of protein ;
detail of affect of protein changes ;

2 named example e.g. PKU ; **R** sickle cell anaemia
lack of enzyme / non functioning enzyme ;
2 x phenotype changes / symptoms ;;

3 chromosome mutation ;
detail of mutation ;
named example e.g. Down's syndrome ;
2 x symptoms ;;

4 max

(b) homozygotes for sickle cell allele die from sickle cell anaemia ;
sickle cell allele frequent in malarial areas ;
heterozygotes are resistant to malaria / have selective advantage ;
therefore pass on sickle cell allele ;
homozygous normal suffer / die from malaria ;

4 max

Total : 8

Q2.

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8 (a) 1. human ;
2. applies selection pressure ;
3. for benefit of human ;
4. choose / breed, parents with suitable trait ;
5. named example (species and characteristic) ;
6. select offspring ;
7. repeat over several generations ;
8. increased allele frequency ; [4 max]

(b) (i) 140 (%) ;;
2 marks for correct answer
(14/10 x 100 = 1 mark) [2]

(ii) genetic variation ;
ref. polygenes ;
environmental variation ;
AVP ; e.g. sampling / experimental, error [2 max]

[Total: 8]

Q3.

8 (a) (i) same, mean / mode ;
narrower (5–35) ; *ignore height, curve should be symmetrical* [2]

(ii) stabilising ; [1]

(b) (i) mean / mode, to left of 20cm ;
narrower (0–35) ; *ignore height, curve should be symmetrical* [2]

(ii) directional / evolutionary ; [1]

(iii) fishing ;
predation ;
AVP ; [2 max]

[Total: 8]

Q4.

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5 **(a)** *(A.) porcatus* ; [1]

(b) 1 *A. brunneus, A. smaragdinus and A. carolinensis* have smaller differences with *A. porcatus* (than with others)/AW ;

2 therefore more closely related to *A. porcatus* (than to each other) ;

3 use of figures ;

4 AVP ; e.g. comment about figures for *A. brunneus* with *A. smaragdinus*/ ref. different times of separation [3 max]

(c) 1 allopatric speciation ;

2 (lizard populations) separated by water ;

3 geographical/physical, barrier ;

4 no, breeding/gene flow, between populations ;

5 mutations occur ;

6 different selection pressures/different (environmental) conditions ;

7 genetic change ; e.g. different alleles selected for/change in allele frequency/ change in gene pool/advantageous alleles passed **on** ;

8 (can result in) different chromosome numbers ;

9 genetic drift ;

10 ultimately, reproductively isolated/cannot interbreed ; [4 max]

[Total: 8]

Q5.

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5 **(a)** divergence values less for *persimilis* than for *pseudoobscura* (at all DNA regions) ; **ora** use of figures ; [2]

(b) 1 some regions of DNA more prone to mutation than others ;

2 mutation in some regions likely to be fatal (so not seen in populations) ;

3 there tends to be less divergence if DNA is part of an important gene/**ora** ;

4 detail ; e.g. causes change in essential protein [2 max]

(c) 1 allopatric speciation ;

2 geographical/physical, barrier ;

3 no, breeding/gene flow, between populations ;

4 mutations occur ;

5 different selection pressures/different (environmental) conditions ;

6 genetic change ; e.g. different alleles selected for/change in allele frequency/change in gene pool/advantageous alleles passed on ;

7 genetic drift ;

8 (ultimately) cannot interbreed/reproductively isolated ; [4 max]

[Total: 8]

Q6.

