AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.4.5 SPECIES AND TAXONOMY

SCORE	PERCENTAGE
/223	%

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Q1.

(a) 1. (It shows) smaller groups within larger groups / larger groups containing smaller groups;

Accept groups within groups

2. With no overlap (between groups);

2

(b) Family;

Accept phonetic spellings

1

(c) 1. Sine song is (very) similar / same length (for both, so closely related).

2. (But) have different peaks / pulses (in pulse song);

Must give a difference, not just state they are different

Accept suitable differences eg number / length / amplitude / interval

2

(d) 1. (Three) peaks (in pulse song) occur at the same time (since both female) / songs identical / male peaks are different;

Accept suitable differences in male peaks eg number / length / amplitude / interval

2. (Therefore) no male (song) to stimulate / cause mating;
OR
Nothing to stimulate / cause mating;

2

[7]

Q2.

(a) (A measure of) the number of (different) species in a community;

For 'community' accept 'habitat/ecosystem/one area/environment'

Reject 'in a population'.

1

(b) **Yes, natural best, because**

1. Peak of (mean) bee numbers in natural habitat is highest;

For accept description for 'peak'.

2. The (mean) number of bees was higher in the natural habitat until day 200;

2. For 'day 200' accept any day between 190 and 210.

2. For 'until day 200' accept 'for 200 days'.

3. (Mean) species richness in natural habitat higher at all times;

No, natural not best, because

4. Lowest (mean) number of bees after day 220;
4. For 'day 220' accept any day between 210 and 230.

Yes, town worst, because

5. Peak of species richness higher in both natural and farmland

OR

Species richness lowest in town from day 125;
For 'day 125' accept any day between 115 and 135.

No, town not worst, because

(Mean) species richness is lower in farmland until day 125;
For 'day 125' accept any day between 115 and 135.
For 'until day 125' accept 'for 125 days'.

7. Similar (mean) number of bees to farmland;

OR

(Mean) number of bees lower in farmland until day 140;
For 'day 140' accept any day between day 130 and 150.
For 'until day 140' accept 'for 140 days'

General, no, because

8. Index of diversity of bees not measured

OR

The number of bees of each species is not known;

4 max

(c) 1. Must not harm the bees
OR
Must allow the bee to be released unchanged;

2. Must allow close examination
OR
Use a key (to identify the species);
Accept method that allows close examination
Ignore references to DNA sequencing
Accept 'use photographs/specimens (to identify species)'

2

(d) 1. Collect at more times of the year **so** more points on graph/better line (of best fit) on graph;
Both suggestion and explanation is required for each mark point.
The explanation must relate to the graph.

2. Counted number of individuals in each species **so** that they could calculate index of diversity;

3. Collected from more sites/more years **to** increase accuracy of (mean) data;

For 'accuracy' accept 'representative'.

2 max

(e) 1. *A. chlorogaster* and *A. piperi* are more closely related (to each other than to *P. pruinosa*);

Must be a comparative statement.

Accept A. chlorogaster and A. piperi share a more recent/closer common ancestor (than they do with P. pruinosa);

Ignore references to A. chlorogaster and A. piperi not being related to P. pruinosa or not having a common ancestor with P. pruinosa.

2. Because they are in the same genus;

2

[11]

Q3.

(a) 1. Species = (A group of) organisms that are able to produce fertile offspring;
2. Species richness = the number of (different) species in a community;

2. Accept in a habitat / ecosystem / area

2. Reject in a population

2. Ignore 'types' unqualified

2

(b) 5;

1

(c) 1. Number of individuals of each species not known;
2. **Almost** all (of sample A / the 68%) could be of the same species;
3. Two / other samples have a higher number of species / higher species richness but a lower number of individuals / fish;
4. Other samples may have more individuals of each species;

2. If not stated otherwise, assume MP2 relates to sample A / 68%

3 max

[6]

Q4.

(a) 1. (Without genetic analysis / **X**) *mackloti and olivaceus* have a more recent common ancestor with each other (than with *papuana*);
2. (Genetic analysis indicates / **Y**) *papuana and mackloti* have a more recent common ancestor with one another (than with *olivaceus*);

Accept 'more closely related to' for 'more recent common ancestor'

2

(b)

Domain	Eukaryote
Kingdom	Animal
Phylum	Chordata

Class	Reptilia
Order	Squamata
Family	Python

;

All 5 correct = 1 mark
Any errors = 0 marks

1

(c) Genus / genera;

If the response has two answers no mark is awarded.

1

(d) 1. The (base) sequence of DNA;

Accept 'DNA hybridisation'

2. The (base) sequence of mRNA;
3. The amino acid sequence (of proteins);

3

[7]

Q5.

(a) 1. Same genus;

2. Same evolutionary origin / common ancestor.

2

(b)

Taxon	**Name of Taxon**
Domain	Eukarya
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Rodentia
Family	Muridae

3 correct = 2 marks
2 correct = 1 mark
1 or 0 correct = 0 marks

2

(c) 1. (No) SDs of means of body sizes / sizes of parts of bodies overlap;

2. Calculation of correct head and body: tail ratios;

3. Almost identical, so same body shape / proportions;

3

(d) 1. Breed the two mice together;

2. (Same species) produce fertile offspring.

