17. Selection and Evolution

17.3 Evolution

Paper 4

Marking Scheme

Q1.

(b)(i)	*any **three** from:* 1 formation of new species from, pre-existing species / common ancestor ; 2 change in, characteristics / phenotypes ; 3 over, time / generations ; 4 natural selection ; 5 changes in, gene pools / allele frequencies **or** genetic drift ;	**3**

(b)(ii)	*any **three** from:* 1 compare sequences (of DNA) ; 2 the more similar the sequences the more, closely related the species / recent the common ancestor ; **ora** 3 over time mutations accumulate **or** less time fewer mutations occurred ; 4 *ref. to* bioinformatics / software / database ; 5 AVP ; e.g. molecular clock / constant rate of mutation e.g. mtDNA has no crossing over e.g. the percentage similarity can be used to build a phylogenetic tree	**3**

Q2.

(b)	*any **three** from*: **1** *ref. to* DNA sequence (for all / three species) ; **2** find / count, nucleotide / base, differences / similarities ; **3** fewer differences means, more closely related / less time since divergence / less time to common ancestor ; **4** bioinformatics / database / software / BLAST ; **5** *S. hammondii* and *S. bombifrons*, have the fewest genetic differences / are the most genetically similar ;	**3**

Q3.

(b)	*any **three** from*: **1** *O. nivara*, adapted to / selected for, dry / drier, conditions / habitats ; **2** different habitats / ecological isolation ; **3** prevent interbreeding / no gene flow / reproductive isolation ; **4** polyploidy / auto(poly)ploidy ; **5** AVP ;	**3**

Q4.

(b)	*any **three** from:* S1 sympatric (speciation) ; S2 different mutations ; S3 gave, (named) phenotypic / behavioural, differences ; S4 which gave behavioural, isolation / separation ; S5 (leading to) inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them ; **or** *any **three** from:* A1 allopatric (speciation) ; A2 geographical, separation / barrier, in the past ; A3 different, mutations / selection pressures ; A4 gave, (named) phenotypic / behavioural, differences ; A5 inability to reproduce together / reproductive isolation / genetic isolation / no gene flow between them, after populations re-join ;	**3**

Q5.

(a)	*any **five** from:* 1 evolution / speciation / natural selection ; 2 random / spontaneous ; 3 mutations (occurred) ; 4 adapting some plants to, alpine habitat / high altitude / mountains ; 5 (in this habitat) these plants, survived / were selected for ; 6 (selection pressure is / must resist) cold / strong winds / thin soil ; 7 alleles for alpine features passed to offspring ; 8 change in, allele frequency / gene pool (of population) ; 9 population become, morphologically / physiologically / biochemically, different ; 10 less, herbivores / competition, in new <u>niche</u> ; 11 AVP ;	**5**
(b)(i)	*any **three** from:* 1 time period = from 0.95 million years (to present) ; 2 mountains high enough to exceed treeline ; 3 this provides alpine, habitat / region / niches ;	**3**

(b)(ii)	*any **two** from:* 1 compare / find similarities in / find differences in, DNA ; 2 of alpine species and related (lowland) species ; 3 find (time) when species, evolved / separated / diverged / speciated ; 4 many, DNA / base / nucleotide, differences / changes / mutations, means they, separated a long time ago / have a distant common ancestor ; 5 AVP ;	**2**

Q6.

(a)	*any **four** from:* **1** geographical isolation / allopatric (sub)speciation ; **2** little / no, (inter)breeding / gene flow, between populations ; **3** different, selection / selective, pressures (on each population) ; **4** different mutations (in each population) ; **5** adaptation to, environment / habitat / climate / food / vegetation ; **6** gives, morphological / ecological / behavioural, differences ;	**4**

Q7.

(a)	*any **four** from:* 1 geographical isolation / barrier qualified ; **Ignore** separation 2 no, interbreeding / gene flow (between European and American populations) ; **Ignore** reproductive isolation here (needs to be late on in process) 3 different, environmental (conditions) / selection pressures ; 4 random / different, mutations ; 5 **different**, alleles selected for / gene pool / changes in allele frequency ; 6 populations have different, morphological / physiological / behavioural, features ; 7 after, a long time / many generations, reproductive isolation occurs / cannot interbreed to produce fertile offspring ; 8 allopatric (speciation) ;	**4**

(c)	1 European bison has a, close / recent / common, ancestor with that of, cattle / *Bos* **or** European bison is more closely related to, cattle / *Bos*, (than to American bison) ; 2 European bison may have interbred with, cattle / *Bos* ; 3 mitochondria are inherited from, mother / female ;	**3**

Q8.