8 **(a)** *north island*
1. fewer / less abundant, hedgehogs allow increase (in both lapwing and redshank) ;
2. breeding pair figs for either bird for 1983 and 2000 **or**
   % change in population over that time for either bird ;

south island
3. presence of hedgehogs causes decrease (in both lapwing and redshank) ;
4. breeding pair figs for either bird for 1983 and 2000 **or**
   % change in population over that time for either bird ; [3 max]

(b) 1. (oystercatchers have) less competition ;
2. hedgehogs mostly eat lapwing and redshank eggs / hedgehogs don't eat oystercatcher eggs ;
3. (oystercatcher) eggs are, too large / camouflaged / inaccessible / distasteful
   or
   oystercatchers defend their, nests / eggs ; [2 max]

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(c) 1. idea of geographical isolation ;
2. no interbreeding / gene flow, between <u>populations</u> ;
3. mutations occur ;
4. different, selection pressures / environmental conditions ;
5. genetic change / AW ;
6. genetic drift ;
7. (eventually) reproductive isolation ;
8. <u>allopatric</u> speciation ; [4 max]

[Total: 9]

Q7.

8 reproductive ;
constant / stable / AW ;
variation ;
alleles ;
gene ; [5]

[Total: 5]

Q8.

1 **(a)** 1. similar, morphological / physiological / biochemical / behavioural, features ;

2. interbreed / reproduce, to produce fertile offspring ;

3. occupy same niche ;

4. reproductively isolated ; [2 max]

(b) *isolating mechanism* – geographical / land barrier / AW **or** behavioural / AW ; [1]

(c) 1. no, breeding / gene flow, between <u>populations</u> ;

2. (gene) mutations occur ;

3. different selection pressures / different (environmental) conditions ;

4. genetic change ; e.g. different alleles selected for / change in allele frequency / change in gene pool / advantageous alleles passed **on** ;

5. different chromosome numbers ;

6. genetic drift ;

7. do not recognise song ;

8. therefore cannot interbreed ;

9. <u>allopatric</u> (speciation) ; [5 max]

[Total: 8]

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Q9.

1 (a) (i) two peaks ;

dip in middle connected ; **R** no intermediates shown [2]

(ii) mates selected by size ;

few intermediates mate ;

intermediates selected against / extremes selected for ;

<u>alleles</u> for extreme phenotypes (more likely to be) passed on ; **ora**

AVP ; e.g. habitat for intermediate size no longer available / difference in predation [3 max]

(iii) <u>stabilising</u> ; [1]

(b) sympatric / occurs in same location **or**
allopatric / physical separation ;
ref. different selection pressures ;

eventual reproductive isolation / no longer interbreed ; [2 max]

[Total: 8]

Q10.

8 (a) 550(%);;

allow one mark for $\frac{104 - 16}{16}$ *(x 100)* [2]

(b) 1. limiting/density dependent, factors or described;

2. reached carrying capacity/AW;

3. competition/AW;

4. for, food/nesting sites/resources;

5. large population attracts predators;

6. large population spreads disease more easily; [max 4]

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(c) 1. not many to begin with;

2. are carnivorous;

3. prey numbers fell;

4. slower reproductive rate;

5. more likely to migrate (to other areas);

[max 2]

[Total: 8]

Q11.

8 **(a)** 1. allopatric speciation;

2. fish populations isolated;

3. geographical / physical / land, barrier;

4. no, breeding / allele flow / gene flow, between populations;

5. mutations occur;

6. different selection pressures / different (environmental) conditions;

7. advantageous alleles selected for / advantageous alleles passed on;

8. change in, allele frequency / gene pool;

9. (can result in) different chromosome numbers;

10. genetic drift;

11. ultimately, reproductively isolated / cannot interbreed; [5 max]

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(b) 1. conditions remain the same within the pool;

2. best adapted fish (to conditions in pool) survive;

3. extreme phenotypes, selected against / do not survive; [2 max]

(c) 1. numbers of all species increase initially;

2. due to more, breeding space / food;

3. competition between (four) species;

4. (possible) reduction in numbers within, some / all, species;

5. not all species (may) survive;

6. different species, restricted to different areas / occupy different niches;

7. interbreeding / hybridisation;

8. AVP; e.g. ref. new selection pressure [3 max]

[Total: 10]

Q12.

