

7.2 Genetics, populations, evolution, ecosystems (A-Level Only) - Evolution and speciation - Mark schemes

Q1.

- (a) Formation of new species / reproductive isolation;
Ignore ref. to mechanisms involved

From a population (living in the same area / place) / without geographical isolation;

2

- (b) Small shell of T,
Accept converse statements

Wave action (greatest) at top of shore;
Note – pairs of statements – environmental factor; and possible effect on survival;

Only small snails can get into cracks in rock (to shelter);
Thick shell of M,
More crabs in middle shore;
No mark for giving differences

Thicker shelled snails less easy to break open;

OR

More rocks in middle shore to be moved by waves;
Thicker shelled snails less easily broken by rocks;
Large opening of T,
More wave action likely to wash snails away;
Larger opening, (suggests) snails with larger foot to hold on with less likely to be washed away;

OR

Smaller opening of M,
More crabs in middle shore;
Snails with smaller opening harder to get claws into;

4 max

- (c) Reproductive isolation required for speciation;
Accept descriptions of reproductive isolation

Isolation by male choice / form T males nearly always choose form T female, so (nearly) reproductively isolated (from form M);
Behavioural isolation / mechanism;

2 max

[8]

Q2.

- (a) All the alleles in a population;
Accept: The number of alleles in a population.
Note: All or number of alleles in a species on its own is not enough on its own.

- (b) 1. Occurs in the same habitat / environment / population;
 2. Mutation/s cause different flowering times;
 3. Reproductive separation / isolation
OR
 No gene flow
OR
 Gene pools remain separate;
 4. Different allele/s passed on / selected
OR
 Change in frequency of allele/s
 5. Disruptive (natural) selection;
 6. Eventually different species cannot (inter)breed to produce fertile offspring;
1. *Accept: are **not** geographically isolated / separated.*
 1. *Accept: same place*
 3. *Accept: no interbreeding but must be a separate idea from mark point 6 which relates to definition of a species.*
- Note: Answers relating only to allopatric speciation = 3 max, mark points 3, 4 and 6.*

5 max

[6]

Q3.

- (a) 1. Correct answer of 19.4 / 19.41%
OR
 19.47 / 19.5% = **2 marks**;
 2. Incorrect answer but shows increase of 1,048,320 **OR** 1,051,200 = one mark;
Accept: 19.46% for one mark.
- 2
- (b) 1. Less / no acetylcholine broken down;
 2. Acetylcholine attaches to receptors;
 3. (More) Na⁺ enter to reach threshold / for depolarisation / action potential / impulse;
1. *Accept: more acetylcholine present / remains.*
 - 1 and 2. *Accept: remains attached for longer = 2 marks.*
 3. *Must be sodium ions.*
- 3
- (c) 1. Isolated **so** inbreeding / low genetic diversity / small gene pool;
 2. Allele inherited (through generations) from (common) ancestor;
1. *Ignore: Founder effect.*
 1. *Accept: no interbreeding with other populations.*
 1. *Reject: interbreeding within the population.*
- 2
- (d) 1. AD / symptoms develops late / at 49;
 2. Have already reproduced;
Note: 'It' is not equivalent to AD / symptom as the question stem relates to the mutation.
- 2
- (e) 1. Epigenetics / environment / named factor e.g. stress, alcohol, toxins, diet, exercise, smoking;

2. methylation (of genes)
OR
 acetylation (of histones);
1. *Ignore: gender and lifestyle.*
 2. *If further details are provided the context must be correct e.g. increased methylation or decreased acetylation inhibit gene expression / transcription.*
- 2
- (f) 1. One person was homozygous dominant / has two dominant alleles = 2 marks;
 2. For one mark has two alleles / chromosomes;
1. *Accept; homozygous dominant genotype e.g. 'one person has AA' for 2 marks.*
 2. *Accept: is diploid or has two copies of the gene.*
- 2
- (g) 1. (GCA / triplet) is common / found in other places;
 2. Would not know if it was the mutation / allele / gene
OR
 Produces 'false positives'
1. *Accept: Probe will bind elsewhere.*
- 2

[15]

Q4.

