AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.7.3 EVOLUTION AND SPECIATION

SCORE	PERCENTAGE
/281	%

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Q1.

(a) 1. LP due to mutation
OR
Allele due to mutation;

Reject mutation caused by drinking milk.

Reject (LP) gene

2. Milk provides named nutrient;

Accept any correct named nutrient e.g. glucose, galactose, protein

Ignore 'sugar' 'lactose' as named nutrient

3. Individuals with LP more likely to survive **and** reproduce
OR
Individuals with advantageous allele more likely to survive **and** reproduce;

Reject (LP) gene

Accept 'individuals who produce lactase' for 'LP individuals'

Accept 'pass on allele/LP/characteristic' for reproduce.

4. Directional selection;

5. Frequency of allele increases (in the offspring/next generation);

*Accept description of increasing frequency of allele e.g. 'higher proportion', 'more common' but ignore increase in **number** of allele*

4 max

(b) 1. Dominant allele;

2. (Always) expressed/shown (when present in phenotype/offspring)
OR
Expressed when only one (dominant allele) present;

2

(c) 1. Mutation in promoter (DNA/gene) for transcription factor
OR
Mutation in promoter (region/DNA) for the gene
OR
Mutation in gene for transcription factor;

Accept mutation in an epistatic gene

2. Lactase gene continues to be transcribed/active;

2

[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.

1

(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) 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]

Q6.

(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;

5

(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: '<u>same</u> alleles/ <u>same</u> DNA bases in three species/subspecies'.

Note: mark point 2 can be awarded without mark point 1.

2

[7]

Q7.

(a) 1. <u>Geographic(al)</u> 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]

Q8.

(a) 1. Allows (valid) comparison;

2. Number / sample size may vary;

2

(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.

2

(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;

3

[7]

Q9.

(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]

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) All the fish / all the species / all the populations / all the organisms;

Must indicate all / every species.

Reject answers that suggest other fish / organisms might be present.

1

(b) (i) 1. Capture sample, mark and release;

2. Appropriate method of marking suggested / method of marking does not harm fish;

E.g. Cutting a fin / attaching a tag / paint / marker.

3. Take second sample and count marked organisms;

May be awarded from equation if not given here.

4. $$\text{Population} = \frac{\text{No in sample}_1 \times \text{No in sample}_2}{\text{Number marked in sample}_2};$$

Accept any valid alternative to equation or answer expressed as a ratio.

3 max

(ii) One suitable reason;

Accept other valid answers, which must, however, relate to breeding / only works if population constant.

E.g. population increases / changes (between first and second sample)

1

(c) 1. With different mouth eats different food / has different way of feeding / specific mouth shape for specific food;

Catches more food and gas exchange are neutral

2. Competition between species / interspecific competition is reduced;

Reject intraspecific

2

[7]

Q12.

(a) (i) Non-living / physical / chemical factor / non biological;

Do not accept named factor unless general answer given.

1

(ii) Accept an abiotic factor that may limit photosynthesis / growth;

Reject altitude / height

Water

Named soil factor

Not "soil" / "weather"

Light

Carbon dioxide

Accept Oxygen

Incline / aspect

Wind / wind speed

1

(b) 1. Correct explanation for differences between day and night e.g. photosynthesises only during the daytime / no photosynthesis / only respiration at night;

2. Net carbon dioxide uptake during the day / in light

OR

No carbon dioxide taken up at night / in dark / carbon dioxide released at night / in dark;

3. At ground level more respiration / in leaves more photosynthesis;

4. Carbon dioxide produced at ground level / carbon dioxide taken up in leaves;

Principles

Comparing day and night / light and dark

1. Explanation in terms of photosynthesis / respiration

2. Effect on carbon dioxide production / uptake

Comparing leaves with ground level

3. Explanation in terms of photosynthesis / respiration

4. Effect on carbon dioxide production / uptake

2 and 4 must relate to why the change occurs

4

(c) 1. Variation in original colonisers / mutations took place;

2. Some better (adapted for) survival (in mountains);

2. Allow "advantage so able to survive"

3. Greater reproductive success;

4. Allele frequencies change;

4. Reject gene / genotype

3 max

[9]

Q13.

(a) (i) Antibiotics kill other bacteria / *Clostridium* is resistant;

Less / no competition so (*Clostridium*)
reproduces / replicates / multiplies / increases in number;

Reference to bacteria being 'immune' negates first marking point.

Reference to mitosis negates second marking point.

2

(ii) Immune system less effective / more likely to have other infections / been in hospital;

Accept: 'Weak / lower' immune system'.

1

(b) Attaches to <u>active</u> <u>site</u> (of enzyme);
(Methicillin) is a competitive inhibitor / prevents monomers / substrate attaching (to enzyme);

'Competes for active site' = 2 marks.

Neutral: 'Prevents monomers joining / attaching to each other'.

Allow one mark max for answers relating to non-competitive inhibitor changing active site / preventing substrate attaching.

Do not penalise Methicillin forms an enzyme / substrate complex.

2

(c) (i) Have other illness / medical condition / 'weak' immune system / disease / infection;

Reject: Due to 'other factors', 'are smokers', 'are obese' unless related to disease or illness.

1

(ii) Increase up to 2006 / 20 (per 100 000) then decreases;

1

(iii) Correct answer in range of 52 – 59.1% = two marks;

Incorrect answer but shows change as between 4.8 – 5.2 / shows correct subtraction giving this change e.g. 14 – 9 = one mark.

2

[9]

Q14.