	*any **five** from:* 1 geographical, isolation / separation **or** *ref. to* Panama / land, separating populations ; 2 no, gene flow / interbreeding, between both populations ; 3 different, environmental conditions / selection pressures ; 4 random / different, mutations ; 5 (different), alleles selected for / gene pool / changes in allele frequency ; 6 over time populations have different, morphological / physiological / behavioural, features ; 7 eventually reproductive isolation occurs ; 8 allopatric speciation ;	**5**

Q9.

(a)	*any **four** from:* 1 *ref. to* geographical isolation; 2 no, gene flow / breeding, between populations (on the different islands) ; 3 different, selection pressures / environmental conditions (on the different islands) ; 4 different mutations occur (on the different islands) ; 5 some mutations make individuals better adapted ; 6 those individuals, survive / reproduce ; 7 pass on advantageous alleles ; 8 *ref. to* many generations ; 9 reproductive isolation ; 10 allopatric speciation ;	**4**

(c)	*any **one pair** from:* 1 large quantity in the cell ; 2 (so) easier to, extract / amplify, DNA for testing ; *or* 3 small genome size ; 4 (so) easier to locate specific section of DNA to test ; *or* 5 mtDNA is, a single copy of DNA / not paired alleles / haploid ; 6 (so) only mutation causes it to change ; *or* 7 inherited maternally ; 8 (so) all mtDNA sections are shared between all members (of maternal) family ; *or* 9 mutation rate is higher / no enzymes to repair mutations / faster molecular clock ; 10 (so)more choice of suitable sections of mtDNA to test / more accurate time estimate ;	**2**

Q10.

	*any **five** from:* 1 due to (Great Central) Valley / during migration, populations / they, are separated / geographically isolated ; 2 no, mating / breeding / gene flow, between, them / populations ; 3 different (named), selection pressures / environments / conditions / habitats ; 4 different mutations ; 5 natural selection ; 6 genetic drift / founder effect ; 7 change in allele frequency **OR** change in / different, gene pool ; 8 leads to different, morphological / behavioural / biochemical / physiological, features ; 9 allopatric speciation ;	**5**

Q11.

(a)(ii)	*any **five** from:* 1 *ref. to* geographical isolation ; 2 no, gene flow / interbreeding, between, **A** and **B** / populations ; 3 different, selection pressures / environmental conditions (for **A** and **B** populations) ; 4 different mutations occur (in **A** and **B** populations) ; 5 some mutations make individuals better adapted ; 6 those individuals, survive / reproduce ; 7 pass on advantageous alleles ; 8 *ref. to* many generations ; 9 reproductive isolation ; 10 allopatric speciation ;	**5**

Q12.

(a)	*any **four** from:* **1** *ref. to* geographic isolation / geographic barrier / named barrier / populations are separate; **2** no, breeding / gene flow, between **populations** ; **3** different, selection pressures / environmental conditions ; **4** different mutations occur ; **5** *ref. to* some individuals, better adapted / have selective advantage ; **ora** **6** natural selection ; **7** allopatric (speciation) ; *ignore sympatric speciation*	**4**
(b)	*any **three** from:* **1** not pre-zygotic as they mate (to produce hybrids) ; *post-zygotic as:* **2** (some) hybrids, infertile / sterile ; **3** (as they) cannot carry out meiosis ; **4** (because) have problems with pairing of homologous chromosomes / have different chromosome numbers ; **A** *ref. to* numerical values, e.g. 34 and 40 / 37 / odd number of chromosomes **5** selection against hybrids **or** hybrids, may die / are not viable ; **6** (due to) *idea that* higher intestinal worm number is a disadvantage ;	**3**

Q13.

(a)	*any **four** from:* **1** geographic(al), isolation / barrier between populations ; **2** no / low / less, (inter)breeding / gene flow ; **3** different mutations occur ; **4** different (named), selection pressures / environment(al conditions) ; **5** natural selection ; **6** genetic drift ; **7** allopatric (sub)speciation ;	**4**
(b)	cytochrome c oxidase / (mitochondrial) gene / DNA / base, sequences, (nearly) identical / (very) similar ; small number of bases different / low percentage difference ; difference to other species is greater ;	**2**

Q14.