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5	(a) 1	pools separate fish;	
	2	reference to geographic isolation/allopatric;	
	3	prevent interbreeding AW;	
	4	no gene flow/AW;	
	5	conditions different in the different pools;	
	6	different characteristics selected for in the different pools;	
	7	reference genetic drift;	**4 max**
	(b) 1	conditions remain the same within each pool;	
	2	idea of extreme phenotypes selected against/do not survive;	
	3	only those fish well adapted to conditions in each pool survive;	**3**
	(c) 1	reference competition between species/niche and competitive exclusion;	
	2	reduction in number of species/not all species will survive;	
	3	species restricted to different areas;	
	4	all/most species survive;	
	5	one species likely to be better adapted than all the other species;	
	6	reference hybridisation/interbreeding/no interbreeding;	
		1 and 2 linked	
		3 and 4 linked	**2 max**
			Total 9

Q13.

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Question 4

(a) most birds that survive drought years have larger beaks ;
because they have been able to feed on larger seeds ;
these characteristics are inherited ;
after drought years mainly birds with large beaks remain to breed ; **[3 max]**

(b) abundance of smaller seeds in drought free years ;
large beaks and bodies no longer at an advantage ;
smaller bodies and beaks selected / survive to reproduce ;
ref. smaller birds produce more offspring / require less food ;
ref. to competition in normal years ;
ref. to overproduction of offspring ;
extreme phenotypes unfit ;
ref. to very small birds unable to open any seeds ;
avp ; **[3 max]**

(c) ref. isolation of islands ;
ref. different environmental conditions / selection pressures on different islands ;
ref. adaptive radiation ;
ref. stabilizing selection ; **[2 max]**

Total [8]

Q14.

Question			Expected Answers	Marks
4	(a)		similar morphological, physiological, biochemical and behavioural features ; *(minimum 3 for mark)* interbreed / reproduce ; produce fertile offspring ; occupy same niche ; reproductively isolated;	2 max
	(b)		isolating mechanism – land barrier / AW ; *accept geographical isolation* type of speciation – allopatric ;	2
	(c)	1	geographical barriers / description ;	
		2	barrier to gene flow ;	
		3	no interbreeding / separate breeding populations / reproductively isolated ;	
		4	(gene) mutations occur / new alleles ;	
		5	different selection pressures / e.g. of selection pressure ;	
		6	ref. natural selection / description ;	
		7	change in allele frequency / OWTTE ;	
		8	develop different chromosome numbers / ref. polyploidy ;	4 max
				[Total: 8]

Q15.

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9 (a) ref. mosquitoes, are vectors / carry malaria ;
conditions in those areas suitable for mosquitoes / ora ; [2]

(b) 1. areas of SCA and malaria incidence match / AW ;
2. homozygous, recessive / for SCA allele, die of SCA ;
3. homozygous, dominant / for normal allele, susceptible to / die of , malaria ;

4. heterozygous have, SCA symptoms / sickle cell trait ;
5. but are resistant to malaria ;
6. have selective advantage / survive ;
7. pass on, recessive / sickle cell, allele ;

8. SCA no advantage outside of malarial areas ;
9. SCA and malaria both act as selection pressures ; [4 max]

[Total: 6]

Q16.

2	(a)	1	population increases slowly at first / ref. lag phase ;	
		2	(because) adjusting to pond environment ;	
		3	(then) steep increase / log phase / exponential increase / rapid growth or reproduction phase ;	
		4	(because) abundant food source / named other factor ;	
		5	stationary phase ;	
		6	fall in population size / death phase / decline phase ;	
		7	(due to) predation / build up of waste ;	
		8	competition for named resource ; e.g. food shortage	
		9	idea of further increase and fall / ref. population size may be cyclic ;	[5 max]
	(b)		variation means the presence of different characteristics ;	
			resulting in different survival rates / AW ;	
			(leads to) reproductive, success / failure ;	[2 max]
				[Total: 7]

Q17.