- (a) (No – no mark)
 Graph / bar chart only shows number of species, not the name of the species.
- 1
- (b) (No – no mark)
1. Mutations are spontaneous / random;
 2. Only the rate of mutation is affected by environment;
 3. Different species do not interbreed / do not produce fertile offspring;
 4. So mutation / gene / allele cannot be passed from one species to another.
- Ignore references to correlation does not prove causation*
- 4
- (c) 1. Initially one / few insects with favourable mutation / allele;
 2. Individuals with (favourable) mutation / allele will have more offspring;
 3. Takes many generations for (favourable) mutation / allele to become the most common allele (of this gene).
- 3

[8]

Q5.

- (a) 1. No interbreeding / gene pools are separate / geographic(al) isolation;
Accept: reproductive isolation as an alternative to no interbreeding.
2. Mutation linked to (different) markings/colours;
 3. Selection/survival linked to (different) markings/colours;
 4. Adapted organisms breed / differential reproductive success;
Note: 'passed on to offspring' on its own is not sufficient for reproduction.
 5. Change/increase in allele frequency/frequencies;

- (b) 1. (Compare DNA) base sequence / base pairing / (DNA) hybridisation;
Ignore: compare chromosomes / 'genetic make-up'.
Accept: (compare) genes / introns / exons.
*Note: reference to **only** comparing alleles is 1 max.*
2. Different in six (species) /different in different species / similar in three (subspecies) /similar in same species/subspecies;
Ignore: compare chromosomes / 'genetic make-up'.
Reject: 'same alleles/ same DNA bases in three species/subspecies'.
Note: mark point 2 can be awarded without mark point 1.

2

[7]

Q6.

- (a) 1. Geographic(al) isolation;
2. Separate gene pools / no interbreeding / gene flow (between populations);
Accept: reproductive isolation
This mark should only be awarded in context of during the process of speciation. Do not credit if context is after speciation has occurred.
3. Variation due to mutation;
4. Different selection pressures / different abiotic / biotic conditions / environments / habitats;
Neutral: different conditions / climates if not qualified
Accept: named abiotic / biotic conditions
5. Different(ial) reproductive success / selected organisms (survive and) reproduce;
Accept: pass on alleles / genes to next generation as equivalent to reproduce
6. Leads to change / increase in allele frequency.
Accept: increase in proportion / percentage as equivalent to frequency

6

- (b) 1. Capture / collect sample, mark and release;
2. Method of marking does not harm lizard / make it more visible to predators;
3. Leave sufficient time for lizards to (randomly) distribute (on island) before collecting a second sample;
4. (Population =) number in first sample × number in second sample divided by number of marked lizards in second sample / number recaptured.

4

- (c) 1. High concentration of / increase in carbon dioxide linked with respiration at night / in darkness;
2. No photosynthesis in dark / night / photosynthesis only in light / day;

Neutral: less photosynthesis

3. In light net uptake of carbon dioxide / use more carbon dioxide than produced / (rate of) photosynthesis greater than rate of respiration;
4. Decrease in carbon dioxide concentration with height;
More carbon dioxide absorbed higher up
Accept: less carbon dioxide higher up / more carbon dioxide lower down
5. (At ground level)
less photosynthesis / less photosynthesising tissue / more respiration / more micro-organisms / micro-organisms produce carbon dioxide.
Neutral: less leaves unqualified or reference to animals

5

[15]

Q7.