(a) (i) Two marks for correct answer of 4;;

One mark for calculation involving 0.2 × 0.2 or 0.04;

2

(ii) 0.2 / the frequency remains the same;

Reject if wrong frequency is quoted

1

(b) (i) 1. There is a <u>probability</u> of 5% / 0.05;

2. That difference in frequencies / difference in results are due to <u>chance</u>;

Accept 95% probability changes in frequencies not different as a result of chance

2

(ii) 1. Directional;

2. The recessive allele confers disadvantage / the dominant allele confers advantage / more likely to survive / reproduce;

Assume "it" to refer to the recessive allele

2. References to selection do not gain credit as the term is in the question. Allow reference to phenotype / enzyme functionality (instead of allele) when describing advantage /

disadvantage.

2

[7]

Q15.

(a) Shows mass of wheat seedlings when grown on their own;

Allows percentage to be calculated / allows comparison / allows effect of competition to be seen;

2

(b) 1. Interspecific competition / ryegrass reduces growth of wheat;

2. Justification by using values;

100% with wheat but less when grown with ryegrass

3. Competition between shoots had a greater effect than competition between roots;

4. Justification by use of values;

*46% when shoots complete / in **Y** / 76% when roots compete / **X***

When marking please number marking points

E.g. 4✓ *means a mark awarded for point 4.*

4

(c) Growth involves enzymes / enzyme-controlled reactions;

Lower temperature means less kinetic energy / fewer collisions / fewer E–S complexes formed;

Wheat and ryegrass affected to a different extent;

Accept other valid physiological processes such as growth involves diffusion / lower temperature means less kinetic energy / molecules move slower.

2 max

[8]

Q16.

(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 < 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]

Q17.

(a) 1. (Colonisation by) <u>pioneer</u> (species);

2. Change in environment / example of change caused by organisms present;

3. Enables other <u>species</u> to colonise / survive;

4. Change in <u>diversity / biodiversity</u>;

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 <u>allele</u> frequency;

In this question must refer to allele where appropriate, not gene.

5

[10]

Q18.

(a) (i) To cut the DNA;

Reject breakdown, cutting out

1

(ii) To separate the (pieces of) DNA;

1

(b) Complimentary base sequence / complementary DNA; binds to both (haplotypes);

Label would show up in both;

Idea of complimentarity required

2

(c) (i) Y chromosome inherited / comes from male parents / only found in males;

1

(ii) Mitochondria in egg / female gamete / no mitochondria come from sperm / male gamete;

1

(d) (i) Allows comparison;

Different (sized) areas covered;

2

(ii) Wolves do not eat all of prey animal / do not eat (large) bones / skin;

Inedible parts make up different proportions / wolf eats different proportions;

2

(e) Limited by food / prey; as prey increases so do wolf numbers / positive correlation;

Large range so other factors involved;

2

[12]

Q19.

(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]

Q20.

(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]

Q21.

(a) (i) 2;

Allow 1.75

1

(ii) 30 / 60 ÷ 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]

Q22.

(a) Cannot make (active) enzyme A (which converts precursor to linamarin) / cannot make linamarin;

1

(b) (i) **AL** + **Al** + **aL** + **al** ;

1

(ii) Meiosis separates alleles / homologous chromosomes / pairs of chromosomes;
Independent assortment / means either of **A** / **a** can go with either of **L** / **l**;

Accept "random segregation" but cancel if reference to crossing-over

2

(c) From parental genotypes: **AaLl** × **AaLl** (no mark)
Note: If wrong parental genotypes / wrong gametes: ALLOW correct derivation of offspring genotypes = 1 max

Correct derivation of offspring genotypes; max 2 marks if error in Punnett square

	AL	**Al**	**aL**	**al**
AL	AALL	AALl	AaLL	AaLl
Al	AALl	AAll	AaLl	Aall
aL	AaLL	AaLl	aaLL	aaLl
al	AaLl	Aall	aaLl	aall

Correct identification of offspring genotypes with at least one **A** and two **l** alleles (= grey cells in above table);
Correct proportion: 3 / 16 / 3:13 / 18.75% ;

3

(d) (i) There was no (significant) difference in damage between cyanogenic and acyanogenic / being cyanogenic has no effect;

1

(ii) The difference (from expected / from chance variation) is significant / difference / results not just due to chance;
Reject null hypothesis;
Being cyanogenic does help protect from slug damage;

3

(e) High slug population:
1. Find only cyanogenic plants / only cyanogenic plants survive;
2. (Cyanide release) limits / stops feeding by slugs / slugs killed;

Accept: converse argument re. acyanogenic plants

Low slug population:
3. Find both types of plant;
4. Less selection pressure on plants from slugs / no selective advantage / no selection / described;

4

[15]

Q23.

(a) Table completed as below:

Kingdom	Animalia / Animals
Phylum	Chordata
Class	Mammalia
Order	Rodentia
Family	Caviidae
Genus	*Cavia*
Species	*porcellus*

Column 1 correct;

Column 2 correct;

2

(b) Mutation occurs;

Correct e.g. of isolating mechanism
e.g.
temporal − different breeding seasons / feeding times /
ecological / behavioural − different courtship displays / different niches / habitats / feeding areas /
mechanical − mismatch of reproductive parts /
gamete incompatibility − sperm killed in female's reproductive tract /
hybrid inviability / hybrid infertility;
Ignore references to "genetic isolation" or "reproductive isolation"

Different selection pressures operate / changes in allele frequency / divergence of gene pools;

3

(c) Using candidate's symbols for alleles −
e.g. B = black, b = brown, S = short, s = long:

Parental genotypes correct: Male **A** SSBb Female **B** SsBB;

Gametes correctly derived from candidate's parental genotypes: SB Sb SB sB;

offspring genotypes correctly derived from candidate's suggested gametes − accept Punnett square or line diagram;

offspring genotypes correct: SSBB SsBB SSBb SsBb;

If monohybrid:cross ⇨ 0 marks

4

(d) There is no (significant) difference between observed and expected results / any difference is due to chance;

1

[10]

Q24.