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2	(a)		*isolating mechanism* - geographical / mountains / physical barrier ; *type of speciation* – allopatric ;	[2]
	(b)	1	mouse populations separated by mountains ;	
		2	no, breeding / gene flow, between populations ;	
		3	mutations occur ;	
		4	different selection pressures / different (environmental) conditions ;	
		5	genetic change ; e.g. different alleles selected for / change in allele frequency / change in gene pool / advantageous alleles passed **on** ;	
		6	(results in) different chromosome numbers ;	
		7	genetic drift ;	
		8	(different populations ultimately) cannot interbreed ; **R** different species	[5 max]
				[Total: 7]

Q18.

6 (a) 86 ;; **A** -86

accept suitable working for one mark e.g. $\frac{1400-190}{1400}\times 100$

or

accept 86.4 for one mark [2]

(b) 1 drought reduced available food **or** fewer small seeds produced ;

2 finches with larger beaks survived **or** finches with smaller beaks died ;

3 able to open tough fruits / ora ;

4 able to feed on larger seeds / ora ;

5 tough fruit / size of seed, acted as selection pressure ; [3 max]

(c) directional / evolutionary ;

selection pressure acts on one extreme (of range) ; [2]

[Total: 7]

Q19.

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8 (a) *any two from*
(cigarette) smoke ;
named air pollutant ;
animal fur / skin flakes / AW ;
perfumes / aerosol / solvents ;
dust / mites ;
pollen / spores ; [2 max]

(b) (i) high tensile strength / withstands pulling forces / fibrous / insoluble / forms fibrils / flexible ; [1]

(ii) 1. inbreeding ;
2. little genetic variation / small gene pool / small population ;
3. many carried faulty allele / AW ;
4. faulty / mutant, allele, could be dominant or recessive ;
5. little phenotypic variation ; [3 max]

[Total: 6]

Q20.

8 pressure ;
mothers / sisters / (female) relatives / (female) offspring ;
alleles ;
generations ;
inbreeding ; [5]

[Total: 5]

Q21.

2 (a) *in context of woolly mammoth*

1. individuals varied (in their phenotypes) ;
2. (phenotypic variation) caused by, genetic variation / mutation ;
3. change in, selection pressure / environmental conditions ;
4. *idea that* variation increases the chance of some individuals surviving / AW ;
5. named adaptation explained ; e.g. better insulation / smaller surface area to volume
6. survivors breed ;
7. passed on <u>alleles</u> to offspring ;
8. changed <u>allele</u> frequency (in population) ; [max 5]

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(b) 1. differences in, primary structure / sequence of amino acids / polypeptide ;

2. provides different, side chains / R groups ;

3. change in, tertiary structure / 3D shape ;

4. effect on quaternary structure ;

5. greater effect on β chain ;

6. change in properties ; **A** function [max 3]

(c) **(i)** 1. still able to offload oxygen (in cold temperatures) ;

2. surface tissues colder than, core / body, temperature ;

3. so can maintain oxygen supply to surface tissues ; [max 2]

(ii) 1. no / tiny, difference in effect of temperature on haemoglobin alone ;

2. so no evidence (woolly mammoth haemoglobin) better adapted ;

3. greater reduction in effect of temperature on haemoglobin with red cell effector in woolly mammoth ; **ora**

4. (so) woolly mammoth haemoglobin (with red cell effector) better adapted to cold ;

5. ref. change to oxygen binding sites ;

6. so can offload oxygen at low temperatures ; [max 4]

[Total: 14]

Q22.

