

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.

- 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.

- 5 (a) (*A. porcatius*) ; [1]
- (b) 1 *A. brunneus*, *A. smaragdinus* and *A. carolinensis* have smaller differences with *A. porcatius* (than with others)AW ;  
2 therefore more closely related to *A. porcatius* (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.

- 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]

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

[5 max]

[Total: 8]

**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 ;  
alleles 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]
- (ii)** stabilising ; [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  $\frac{104 - 16}{16} ( \times 100)$*  [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]



- (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]

- (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.**



- 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.

**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 ; <i>accept geographical isolation</i> 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
		<b>[Total: 8]</b>

**Q15.**

- 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.**

<b>2</b>	<b>(a)</b>	1	population increases slowly at first / ref. lag phase ;	[5 max]
		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 ;	
	<b>(b)</b>		variation means the presence of different characteristics ; resulting in different survival rates / AW ; (leads to) reproductive, success / failure ;	[2 max]
				<b>[Total: 7]</b>

**Q17.**

2	(a)		<i>isolating mechanism</i> - geographical / mountains / physical barrier ; <i>type of speciation</i> – <u>allopatric</u> ;	[2]
	(b)	1 mouse <u>populations</u> separated by mountains ; 2 no, breeding / gene flow, between <u>populations</u> ; 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 <b>on</b> ; 6 (results in) different chromosome numbers ; 7 genetic drift ; 8 (different populations ultimately) cannot interbreed ; <b>R</b> different species		[5 max]
				<b>[Total: 7]</b>

**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.**

- 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 alleles to offspring ;
  8. changed allele frequency (in population) ; [max 5]



- (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  $\beta$  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.**

- 2 (a) (i)**
1. coelacanth  $\alpha$  chain has higher percentage of matches ;
  2. with both adult and larval amphibians ;
  3. coelacanth  $\beta$  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  $\beta$  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]



- (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  $A^0$  increases ; ora for  $A^1$

$A^0$  more frequent at high altitudes /  $A^1$  more frequent at low altitudes /  
intermediate frequency of either allele at intermediate altitude ;

[2]

- (ii) *idea of* (pre-existing) genetic variation in deer mouse population ;  
at high altitude mice with, glycine /  $A^0$ , more likely to survive / have selective advantage ; **ora**  
mice (with  $A^0$ ) reproduce (at high altitude) ; **ora**  
and pass on the  $A^0$  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]

**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]

- (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.**

- 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]

**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



- (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.**



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 ; <b>R</b> genes 9 genetic variation leads to change in phenotype ; 10 ref: changes in gene pool ; 11 <u>over time</u> 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]
<b>[Total: 15]</b>		

**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]

- (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.

- 11 (a) 1 chiasma / crossing over ;  
2 between non-sister chromatids ;  
3 of, homologous chromosomes / bivalent ;  
4 in prophase 1 ; *linked to 1*  
5 exchange of genetic material / AW ; *R genes unqualified*  
6 linkage groups broken ;  
7 new combination of alleles ;
- 8 independent assortment ; *R random assortment*  
9 metaphase 1 ; *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. 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]

5.

- 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]

- (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]



- (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]

(b)

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

[6 max]

**[Total: 15]**



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