(a) Excitation of chlorophyll molecule / electrons / energy of (pairs of) electrons raised to higher energy level;

Electron(s) emitted from chlorophyll molecule;

Electron(s) to electron transport chain;

Loss of energy by electron(s) along electron transport chain;

Energy lost by electron(s) is used to synthesise ATP;

From ADP + Pi;

"By electrons" need not be stated in each marking point if it can be reasonably inferred that the candidate is referring to electrons

max 5

(b) Little green light reaches bottom as absorbed by surface dwellers / water;
Red and blue not absorbed and so penetrate;
Variation in pigments of sediment dwellers;
Bacteria with chlorophyll at an advantage as chlorophyll absorbs red and blue;
(Survive to) reproduce in greater numbers and pass on advantageous alleles / genes in greater numbers / increase in frequency of advantageous alleles in subsequent generations;
Increase in frequency / numbers of bacteria with chlorophyll;

6

[11]

Q25.

(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 × candidates

p × candidates q;

4 max

[9]

Q26.

(a) (i) Continuous variation – range of values / not discrete categories / many categories / no gaps;

1

(ii) Crossing over / chiasmata;
Random segregation / independent assortment;
In meiosis I and meiosis II;

max 2

(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;

max 2

[4]

Q27.

(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;

1 max

(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;

3

[6]

Q28.

(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]

Q29.

(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]

Q30.

(a) breed together;
if fertile offspring, then same species;

2

(b) <u>isolation</u> 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]

Q31.

(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]

Q32.

(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]

Q1.

(a) Despite less than 13% of students obtaining more than two marks, this question proved to be an excellent discriminator. The most frequently awarded marking point was that the frequency of the *LP* allele would increase in the offspring generation. Many students who gained this mark often gained credit for stating that individuals with the advantageous allele would survive and reproduce. However, poor terminology, particularly referring to 'gene' rather than 'allele', prevented a significant number of students from gaining this mark. There were also many references to 'alleles surviving and reproducing'. Although many students realised that drinking milk gave a nutritional advantage, a named nutrient was not always included to gain a mark. Similarly, mutation was mentioned by some students but this was often not credited as many of these responses suggested that drinking milk had caused the mutation. Directional selection was only included in a minority of responses. A significant minority of students thought that *LP* occurred in cattle and suggested that cattle were selectively bred to continue lactase production. Some students also suggested that the allele for *LP* was obtained from cow's milk.

(b) Approximately 50% of students gained a mark on this question, invariably for referring to *LP* as a dominant allele. Half of these students obtained the second mark by explaining that dominant alleles were expressed (in the phenotype). Many students who scored zero simply suggested that selection for the *LP* allele caused its rapid rise, indicating they had not carefully read the question. Perhaps of greater concern was the number of students who suggested that the recessive allele of the *LP* gene had reverted to its dominant form either via mutation, methylation or acetylation.

(c) As expected, this proved difficult for many students with only 18% obtaining at least one mark and 5% gaining both marks. Many students had no idea how a mutation in DNA could cause lactase persistence. There was often confusion between lactase and lactose. Misconceptions included: mutations in proteins, mutations causing new genes to code for lactase and epigenetic changes/methylation/acetylation initiating lactase production. Some responses described deletion mutations in a different gene on the same chromosome, resulting in a frameshift which affected the lactase gene. Students who had some idea did write about mutations in a gene that codes for the protein that switches off lactase. Others mentioned transcription factors, but the mutations were often in the transcription factor rather than in the gene coding for it.

Q2.

(a) Less than 50% of students gained this mark. The most common errors included: referring to genes instead of alleles, describing frequency of an allele, or mentioning species without any reference to a population or area.

(b) Interestingly, this question asked about a new topic on the specification, sympatric speciation, and proved to be the most effective discriminator on the exam paper. Less than 2% of students obtained all five marks, and almost 25% scored zero. The main problem was that many students provided a description of allopatric speciation rather than sympatric speciation, despite the clear direction provided in the question stem. These answers were limited to a maximum of three marks, but often only gained a single mark. When students did describe sympatric speciation, relatively few mentioned that it occurs in the same area / place / population, and fewer still referred to disruptive selection, although maximum marks could still be achieved

without including this latter idea. The most frequently credited mark points related to reproductive isolation, described in a variety of ways, and for providing a definition of a species, i.e. the inability to breed to produce fertile offspring. Better students did appreciate that a mutation would have led to a difference in flowering times, and that different alleles would be passed on in the reproductively isolated sub-populations. Unfortunately, many students referred to genes rather than alleles and thus failed to obtain this latter mark point. For some unknown reason, a significant minority of students thought that palms, having been separated by flowering time, go on to reproduce asexually. A few students misinterpreted the question entirely and provided a description of succession.

Q3.

(a) Over a third of students obtained both marks for this question, for answers of 19.41 / 19.4% or 19.47 / 19.5%, depending on whether the student used 7 x 52 (weeks) or 365 as the number of days in a year. Almost a third of students gained one mark for correctly calculating the increase in AD cases per year as being 1 048 320 or 1 051 200, depending on the number of days used. Incorrect rounding to give 19.46% was quite common, to gain one mark.

(b) The majority of students gained at least one mark for stating that less acetylcholine would be broken down, or that more acetylcholine would be present. Almost half of these students obtained a second mark for stating that the acetylcholine binds to receptors. However, only 10% of students obtained maximum marks by describing how an impulse would be produced in the postsynaptic neurone. Many students did appreciate that sodium ion channels would open, but then failed to mention that sodium ions would then enter to cause depolarisation.