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2 **(a)** **(i)** 1. coelacanth α chain has higher percentage of matches ;

2. with both adult and larval amphibians ;

3. coelacanth β chain has higher percentage of matches with larval amphibians (rather than adults) ;

4. figures to support mp1 or mp3 or mp6 (comparing coelacanth with lungfish);

5. supports closer relationship of coelacanth and amphibia ;

6. (but) lungfish β chain has higher percentage of matches with adult amphibian (than coelacanths) ;

7. does not support suggestion / supports closer relationship lungfish and amphibia ;

[max 4]

(ii) 1. larvae aquatic **and** adults (partly) terrestrial / AW ;

2. different oxygen concentration available ;

3. need haemoglobins with different oxygen affinities ; [max 2]

(b) **(i)** 1. idea of, unchanging / constant, environment ;

2. oxygen concentration acts as a selective agent ;

3. organisms best adapted to these conditions survive ; ora

4. extreme (phenotypes) selected against ;

5. ref. narrow range of genetic variation / allele frequency maintained ;

6. sketch graph ;

7. ref. mutation ; [max 3]

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(ii) 1. ref. change in oxygen concentration ;

2. (low) oxygen concentration acts as selective agent ;

3. some individuals (in population) are better adapted ;

4. these are more likely to survive ; ora

5. directional selection ;

6. sketch graph ;

7. populations develop in different concentrations of oxygen ;

8. disruptive selection ;

9. sketch graph ;

allow either mp6 or mp9 but not both [max 3]

(c) 1. (same) species separated into separate populations ;

2. (by) geographical isolation / named example ;

3. prevents interbreeding between populations / no gene flow ;

4. ref. to different selection pressures ;

5. change in allele frequencies ;

6. eventually do not successfully interbreed ;

7. allopatric speciation ;

8. ref. to genetic drift / founder effect / different mutations / (different) new alleles ; [max 3]

[Total: 15]

Q23.

5 **(a)** random / spontaneous ;

mutation ;

base / nucleotide / triplet, change / substitution ; **R** addition / deletion [max 2]

(b) **(i)** as altitude increases frequency of $\mathbf{A^0}$ increases ; **ora** for $\mathbf{A^1}$

$\mathbf{A^0}$ more frequent at high altitudes / $\mathbf{A^1}$ more frequent at low altitudes / intermediate frequency of either allele at intermediate altitude ; [2]

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(ii) *idea of* (pre-existing) genetic variation in deer mouse population ;

at high altitude mice with, glycine / $\mathbf{A^0}$, more likely to survive / have selective advantage ; **ora**

mice (with $\mathbf{A^0}$) reproduce (at high altitude) ; **ora**

and pass on the $\mathbf{A^0}$ allele ; **ora**

partial pressure / concentration, of O_2 acts as a selection pressure ;

ref. to disadvantage of haemoglobin with very high affinity at low altitude ;

as less able to unload oxygen (in respiring tissues) ; [max 4]

[Total:8]

Q24.

2 **(a)** presence of C base in DNA (code) changes amino acid (in myostatin) ;

myostatin in CC horses, is inactive / not produced ; **ora for TT**

in CC horses muscle, differentiation / growth, has not been slowed ; **ora for TT** [max 2]

(b) CC genotype does best in short races ;

data quote ; e.g. 75% winners at 1.0 km ;

TT genotype does better in longer races ;

data quote ; e.g. about 60% of winners at 2.6 km

CT genotype has some winners at all distances ;

CT does best at 1.8 km ; [max 4]

(c) **(i)** by humans ;

individuals with desired features chosen to breed / AW / named example ; [2]

(ii) can choose parents genotypes to breed ;

CC for racing short distances / TT for racing long distances / CT as all-rounders ;

ref. need to keep all three genotypes in population ; [max 2]

[Total:10]

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Q25.

4 **(a)** details of electrophoresis ;;

any 2 from
DNA cut by, restriction enzyme(s)/endonuclease(s)

loaded (into wells) at, negative end/cathode end, (of gel)

ref. buffer/electrolyte

(negatively charged) DNA attracted to, anode/positive electrode

separation due to, electric field/potential difference

short pieces/smaller mass, move further (in unit time)/move faster **ora**

fluorescent/radioactive, DNA probes

compare, DNA sequences/bands, (of male lizard and hatchling) ; [3]

(b) **(i)** *body length*
no relationship (between body length and number of offspring) ;

small/intermediate, body length produce more offspring ;

sprint speed
lizards with greater sprint speed sire more offspring ;

use of two paired figures from Fig. 4.3 to support relationship ; [4]