- (a)
 1. Allows (valid) comparison;
 2. Number / sample size may vary;
- (b)
 1. Increased chance of (severe malaria) with blood group A / decreased chance of (severe malaria) with sickle cell;
Accept: converse for mild malaria i.e. increased chance of mild malaria with sickle cell / decreased chance of mild malaria with blood group A.
Accept: if answer is comparative e.g. greatest risk of severe malaria with blood group A.
 2. One mark for one of the following:

almost equal chance with blood group O / slightly greater chance of mild malaria with O / slightly lower chance of severe malaria with O / 2.5 x / 2.48 x / more than twice the chance of severe with blood group A / (almost) 50% / half the chance of severe malaria with sickle cell / twice the chance of mild malaria with sickle cell;
Neutral: answers which only refer to or use ratios.
- (c)
 1. Individuals with the **Hb^C** (allele) reproduce;
 2. Pass on **Hb^C** (allele) which increases in frequency;
 3. **Hb^A Hb^A** individuals less likely to survive / reproduce / frequency of **Hb^A** (allele) decreases;

2

2

3

[7]

Q8.

- (i)
 1. Identical twins show genetic influence / differences between them show environmental influence;
Neutral: allows a comparison
It must be clear which set of twins is being referred to
 2. Non-identical twins (also) show an environmental / non-genetic

influence;

*It must be clear which set of twins is being referred to
Do not credit repetition of bullet points in stem*

2

- (ii) Genes play a greater role / environment plays a lesser role;

Must be comparative

Neutral: genes are involved

Neutral: involves genes and the environment

1

- (iii) Any suitable suggestion for a maximum of two marks e.g.:

Neutral: 'environment' as in question stem

Neutral: unqualified ideas such as health / lifestyle

1. Age;
2. Sex (non-identical twins);
3. Family / medical history (of mental illness);
4. No use of recreational drugs;
5. Ethnic origins;

2 max

[6]

Q9.

- (a) variation present in (original population);
(copper) tolerant individuals more likely to survive;
(these reproduce and) pass on genes (to next generation / offspring);
more / increase (in frequency) of copper tolerance alleles / genes;

4

- (b) 1. reproductively isolated / no interbreeding (due to different flowering times);
2. conditions different for two populations / different selection pressures;
3. different features or plants are selected or survive / different adaptations;
4. populations become (genetically) different / unable to produce fertile offspring;

4

[8]

Q10.

- (a) 1. Chlorophyll absorbs light energy;
*Accept light energy 'hits' chlorophyll
Accept photon for light energy*
2. Excites electrons / electrons removed (from chlorophyll);
Accept higher energy level as 'excites'
3. Electrons move along carriers / electron transport chain releasing energy;
Accept movement of H⁺ / protons across membrane releases energy

4. Energy used to join ADP and Pi to form ATP;
Negate 'produces energy' for either mark but not for both
Accept energy used for phosphorylation of ADP to ATP
Do not accept P as Pi
5. Photolysis of water produces protons, electrons and oxygen;
3. and 4.
6. NADP reduced by electrons / electrons and protons / hydrogen;
Accept NADP to NADPH (or equivalent) by addition of
electrons / hydrogen
Do not accept NADP reduced by protons on their own

5 max

- (b)
1. Variation / variety;
 2. Mutation;
Do not accept answers which suggest the mutation is
caused by copper
 3. Some plants have allele to survive / grow / live in high concentration of copper / polluted soils;
Reference to immunity disqualifies this mark
Do not disqualify mark for references to allele providing
resistance to copper
 4. (Differential) reproductive success / adapted organisms reproduce;
 5. Increase in frequency of allele;
 6. No interbreeding (with other populations) / separate gene pool / gene pool differs (from other populations);
Accept reproductive isolation

5 max

[10]

Q11.

- (a)
1. (Colonisation by) pioneer (species);
 2. Change in environment / example of change caused by organisms present;
 3. Enables other species to colonise / survive;
 4. Change in diversity / biodiversity;
 5. Stability increases / less hostile environment;
 6. Climax community;
Example of change e.g. formation of soil / humus / organic
matter / increase in nutrients;
Do not accept genetic diversity for mark point 4.

5 max

- (b)
1. Geographical isolation;

2. Variation due to mutation;
3. Different environmental / abiotic / biotic conditions / selection pressures;
4. Selection for different / advantageous, features / characteristics / mutation / / allele / differential reproductive success / (selected) organisms survive and reproduce;
5. Leads to change in allele frequency;
In this question must refer to allele where appropriate, not gene.