(c) Over 50% of students scored zero for this question, usually due to answers lacking complete explanations for the valid suggestions they outlined. Less than 2% of students gained both marks. The most frequently credited response was that isolation had resulted in a small gene pool or low genetic diversity. Poor use of terminology also prevented many students gaining both marks. Invariably, students referred to the gene or mutation, rather than the allele being inherited from a (common) ancestor. There was also considerable confusion in the use of the terms inbreeding and interbreeding. There were also many responses which referred to genetic bottlenecks, the Founder effect, and an increase in the rate of mutation in isolated areas. A significant number of students suggested that the late onset of AD enabled individuals still to reproduce and pass on the mutation. This would explain why the frequency of the mutation had not been reduced (part d), rather than why there is a high frequency of this mutation to begin with.

(d) Almost a third of students obtained both marks, clearly expressing the idea that, due to the symptoms of AD developing late on, affected individuals would have already reproduced. Over 50% of students scored zero, often providing responses that suggested that the mutation was not harmful, or indeed that it was beneficial. An improvement in health care was also provided as an explanation for the frequency of the mutation not being reduced. Students obtaining one mark often did not refer to the late onset of AD, but did understand that individuals with the mutation could still reproduce and pass on the allele.

(e) Over 50% of students scored zero on this question. Many of these responses suggested that differences in the ‘level’ of acetylcholine, or exposure to mutagenic agents, caused the variation in the age at which the mutation is expressed. Over a third of students obtained one mark, usually by naming an environmental factor such as diet, smoking or stress. Answers specifically referring to epigenetics for at least one mark were infrequent. These responses often gained a second mark, 10% of

students, for mentioning methylation or acetylation. Students who described these processes generally provided correct details.

(f) Almost three out of ten students obtained one mark for explaining the sample size of 204 in terms of two copies of chromosome 14 or two copies of an allele. A common error was to refer to two chromatids. Explaining why there were only 74 potential AD cases when 75 mutations had been detected proved very challenging, with only 2% of students gaining this second mark. Many students suggested that the allele causing AD is recessive, despite line 18 of the comprehension passage stating that it is dominant. A common misconception was that one individual was heterozygous for the condition. Other incorrect responses focused on AD not having yet developed, or attempted to explain the data in relation to the degeneracy of the genetic code.

(g) Over 10% of students did not attempt this question, and over 5% omitted the parts (e) and (f). It seems likely that some students had difficulty completing the paper, but it was also evident that these last three questions were demanding. Only 25% of students obtained a mark on this question. Almost all of these students gained one mark for realising that the GCA triplet would occur in a number of different places. Half of these students then explained that you could not then determine if the mutation was present or not. As in part (f), a number of incorrect ideas were linked to the degenerate nature of the genetic code. The misconception that probes were being used to sequence the whole genome arose, so lots of different primers would be needed and it would be very time consuming and costly. The probe was sometimes thought only to be able to identify the mutation if the gene had been expressed to cause the disease, or that the probe would not bind because the mutation had not occurred yet. A surprising number of students said the sequence of the mutation was not known, so therefore a probe could not be made, or that the mutation was different in different people.

Q6.

(a) This question proved to be a very effective discriminator. 60% of students were able to obtain at least three marks often by reciting the basic principles of speciation. The marks most frequently credited referred to geographical isolation, differential reproductive success and change in allele frequency. Many of these students failed to gain further credit as they did not use the specific information provided on the coloured skin markings. Better answers applied this information, outlining that mutations could result in particular skin colourations and selection for these giraffes could eventually lead to speciation. Consequently, only 10% of students achieved maximum marks.

(b) One in every three students obtained both marks. These students provided clear explanations on how the mitochondrial DNA of different giraffes could be compared to determine if they were the same species. The most frequently used method was to compare DNA base sequences. Students obtaining a single mark often failed to outline specifically how they would compare mitochondrial DNA. However, these students gained credit for stating that the DNA of different species of giraffes would have more differences than would subspecies.

Q7.

(a) This question proved to be a very effective discriminator despite similar questions on speciation occurring previously in this component. The vast majority of students obtained the mark for geographical isolation / separation. However, many students only referred to the lack of interbreeding after the new species had been formed rather than during the process of speciation. These responses did not obtain the

equivalent mark point. Variation and mutation were not always linked or one of these was omitted. Mutations were occasionally caused by the environment or by variation. Different selection pressures were well known although sometimes there were vague references to 'different conditions' or 'different climates'. Most students understood that differential reproductive success resulted in a change in allele frequency although weaker students referred to 'alleles reproducing'. Less than five percent of students managed to miss every marking point, sometimes after writing a whole page in response. These answers often described succession or directional selection.

(b) As expected this question was very well answered with over seventy percent of students obtaining three out of the four marks available and just over a third obtaining maximum marks. Although there was some variation in which marking points were omitted, a significant number of students did not mention leaving time for lizards to distribute randomly in the population before obtaining a second sample. Other common errors included omitting any reference to releasing the lizards after they were initially captured and / or providing an incorrect equation for calculating the final population. Most students appreciated that the method of marking the lizards should not cause harm or make them conspicuous to predators.