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(ii) lizards with longer (hind) legs will tend to have more offspring ;

so will have a greater chance of passing on their alleles ;

(over time) the frequency of alleles (for long hind leg) will increase ;

so mean hind leg length will increase ;

directional selection ; [max 3]

(c) no, breeding / allele flow / gene flow, between (lizard) populations ;

different selection pressures / different (environmental) conditions ;

mutations occur ;

advantageous alleles, selected for / passed on ;

change in, allele frequency / gene pool ;

genetic drift ;

(eventually) unable to interbreed ;

allopatric speciation ; [max 5]

[Total:15]

Q26.

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1 **(a)** 1 (ideal characteristics) selected by humans/AW ;

2 one example of features ; e.g. calm temperament/obedient/intelligent

3 allowed to mate/ bred together ;

4 offspring with ideal characteristics chosen to mate ;

5 over (many) generations ;

6 allele frequency (for ideal characteristics) increases ;

7 directional selection ; [max 4]

(b) **(i)** *jackal*
behavioural/reproductive/AW ;

dingo
geographical/AW ; [2]

(ii) *one species*
all breeds form fertile offspring with (domestic) dog ;

separate species
idea of different types of jackal do not interbreed (to produce fertile offspring) ; [2]

[Total: 8]

Q27.

1 **(a)** **(i)** C (cytosine) is replaced by T (thymine) ;

GCC becomes GTC/GCT becomes GTT ; [2]

(ii) change in, active site/tertiary structure/3D structure ; [1]

(b) 1 natural selection ;

in Europe
2 more, fungus/ochratoxin A ;

3 ochratoxin A/fungus, acts as selection pressure ;

4 heterozygotes/carriers, have advantage ; **AW**

5 (heterozygotes/carriers) survive/reproduce ; **A** selected for/less likely to develop renal cancer

6 pass on, advantageous/PKU, allele ;

7 frequency of PKU allele increases ;

8 *idea that* people with PKU are treated so also pass on recessive allele ;

accept ***ora*** *Sub-Saharan Africa* [max 5]

[Total: 8]

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Q28.

2	(a)	to prevent extinction ; to maintain, genetic diversity / gene pool ; to counteract inbreeding depression ; store of alleles ; for use in future / when needed ; for changed environment ; [*A e.g. of change - abiotic or biotic*] for, selective breeding/genetic engineering ;	max 4
	(b)	artificial selection ; (often) faster than evolution ; man selective agent ; (dependent on) variation in, IR59655/parent variety ; plants chosen for desired traits and interbred ; offspring selected for desired traits and interbred ; ref. to traits in table ;	max 4
			Total: 8

Section_B

1.

7	(a)	1	ref. continuous / discontinuous variation ;	
		2	genetic / inherited variation ;	
		3	variation in phenotype / characteristics / AW ;	
		4	(can be due to) interaction of genotype and environment ;	
		5	e.g. of characteristic that influences survival ;	
		6	ref. intraspecific competition / struggle for existence ;	
		7	those with favourable characteristics survive / AW ;	
		8	pass on favourable characteristics to offspring ;	
		9	those with disadvantageous characteristics die ;	**6 max**

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(b) 10 ref. to definition of species ;

11 ref. allopatric ;

12 geographical isolation ;

13 ref. to examples e.g. islands / lakes / mountain chains / idea of barrier ;

14 ref. to example organism ;

15 ref. to populations prevented from interbreeding ;

16 isolated populations subjected to different selection pressures / conditions ;

17 over time sufficient differences to prevent interbreeding ;

18 ref. sympatric ;

19 ref. to reproductive isolation ;

20 ref. behavioural barriers (within a population) ;

21 e.g. day active / night active ;

22 correct ref. to gene pool ;

23 change in allele frequencies ; **9 max**

Total: 15

2.