5

[10]

Q12.

- (a) Same number of ryegrass seedlings in distilled water;

1

- (b) (i) Produce null hypothesis;

Carry out Spearman Rank correlation test / find correlation coefficient;

Use values to show $P < \text{critical value}$ / find probability of results being due to chance;

Accept valid example

E.g. There is no correlation between inhibition of germination and the concentration of the extract.

2 max

- (ii) May be another factor / named factor (that also inhibits germination);
e.g. amount of water in extract

1

- (c) (i) Extract inhibits ryegrass germination / extract stops ryegrass starting to grow;

Inhibition of root length / causes ryegrass to have shorter roots;

2

- (ii) Scientists crushed plants to get extract;

Plants might not secrete substances in the extract into the soil;

These substances might get broken down in the soil;

Wheat and ryegrass might not grow at the same time / wheat plants might not produce substance when ryegrass is growing;

Concentration of extract in the soil might be different from that in solution;

3 max

[9]

Q13.

- (a) Small surface area to volume ratio / more fat;

Lose less heat (to the environment) / for insulation when they are sitting on

- eggs; 2
- (b) (i) The further north / higher the latitude, the higher the percentage (of white snow geese); 1
- (ii) Snow lying longer / melts slower further north / at greater latitudes;
White geese better camouflaged (further north);
Predation linked to survival / reproductive success;
Q In order to gain the last marking point, candidates must explain how survival or reproductive success is affected. 3
- (c) Snow melts earlier / snow melts further north / less snow;
White geese decreasing as less well camouflaged / at disadvantage / blue geese increasing as better camouflaged / at an advantage; 2
- (d) (i) Stabilising;
Do not accept stable 1
- (ii) Few geese survive at the extremes / most survive from the middle of the range; 1
- [10]**

Q14.

- (a) Kingdom / phylum / class; 1
- (b) (i) 6; 1
- (ii) Family; 1
- (iii) The two species of *Mirounga* shared a common ancestor more recently than they did with *Monarchus tropicalis*; 1
- (c) Difference in DNA / base sequence / alleles / genes; 1
- [5]**

Q15.

- (a) (i) 2;
Allow 1.75 1
- (ii) $30 / 60 \div$ answer to part (i) if incorrect;
Allow 34(.315) 1
- (b) Song characteristic of species / differs between species;

Song linked to courtship at night / living underground;

2

(c) Females not attracted to call of male / does not recognise male;

Because of differences in song;

Necessary precursor to mating;

Hybrids are sterile;

2 max

[6]

Q16.

(a) Genetic (factors)/genes/alleles/mutations/meiosis;

1

Environmental (factors)/environment;

1

(b) New species form from different populations/groups/gene pools;

1

In different areas/from isolated populations;

Accept alternatives/descriptions for 'populations'

1

[4]

Q17.

- (a)
- 1 4 year cycles;
 - 2 predator / stoat peaks after prey / lemming;
 - 3 lemmings increase due to low numbers of stoats / available food;
 - 4 more food for stoats so numbers increase;
 - 5 increased predation reduces number of lemmings;
 - 6 number of stoats decreases due to lack of food / starvation;

6

(b) smaller populations have fewer different alleles / more homozygosity / less heterozygosity / smaller gene pool / lower genetic variability;
migrants bring in new alleles / increase gene pool;

2

(c) geographical isolation of populations;
variation present in population(s);
different environmental conditions / different selection pressures / different phenotypes selected;
change in genetic constitution of populations / gene pools / allele frequency;

4

[12]

Q18.

(a) zooplankton nearer surface at night;
algae only found at surface;
photosynthetic;
no / little light below 30 / 40m;

3

- (b) (i) with increasing time predators have been present in the lake, the greater the depth at which the zooplankton occur during the day; 1
- (ii) variation in migration behaviour;
vertical migration reduces chance of predation / prey can't be seen in low light intensity;
those that migrated more likely to reproduce;
genes / alleles (for behaviour) passed to next generation;
increase in frequency of gene / allele in population; 3 max

[7]

Q19.