(c) This was another question which proved to be a good discriminator and provided a good spread of marks. There were some excellent answers with these students providing a detailed account of the relative effects of photosynthesis and respiration on the concentration of carbon dioxide in a forest over a period of 24 hours and at different heights above the ground. These answers included reference to the greater rate of photosynthesis than respiration during the day, a concept that was not found in the vast majority of scripts. At the other end of the range ability, students often only gained credit for linking an increase in concentration of carbon dioxide at night to respiration. Better answers did refer to 'no photosynthesis' at night for a second mark but a surprising number of students referred to 'less photosynthesis' at night, suggesting that it was still occurring. The information about heights above ground tended to be less clear and often failed to include more or less (respiration or photosynthesis). A surprising number of students suggested there was a greater carbon dioxide concentration higher up linked with more photosynthesis, despite previously giving correct descriptions of carbon dioxide uptake for photosynthesis and its release from respiration and gaining some of the earlier marking points. References to microorganisms were rare. A minority of answers described and explained changes in oxygen levels. Some students believed that the light-independent reaction could occur at night. A few responses described carbon dioxide levels in the upper layers of the atmosphere (troposphere, stratosphere).

Q8.

(a) The vast majority of students gained one mark for explaining that using ratios enabled a (valid) comparison to be made. However, only half of these students then explained that ratios would not be affected by different sample sizes. Incorrect responses referred to ratios being easier to work with, or that they would allow statistical tests to be performed.

(b) Most students had no difficulty linking red blood phenotypes to the chance of developing severe malaria rather than mild malaria for one mark. However, only half of these students then gave a correct numerical comparison to gain a second mark.

(c) The majority of students understood why the frequency of the Hb^C allele was higher in malarial areas but only the better responses explained it in a way that enabled them to gain all three marks. Most answers only referred to the Hb^C allele. Most students appreciated that individuals with the Hb^C allele were more likely to survive

malaria and to reproduce. However, students did not always fully explain that the Hb^C allele would be passed on to future generations, thus increasing the frequency of this allele. Very few students appreciated that selection would operate against Hb^AHb^A individuals.

Q9.

(i) It was disappointing that only one-third of students scored at least one mark. Students who failed to score nearly always simply repeated information given in the question stem. Responses such as 'to see if schizophrenia is due to genes or the environment' and 'identical twins are genetically identical but non-identical twins are not genetically identically' were widespread. Only the very best responses referred to *each type* of twin and explained their role in determining the relative effects of genes and the environment in the development of schizophrenia.

(ii) 70% of students were aware that the data suggested genes play a greater role in schizophrenia than the environment. Students who failed to score nearly always gave statements that were not comparative, e.g. 'genes are involved' and 'genes and the environment are involved'.

(iii) Just over 60% of students gained full marks with answers such as age, sex or family history of mental illness. Weaker responses such as 'health', 'lifestyle' and 'environment' were not credited.

Q10.

(a) This question was well answered by students with over eighty percent of students obtaining three or more marks. The most commonly awarded marks were; electrons becoming 'excited', energy being released from the ETC, energy being used to form ATP from ADP and Pi and details of the photolysis of water. Marks were often not awarded because of references to chlorophyll absorbing light rather than light energy (or photons), or for referring to NAD being reduced rather than NADP. However, it was clearly evident that this topic is well understood by most students, with many answers including factual details well beyond the requirements of the specification.

(b) This question proved to be a relatively good discriminator and provided a good spread of marks. There were some excellent answers where students provided a detailed account of speciation, clearly linking this process to the context of the question. At the other end of the range, there were references to plants becoming 'immune to copper' and considerable confusion between genes and alleles. Most students referred to a mutation, to an allele providing 'resistance to copper' and to differential reproductive success. Better answers mentioned the 'allele for copper resistance' and often appreciated that the frequency of the allele would increase in future generations. Far fewer students mentioned 'variation'. A significant minority of students provided a description of succession, often in addition to explaining speciation.

example change

Q11.

(a) Many students gave a full definition, including location and time. A surprising number of students gave vague responses relating to a group of organisms, a collection of organisms or a number of organisms. Some only referred to animals or just several different species or all the organisms of one species, without the important idea of the community including all the organisms in the location.

(b) In their answers to part (i), there were many very clear accounts that scored all four marking points. Quite a few students forgot to mention releasing the fish or failed to describe either a way of marking the fish or that the method should not harm the fish or make them more visible to predators. References to the percentage of marked fish in the second sample were often seen. The equation was sometimes incorrect with the total number caught as the denominator.

The vast majority of students gained the mark for part (ii), clearly understanding that the population would be increasing. Other correct answers related to behaviour during the breeding season that would result in an unrepresentative number of fish being caught. Some responses failed to gain credit because they did not clearly relate to behaviour associated with breeding.

(c) Many students correctly linked the shape of the mouth to the different food types exploited. However, while competition was sometimes mentioned, only the better students were able to link this to reducing competition between species, thereby showing an understanding of the significance of the niche. A significant number tried to explain how different mouth shapes arise by natural selection.

Q12.

(a) Part (i) was correctly answered by many as a non-living factor, and most students gave a suitable example for part (ii).

(b) Answers to this question were frequently very disorganised, with students wasting many lines describing the data before attempting an explanation. The first marking point was often gained, usually for no photosynthesis at night, but students did not then develop the idea and explain that this resulted in no carbon dioxide being taken up at night. The production of carbon dioxide in respiration, and therefore that the uptake in the light was a net movement, was also very rarely mentioned. A few students tried to include the detail of the Calvin cycle to explain the reduction in carbon dioxide levels. Marking point 4 was often awarded for carbon dioxide taken in by leaves. The higher concentration of carbon dioxide at ground level was sometimes explained as being because it is denser than oxygen.