(a)(i)	1 (chromosome numbers) are the same ; **R** similar numbers *reasons* *any **one** from:* 2 as hybrids are fertile / described ; 3 two identical sets of chromosomes pair up / homologous chromosomes pair up / bivalents form (in meiosis) ; 4 meiosis occurs ;	**2**
(a)(ii)	*any **four** from:* 1 behavioural isolation ; 2 reproductive isolation ; 3 no gene flow with parent, species / populations ; 4 (so) hybrid gene pool maintained / AW ; 5 different mutations (occur in hybrid population to parent populations) ; 6 natural selection ; 7 pre-zygotic isolating mechanism ; 8 sympatric (speciation) ;	**4**

(b)	*any **two** from:* 1 hybrids, are eaten / die / fail to reproduce ; **ora** 2 hybrid gene pool not maintained ; 3 parents better adapted ; 4 *ref. to* disruptive selection ;	**2**

Q15.

(a)	*idea that* organisms have changed over time ;	**1**
(b)	*any* ***four*** *from:* 1 *ref. to* mutation ; 2 (mutation) results in a change in eye structure ; 3 *ref. to* natural selection / selective advantage ; 4 light receptor (cells) develop ; 5 light receptor layer becomes cup-shaped ; 6 *idea that* entry for light becomes narrower ; 7 lens forms ; 8 fixed lens / cornea, (forms) ;	**4**

(c)	*any* ***two*** *from:* *must refer to both octopus and mammal* 1 had similar, selection pressures / light conditions ; 2 allows organisms to escape predators ; 3 allows organisms to find food ; 4 convergent evolution / described ;	**2**
(d)(i)	shared origin / common ancestor / same ancestor ;	**1**
(d)(ii)	*any* ***two*** *from:* 1 compare (amino acid sequences of two species) ; 2 more similar (amino acid sequence) more closely related the species are ; **ora** 3 more similar (amino acid sequence) more recent common ancestor / less time has elapsed (since a common ancestor); **ora** 4 *ref. to* molecular clock ;	**2**

Q16.

(c)	*any* ***three*** *from:* 1 allopatric ; 2 populations / lizards / *A. sagrei*, on different islands, geographically / geologically, isolated / separated ; 3 have different, selection pressures / environmental conditions ; 4 different mutations occur ; 5 genetic drift ; 6 no gene flow / reproductive isolation, between, lizards on different islands / populations / (new) species ; 7 genetic differences accumulate ;	**3**

Q17.

(b)	*any 3 of:* 1 separated by a geographical barrier / description ; 2 different, environmental conditions / selection pressures ; 3 allopatric speciation ; 4 reproductive isolation / no breeding with mainland flies / no gene flow (between two populations) ; **A** pre-zygotic isolation 5 new allele not, lost / diluted in frequency ; 6 founder effect / genetic drift ; 7 (more pronounced) in small population ;	**3**
(c)	*any 3 of:* 1 obtain, DNA / genome / gene / base / nucleotide, sequences (from database) ; 2 obtain, amino acid / protein, sequences (from database) ; 3 compare sequences (of two populations) ; 4 calculate percentage of, bases / amino acids, changed ; 5 mitochondrial DNA ; 6 molecular clock / mutation rate, (to estimate time) ;	**3**

Q18.

(a)(i)	(O'ahu) 0.013 ;	**1**
(a)(ii)	*any two from* **1** Hawai'i is youngest island / formed only 0.4 million years ago ; **2** less / little, time for, *Mecyclothorax* / beetles / them, to, colonise / arrive / speciate ; **3** Hawai'i has large area so, density / number of species per km^2, is low ; **4** early stage of succession / low habitat diversity ;	**2**
(a)(iii)	*any two from* **1** O'ahu is further away from Maui (than Moloka'i) ; **2** fewer, *Mecyclothorax* / beetles / species, reached O'ahu ; **3** O'ahu was colonised later ; **4** less time for speciation ;	**2**
(b)	*any four from* **1** allopatric speciation ; **2** geographical isolation / population became divided ; **3** different, mutations / alleles / gene pools, in different, populations ; **4** *ref. to* different selection pressures ; **5** no, gene flow / interbreeding, between populations ; **6** genetic differences accumulated ; **7** natural selection ; **8** genetic drift / founder effect ;	**4**