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Question			Expected Answers	Marks
7	(a)	1	individuals in population have great reproductive potential / AW ;	
		2	numbers in population remain roughly constant ;	
		3	many fail to survive / die ;	
		4	do not reproduce ;	
		5	due to environmental factors / named factor ;	
		6	variation in members of population ;	
		7	those best adapted survive ;	
		8	reproduce / pass on alleles ; **R** genes	
		9	genetic variation leads to change in phenotype ;	
		10	ref: changes in gene pool ;	
		11	over time produces evolutionary change ;	
		12	new species arise from existing ones	**[8 max]**
	(b)	13	gene) example ; (sickle cell / PKU)	
		14	change in gene / DNA / base change ;	
		15	different amino acid ;	
		16	different polypeptide / different protein / non-functional protein ;	
		17	AVP ; details	
		18	AVP ; details	
		19	(chromosome) example ; (Down's, Turner's syndromes)	
		20	structural changes in chromosomes ;	
		21	change in number of chromosomes ;	
		22	change in sets of chromosomes / ref. polyploidy ;	
		23	AVP ; details	
		24	AVP ; details	**[7 max]**
				[Total: 15]

3.

9 **(a)** 1 code is three, bases / nucleotides ; **A** triplet code

2 (gene) mutation ; **R** chromosome mutation

3 base, substitution / addition / deletion ;

4 addition / deletion, large effect (on amino acid sequence) ;

5 frame shift ;

6 completely new code after mutation / alters every 3 base sequence which follows ;

7 (substitution) often has no effect / silent mutation ;

8 different triplet but same amino acid / new amino acid in non-functional part of protein ;

9 (substitution) may have big effect (on amino acid sequence) ;

10 could produce 'stop' codon ;

11 sickle cell anaemia / PKU / cystic fibrosis ;

12 reference to transcription or translation in correct context ; **A** description

12a AVP ; e.g. protein produced, is non-functional / not produced / incomplete [7 max]

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(b) 13 individuals in population have great reproductive potential / AW ;

14 numbers in population remain roughly constant ;

15 variation in members of population ;

16 environmental factors / named factor (biotic or abiotic) ; *linked to 17 and 18*

17 (cause) many, fail to survive / die / do not reproduce ;

18 those best adapted survive / survival of the fittest ;

19 (reproduce to) pass on alleles ; **R** genes

20 genetic variation leads to change in phenotype ;

21 ref: changes in, gene pool / allele frequency ;

22 over time produces evolutionary change ;

23 new species arise from existing ones / speciation ;

24 directional / stabilising, selection ; [8 max]

[Total: 15]

4.

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11 **(a)**

1 chiasma / crossing over ;
2 between non-sister chromatids ;
3 of, homologous chromosomes / bivalent ;
4 in <u>prophase 1</u> ; *linked to 1*
5 exchange of genetic material / AW ; ***R*** *genes unqualified*
6 linkage groups broken ;
7 new combination of alleles ;

8 <u>independent assortment</u> ; ***R*** *random assortment*
9 <u>metaphase 1</u> ; *linked to 8*
10 detail of independent assortment ;

11 possible mutation ;
12 random mating ;
13 random fusion of gametes ; [7 max]

(b) 14 phenotypic variation results from interaction of genotype and environment / VP = VG + VE ;

15 environment may limit expression of gene(s) / AW ;
16 e.g. for size / mass / height ;
17 because, food / nutrients / ion, missing / malnutrition ;
18 named, nutrient / ion / mineral, missing ;

19 environment may, trigger / switch on, gene ;
20 ref. low temperature and change in animal colour ;
21 ref. high temperature and, curled wing in *Drosophila* / gender in crocodiles ;
22 ref. <u>UV</u> light and melanin production ;
23 ref. wavelength of light and, flowering / germination / fruit colour ;
24 other named trigger plus example ;

25 environment effect usually greater on polygenes / ora ;
26 environment may induce mutation affecting phenotype ; [8 max]

[Total: 15]

5.