(c) There were many excellent answers where all four marking points were clearly understood and explained using the correct terminology. Many students could clearly explain that advantageous characteristics allowed trees to survive and reproduce successfully. They gained two marks. The change in allele frequency was also often correctly explained with fewer incorrect references to genes. There was some apparent misunderstanding of germination which seemed to be taken by some students to mean reproduction. There was the occasional account of succession or descriptions of features advantageous to survival in the mountains. Weaker students could say little more than that the trees with an advantage were more likely to survive. There were frequent references to directional and stabilising selection.

Q13.

(a) (i) This caused little difficulty for most candidates with the vast majority gaining at least one mark for suggesting that *C. difficile* is resistant to antibiotics. Although many candidates realised that the other bacterial species would be killed, they failed to gain a second mark by not stating that there would be an increase in the number of *C. difficile*.

(ii) Most candidates gained this mark by suggesting that the immune system would be less effective. There were several answers linked to older people

taking lots of antibiotics. These responses were not credited.

(b) Although the majority of candidates obtained at least one of the two marks available, there was still some confusion, particularly with weaker candidates, about the precise role of methicillin. Most candidates realised it was a competitive inhibitor but a significant number referred to it possessing an active site. Approximately forty percent of candidates provided a clear accurate explanation of competitive inhibition by methicillin.

(c) (i) The majority of candidates had little difficulty explaining that some of these patients were already ill and this illness could be the cause of death.

(ii) The vast majority of candidates gained this mark by describing the increase in the number of deaths up to 2006 followed by a decrease.

(iii) Less than a third of candidates could correctly calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. A small percentage of candidates obtained a single mark for reading figures from the graph but almost sixty percent scored zero.

Q14.

(a) About 50% of candidates gained both of the marks available for part (i), but of the rest there was considerable evidence of confusion. Nearly all wrote out the equation $p^2 + 2pq + q^2 = 1$, when finding 0.2^2 was all that was needed in this case. Many also did not know whether the allele frequency of 0.2 was the value for q or for q^2. Most candidates responded correctly to part (ii), but a number continued to provide irrelevant detail about the conditions required for the Hardy-Weinberg principle to be valid.

(b) Few candidates gained both the marks available for part (i), as they did not show the necessary understanding of the difference between chance and probability. The answer given by many to part (ii), stabilising selection, suggested that they had not read the stem of this part of the question carefully enough. Those candidates who missed marks in their explanations usually did so because they wrote generally about selection rather than explaining the effect of this allele on survival and reproductive success and the consequent decrease in its frequency.

Q15.

(a) The general purpose of a control experiment was understood well and many expressed the idea that a control would allow comparison with wheat plants grown on their own.
Candidates were less inclined however to point out that a control was necessary in order to determine the dry mass as the relevant percentage.

(b) Most candidates were able to suggest that interspecific competition occurred and extract the relevant data to support this. They experienced considerably more difficulty, however, in explaining the effects of the plastic covers in terms of competition between the roots or the shoots.

(c) The marking guidelines allowed for full credit for less than comprehensive answers to this question. This was perhaps fortunate because few suggested that temperature might have affected wheat and ryegrass seedlings differently.

Q16.

(a) Almost all candidates referred to carrying out the procedure using distilled water but very few indicated that the same number of ryegrass seedlings would be required.

(b) Maximum credit was usually scored in part (a) with candidates correctly choosing the Spearman rank correlation test and indicating either that they would use this to test a null hypothesis or determine the probability of obtaining results by chance. Part (b) was, almost without exception, answered correctly.

(c) Most candidates scored at least one of the two available marks for part (a) by identifying either the reduced germination of ryegrass or the reduced root growth. There were few convincing answers to part (b), however, and most candidates approached this question by unjustified criticism of the experimental approach.

Q17.

(a) It was clearly evident that the majority of candidates had a good understanding of the process of succession. Forty percent of candidates gained maximum marks and over ninety percent of candidates scored at least two marks. Candidates provided either a general description of the key features of succession or described a specific example of succession in sufficient detail to include all the relevant mark points. There were some rather simplistic accounts but generally the standard of the responses in terms of clarity of expression and use of scientific terminology was high. However, some candidates provided a time frame of thousands or millions of years for succession to occur. A few candidates misinterpreted succession and described evolution or eutrophication.

(b) There were some excellent answers with good candidates using the information to provide a detailed account of the processes involved in speciation. At the other end of the range ability, there were some very confused responses which often included statements such as ‘genes dying out’ and ‘species selecting the most advantageous alleles’. Poor powers of expression often prevented weaker candidates gaining credit although it was also evident that many answers were based on a poor understanding of natural selection. There was considerable confusion between genes and alleles and the idea of separate gene pools was often included as a consequence, rather than as a cause, of speciation. Despite the reference to 10 000 years in the stem of the question, only better candidates conveyed the idea that speciation had occurred over a long time period.

Q18.

(a) Most candidates had some understanding of the function of restriction endonuclease but were not always sure of its role in the investigation described. Thus, there were numerous references to the enzyme “cutting out” particular sections of DNA, these pieces ranging from haplotypes, to genes and even chromosomes. Most candidates correctly suggested that electrophoresis would be involved in separating the DNA fragments, although some were clearly of the opinion that it was the chains of DNA that were separated.

(b) Candidates were generally able to describe the complementary base sequence present on the probe but seldom progressed to explain how it could be used to show that the haplotypes concerned were the same.

(c) The majority of candidates linked the Y-chromosome to male inheritance in part (i) although a significant number suggested that the Y-chromosome was inherited from the female. Part (ii) was targeted at stronger candidates, but very few could suggest that mitochondria could only be passed to the offspring in the cytoplasm of the egg.

(d) The responses to part (i) suggested that while many candidates were aware that giving the units per unit area enabled comparison, they were uncertain as to what was being compared. The most frequent suggestion was that it allowed wolves to be compared with prey numbers. Others wrote about the territorial behaviour of wolves or suggested that the mobility of the animals made counting over a larger area too difficult. In part (ii), better candidates appreciated that wolves ate only part of their prey and that the amount eaten differed with different species of prey.