- (a) breed together;
if fertile offspring, then same species; 2
- (b) isolation of two populations;
variation already present due to mutations;

different environmental conditions / selection pressures leading to selection of different features and hence different alleles;
different frequency of alleles;
separate gene pools / no interbreeding; 4
- (c) selection of mate dependent on colour pattern;
prevents interbreeding / keeps gene pools separate; 2

[8]

Q20.

- (a) colder / below 0°C (January) areas, cyanogenic plants die in this cold / acyanogenic survive;
non-cyanogenic allele / gene passed on more often / its frequency increases;
warmer (January) areas cyanogenic plants at advantage,
because of less herbivore selection pressure / feeding;
so cyanogenic survive more often to pass on cyanogenic allele / gene. 4 max
- (b) large (and equal) number of quadrats in each area;
(reject several)
random sampling method, described;
(accept described 'systematic' method)
percentage cover / point hits per quadrat / count plants;
mean / average value for each area;
statistics test to see if differences significant. 4 max

[8]

Q21.

- (a) principle of intraspecific competition;
for amount of food available;
more energy needed to find food / less energy to produce eggs;

OR

number of territories;
more energy spent fighting / defending territory;

OR

availability as prey;
predators spend less time searching for nests;

2 max

- (b) (i) age of bird - young or old birds produce fewer eggs;
time of breeding - early or late breeding less food available /
temperature effect;
genotype - variation in genetic ability to produce eggs;
quality of territory - description of some relevant resource
in territory;
(reject food as resource in territory if given in(a))
predation of eggs - lays more to replace eaten eggs;
- (ii) when high number of eggs, each individual young will receive
less food; reference to mortality rates to disease / predators for
low numbers of eggs; so in both cases low number of offspring
will reach maturity / survive; so less likely to pass on genes / alleles;

1 max

3

[6]

Q22.

- (a) (i) Continuous variation – range of values / not discrete categories / many
categories / no gaps;
- (ii) Crossing over / chiasmata;
Random segregation / independent assortment;
In meiosis I and meiosis II;
- (b) Range influenced by single 'outlier' (*accept anomaly*) /
converse for S.D.;
S.D. shows dispersion / spread about mean / range only shows highest
and lowest values / extremes;
Or
S.D. allows statistical use;
Tests whether or not differences are significant;

1

max 2

max 2

[4]

Q23.

- (a) 1. frequent use of antibiotic creates selection pressure / antibiotic kills bacteria;
2. bacteria with mutation / resistance have (selective) advantage over others /
described;
3. (survive to) reproduce more than other types pass on advantageous allele /
mutated allele in greater numbers;
4. frequency of (advantageous) allele increases in subsequent generations;
(penalise use of "gene" instead of allele once only)
5. frequency of resistant types increases in subsequent generations;

5

- (b) correct answer = 0.18;
 And three marks for three of:
 $p + q = 1$ and $p^2 + 2pq + q^2 = 1$;
 $0.01 = q^2$;
 $q = 0.1$;
 $p = 0.9$
 frequency of heterozygotes = $2pq = 2 \times 0.1 \times 0.9 / 2 \times$ candidates
 $p \times$ candidates q ;

4 max

[9]

Q24.

- (a) 0.32.

Correct answer = 2 marks

Accept 32% for 1 mark max

Incorrect answer but identifying $2pq$ as heterozygous = 1 mark

2

- (b) 1. Mutation produced *KDR minus* / resistance allele;
 2. DDT use provides selection pressure;
 3. Mosquitoes with *KDR minus* allele more likely (to survive) to reproduce;
 4. Leading to increase in *KDR minus* allele in population.

4

- (c) 1. Neurones remain depolarised;
 2. So no action potentials / no impulse transmission.

2

- (d) 1. (Mutation) changes shape of sodium ion channel (protein) / of receptor (protein);
 2. DDT no longer complementary / no longer able to bind.

2

[10]