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11 (a) 1 allopatric speciation ;

2 geographical isolation / spatial separation ;

3 e.g. of barrier ;

4 e.g. of organism ; *must relate to 3*

5 sympatric speciation ;

6 example ;

7 meiosis problems ;

8 polyploidy ;

9 behavioural / temporal / ecological / structural, isolation ;

10 (isolated) populations, prevented from interbreeding / can only breed amongst themselves ;

11 no, gene flow / gene mixing, (between populations) ;

12 different selection pressures operate ;

13 natural selection ;

14 change in allele frequencies ;

15 different gene pool ;

16 over time (differences prevent interbreeding) ;

17 reproductively isolated ; [8 max]

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(b) 18 humans ; *must be linked to, choosing / selecting / mating etc*

19 parents with desirable feature ;

20 e.g. organism **and** feature ;

21 bred / crossed ;

22 select offspring with desirable feature ;

23 repeat over many generations ;

24 increase in frequency of desired allele(s) / decrease in frequency of undesired allele(s) ;

25 background genes ;

26 loss of hybrid vigour / increase in homozygosity / ref. inbreeding depression ;

27 AVP ; e.g. detail of breeding techniques [7 max]

[Total: 15]

6.

9 **(a)** 1 chiasma / crossing over ;

2 between non-sister chromatids ;

3 of, homologous chromosomes / bivalent ;

4 in prophase 1 ;

5 exchange of genetic material / AW ; ***R** genes unqualified*

6 linkage groups broken ;

7 new combination of alleles ;

8 independent assortment (of homologous chromosomes) ; ***R** random assortment*

9 at equator ;

10 (during) metaphase 1 ;

11 possible mutation ;

12 random mating ;

13 random fusion / fertilisation of gametes ; [7 max]

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(b) 14 phenotypic variation results from interaction of genotype and environment / VP = VG + VE ;

15 environment may modify expression of gene(s) ; *must be stated*

16 e.g. for size / mass / height ;

17 because, food / nutrient / ion, missing or in short supply ; **A** malnutrition

18 named, food / nutrient / ion, (missing or in short supply) ;

19 environment may, trigger / switch on, gene ; *must be stated*

20 ref. low temperature and change in animal colour ;

21 ref. high temperature and, curled wing in *Drosophila* / gender in crocodiles ;

22 ref. UV light and melanin production ;

23 ref. wavelength of light and, flowering / germination / fruit colour ;

24 other named trigger plus example ;

25 environment effect usually greater on polygenes / ora ;

26 environment may induce mutation affecting phenotype ; [8 max]

[Total: 15]

7.

9 **(a)** 1 occur during meiosis I ;
crossing over
2 between non-sister chromatids ;
3 of, (a pair of) homologous chromosomes / a bivalent ;
4 in prophase 1 ;
5 at chiasma(ta) ;
6 exchange of genetic material / AW ;
***R** genes unqualified*
7 linkage groups broken / AW ;
8 new combination of alleles (within each chromosome) ;
independent assortment
9 of homologous chromosomes pairs / bivalents ;
10 each pair lines up independently of others ;
11 line up on equator ;
12 (during) metaphase 1 ;
13 results in gametes that are genetically unique / AW ; [9 max]

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(b)

	artificial selection		*natural selection*
14	selection (pressure by) humans	**or**	environmental selection pressure ;
15	genetic diversity lowered	**or**	genetic diversity remains high ;
16	inbreeding common	**or**	outbreeding common ;
17	loss of vigour / inbreeding depression	**or**	increased vigour / less chance of inbreeding depression ;
18	increased homozygosity / decreased heterozygosity	**or**	decreased homozygosity / increased heterozygosity ;
19	no isolation mechanisms operating	**or**	isolation mechanisms do operate ;
20	(usually) faster	**or**	(usually) slower ;
21	selected feature for human benefit	**or**	selected feature for organism's benefit ;
22	not for, survival / evolution	**or**	promotes, survival / evolution ;

[6 max]

[Total: 15]

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