(e) Although the positive correlation between prey index and wolf numbers was usually recognised, few progressed to state that this suggested that food must be limiting population size. Unfortunately, the few who pointed out that other factors might possibly be involved rarely linked this conclusion to the spread of data on the graph.

Q19.

This question was targeted at candidates of more modest ability and tested section 3.4.8 of the specification. It built unavoidably on foundations laid in Unit Biol 2.

(a) The many candidates who focused correctly on heat loss were generally able to gain full credit. Some confusion was demonstrated over the relationship between size and surface area to volume ratio. This concept is specifically mentioned in the list of biological principles given at the end of Unit 2.

(b) Part (i) was answered well although a few candidates clearly did not recognise that a percentage is not the same as an actual number. Answers relating to more geese being found further north did not gain credit. In part (ii) most candidates appreciated that this question related to selection and responded in terms of camouflage and predation. However, a significant number of responses failed to offer an explanation of the specific situation described. These answers were frequently worded in general terms or were, in some cases, related to the size of the geese or to other organisms entirely.

(c) Although there were many excellent answers to this part of the question, there were also responses phrased in unacceptable anthropomorphic language relating to geese “not liking warm conditions” and “feeling happier further north”. Other candidates incorporated material outside the requirements of the question and gave lengthy accounts of the perceived causes of climate change.

(d) Many candidates correctly identified the graph as illustrating stabilising selection but relatively few were able to explain the evidence with sufficient clarity to gain the mark in part (ii).

Q20.

(a) Most candidates correctly identified a taxonomic group to which all seals belonged, although some failed to understand the meaning of the phrase ‘taxonomic group’ and suggested mammals or animals.

(b) In spite of the many correct answers to part (i), there was much less certainty over the identity of a genus. The correct answer of six was seen relatively rarely and, while there was a certain logic to some of the alternatives suggested, it was difficult to understand the reasoning underlying many of the others. Although part (ii) was answered rather better, some of the responses to part (iii) suggested a lack of understanding of the diagram. The references to grandparents and to brothers and sisters suggested confusion of the taxonomic representation here with a family tree. Some candidates also experienced difficulty with the idea of a common ancestor, and clearly interpreted common as meaning found in large numbers. Of those who

did appreciate what was required, only the better candidates answered appropriately.

(c) The concept of genetic diversity is new to this specification and it was encouraging to note that many candidates clearly understood the meaning of the term.

Q21.

(a) Most candidates correctly identified the length of a single song as either 2 or 1.75 seconds but some experienced obvious difficulties in managing the scale bar. Conversion of the answer to part (i) into a rate proved challenging for many, however.

(b) Less able candidates often failed to maintain focus here and, instead of discussing the species-specific nature of mole cricket song, digressed from this theme to review the advantages of courtship behaviour in general. Better candidates produced more directed answers, and often also noted the advantages of song in a species that was nocturnal and lived underground.

(c) Many candidates gained both marks for recognising that the song of the hybrid would not attract a female. Others adopted a different, but acceptable, approach and based their answers on the likelihood that hybrids would be sterile. Such answers, however, tended to labour this point. As a result, they usually failed to gain full credit.

Q23.

(a) The majority of candidates were able to complete the table correctly to show the missing levels of classification of the guinea pig.

(b) In explaining sympatric speciation, many candidates demonstrated that they were well versed in the various forms of isolating mechanism, although some confused sympatric and allopatric speciation, and suggested various inappropriate geographical forms of isolation. Many also appreciated that changes in allele frequency or divergence of gene pools might occur between separate populations. Many forgot to mention *mutation* as the cause of changes in alleles.

(c) Careless handwriting by many candidates made it difficult for examiners to distinguish between letters used as symbols for the alleles. Although a fair proportion got this section completely correct, errors included monohybrid crosses and sex-linkage.

(d) The vast majority understood the meaning of the term *null hypothesis* and were able to state a suitable one.

Q24.

(a) Nearly all candidates were able to described photophosphorylation accurately and many scored full marks.

(b) A good number of candidates recognised the benefit of sediment-dwelling bacteria being able to absorb wavelengths of light that were not absorbed by the surface-dwelling bacteria. However they often then went on to suggest that the bacteria with this ability would out-compete the surface dwellers, rather than sediment dwellers without the ability to synthesise chlorophyll. As a result, some of the points they made about the process of natural selection were in the wrong context.

Q25.

(a) Although most candidates recognised this as a question about natural selection, many did not gain marks by failing to identify the nature of the selection pressure (use of the antibiotic) or to explain how resistance would become widespread. Some candidates answered in a completely different way and, effectively, answered part (ii) by describing the nature of mutations and how they could affect the ability of an antibiotic to bind with receptors in the bacterial membrane. This said, however, there were quite a number of very good responses scoring full marks or nearly full marks.

(b) Many candidates, of all abilities, were familiar with the Hardy-Weinberg equations and were able to apply them to the data given to calculate the frequency of the heterozygotes (0.18/18%). The most common error was to assume that the frequency of those homozygous recessive (0.01) in the population is represented by q, rather than by q2. Some then used this wrong value to find p and, from that, 2pq and so were able to gain some credit for showing elements of a correct method, even though they arrived at an incorrect answer.

Q26.

(a) Most candidates suggested crossing over in prophase I and independent assortment of chromosomes in anaphase I of meiosis. Some correctly suggested independent assortment of chromatids in anaphase II of meiosis.

(b) Explanations of standard deviation and range sometimes suffered as a result of vague and imprecise language. It is not helpful to use the term ‘range’ when trying to explain what range means. It is incorrect to say that standard deviation relates *each value* to the mean, as a good number of candidates suggested, and it is not enough to say that standard deviation describes the spread of data; it describes the dispersion or spread *about the mean*. Candidates need to be more precise in their answers.

Q27.

Poor expression and a tendency to describe rather than explain caused the majority of candidates to score poorly on this question.

(a) The majority of candidates described the pattern shown by the graph. Of those who did explain, the answers were often incomplete. ‘Intraspecific’ competition was rarely mentioned, and candidates often referred vaguely to ‘resources’, rather than a named resource.

(b) Candidates also tended to state rather than explain, and so could not be awarded the mark. In part (ii), poor expression and incomplete answers were common, especially when expressing the chance of survival of the chicks or the reason why chicks were unlikely to develop into adults and pass on their genes. A significant number misread the question and explained why 14 rather than 3 chicks would be an advantage.

Q28.

This question discriminated well and produced the full range of marks.

(a) This was generally well answered with many candidates scoring four or more marks. Explanations of the changes in lemming and weasel numbers were generally done well, and many candidates also mentioned the lag between the changes in the two species. The 4-year cycle was only mentioned by a minority of candidates.

(b) Many candidates did not answer the question set, and instead concentrated on the isolation aspect and how the movement of animals prevented speciation. Many of those that did answer in terms of variation did not mention the large fluctuations in size, stating that any isolated population would have a small gene pool. Many explained why variation was important rather than how it was maintained. The two points in the mark scheme were therefore only scored by the better candidates.

(c) Answers to this part were disappointing with only the best candidates scoring full marks. Although the majority of candidates stated that the two populations had been separated into different environments, many did not mention that were geographically isolated and often incorrectly referred to two species being present at the time of separation. Changes in the two populations were often attributed solely to mutation, with no discussion of the importance of natural selection in the process. Definitions of species were also poor, with many candidates referring to individuals producing infertile offspring, or failing to produce viable offspring.

Q29.

Many good answers were seen to both parts of this question. The topics covered were obviously familiar to many candidates. Where marks were not gained, it was usually because of omissions rather than errors. The full range of marks was seen and the question discriminated well.

(a) Almost all of the candidates obtained a mark for noting that cyanogenic plants might die in areas with very low mean January temperatures. Many went on to obtain a second mark for identifying the positive advantage that cyanogenic plants have in warmer areas, because they deter herbivores. Only the better candidates wrote about the impact of these different selection pressures on allele frequencies in different clover populations. It was encouraging to note that ‘rote answers’, unrelated to this example were absent. Some weaker candidates did fail to score marks because they wrote in general terms about factors affecting natural selection and evolution but with no reference to the specific factors given in this example.

(b) The vast majority of candidates were familiar with the use of quadrats. Many were also able to describe a suitable method for placing these at random locations in the study areas. Some candidates suggested the use of transects and this suggestion was rejected; unless they suggested the use of very large numbers of transects along randomly chosen lines. Many candidates scored one mark for suggesting the use of large numbers of quadrats. A surprising number failed to get this mark, either because they made no reference to sample size, or because they wrote vaguely about ‘several’ quadrats being used. The majority of candidates obtained a mark for what a quadrat might be used to measure. A large number of candidates made reference to the use of statistics but often that was all they said. The examiners were looking for the use of a statistical test to determine whether or not there was a significant difference in the number of clover plants in the two areas.

Q30.

Most candidates had little difficulty obtaining at least half the available marks for this question.

(a) The vast majority of candidates gained both marks, almost invariably for indicating that organisms of the same species would breed together to produce fertile offspring. A few weaker candidates referred to DNA but these answers were only credited when a specific method of comparing the DNA, e.g. DNA sequencing, was mentioned.

(b) Most candidates were able to gain at least one or two marks, often for referring to variation being present in each population and the different selection pressures in the different environments. Better candidates had little difficulty obtaining maximum marks by explaining that organisms with favourable alleles would survive and pass these alleles on to future generations, resulting in a change in the frequency of alleles. However, some weaker candidates provided descriptions akin to Lamarckism, although these were not as prevalent as in previous years.

(c) Unfortunately, a significant number of candidates considered colour and camouflage rather than colour and mate selection. However, candidates making the correct link usually obtained both marking points.

Q31.

(a) The majority of candidates scored at least two marks. Some confused algae with zooplankton or had problems expressing themselves when describing the different depths by using terms such as .higher depth.

(b) Part (i) was answered correctly by most candidates but some misread the data and referred to number of fish rather than time present. Many candidates tried to answer part (ii) in terms of geographical isolation, so there were many references to zooplankton living in deep water, rather than selection acting on the variation in depth of migration during the day. Candidates that linked parts (i) and (ii) together generally scored well, although a significant number of candidates stated that zooplankton had the capacity to learn.

Q32.

(a) There were some good answers to this question, indicating a good understanding of the process. The majority of candidates scored at least two marks and the best candidates scored full marks. Poor expression and incorrect use of terminology were the main reasons why candidates failed to score well. A significant number made no mention of copper tolerance in their answer and just gave a generic description. Many wrote incorrectly about natural selection as a process which occurred when necessary.

(b) This proved to be an effective discriminator. Weaker candidates either just stated that interbreeding between the two types would not be possible, or stated that individuals of different species cannot produce fertile offspring. Only the best candidates were able to give a full explanation of the processes leading to speciation. There was a tendency for candidates to refer to single plants of the two types, rather than populations, and to state that individual plants are adapted to their environment. Poor expression and the incorrect use of technical terms were very common.