2

[9]

Q6.

(a) Phylum;

1

(b) **M** placed correctly between zygote and zygospore;

1

(c) Any valid reasons, e.g.

Asexual

Fewer stages so quicker
OR
Only one parent involved so can colonise new environment
OR
Produces clone so successful (geno / pheno)type maintained;

Sexual

increases genetic diversity so greater chance of survival / success.

2

(d) Spores spread / dispersed further;

1

(e) 1. Measure diameter of large number of spores;

2. Divide measured values by 700 (to find true diameter);

3. Reference to using volume of sphere.

3

[8]

Q7.

(a) PKNJ.

1

(b) *Lutra lutra.*

1

(c) Bone / skin / preserved remains / museums.

1

(d) 1. (Hunting) reduced population size(s), so (much) only few alleles left;
Accept bottleneck

2. Otters today from one / few surviving population(s);
Accept founder effect

3. Inbreeding.

*Allow any **two***

2 max

(e) 1. Population might have been very small / genetic bottleneck;
2. Population might have started with small number of individuals / by one pregnant female / founder effect;
3. Inbreeding.

*Allow any **two***

2 max

[7]

Q8.

(a) 1. Kingdom, Phylum, Class, Order, Family;
2. *Luscinia svecica.*

1 mark for each correct column

Allow Genus and Species if both placed in box for species but not if both placed in genus box

2

(b) Number of different alleles of each gene.

Accept number of different base sequences (found) in each gene

1

(c) 1. Has greater proportion of genes / percentage of genes showing diversity;
2. Percentage is 35% compared with 28% / proportion is 0.35 compared with 0.28.

Allow correct figures that are not rounded up, i.e., 34.9% / 0.349 and 27.8% / 0.278

2

[5]

Q9.

(a) 1. (So) age not a factor in female choice;

2. (So) will attract a mate;

3. (So similar) sexual maturity;

4. (So) have the correct feathers;

4. Accept 'have blue feathers'

2 max

(b) Number the birds, then numbers out of hat / random number generator;

Both aspects needed for mark

1

(c) 1. That movement was not related to some other factor (than the male);

2. That movement (towards the male) indicated mating behaviour;

3. (Females) only respond to throat feathers (of the male) / do not respond to other visual display / sounds / calls (by the male);

2 max

(d) 1. Change in sequence of bases / nucleotides;

2. (As a result of a) deletion / substitution;

3. Change in amino acid sequence / primary structure;

4. Change in tertiary structure of protein;

1. Do not accept 'change in the DNA sequence'

2. Accept e.g. addition / inversion / duplication / translocation

3

(e) **Yes**

1. (From resource A) birds can detect UV light;

2. (From resource B) difference between UVR and NR significant / not due to chance;

3. As error bars do not overlap;

*3 max if only **No** marks awarded*

2. Reject idea that 'results' in resource B are significant / not due to chance, must include idea of 'difference'

3. Reject 'as standard deviations do not overlap'

No

4. UV light may not be involved in mating / other factors may be involved in mating;

5. Some birds in UVR group were attractive to females;

6. (Experiment in resource B) carried out in artificial conditions / only 40 birds used / small sample size;

6. Neutral: idea that this is only one study / that there are no repeats

4 max

[12]

Q10.

(a) (i) (Grouped according to) evolutionary links/history/relationships / common ancestry;

Ignore: closely related, factors, characteristics

Ignore: genetically similar

1

(ii) 1. Able to reproduce;

Accept: smallest taxonomic group/groups of organisms with same genes/ chromosomes/same number of chromosomes

Accept: breed for 'reproduce'

Ignore: mate

Reject: genetically identical

Ignore: similar genes/chromosomes

2. To produce fertile offspring;

Ignore: that are 'viable'

2

(b) Phylum
Class
Family
Genus;

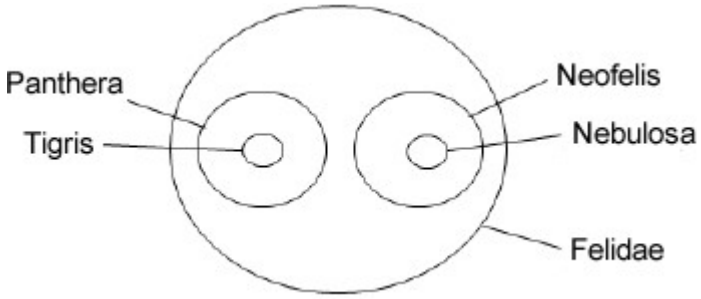
Accept: pleural answers phyla / genera / families

Accept phonetic answers
phyllem/phylem/fylum/fyla/phylae/phyli/jenus/ jenera/familys

All 4 in correct order for 1 mark

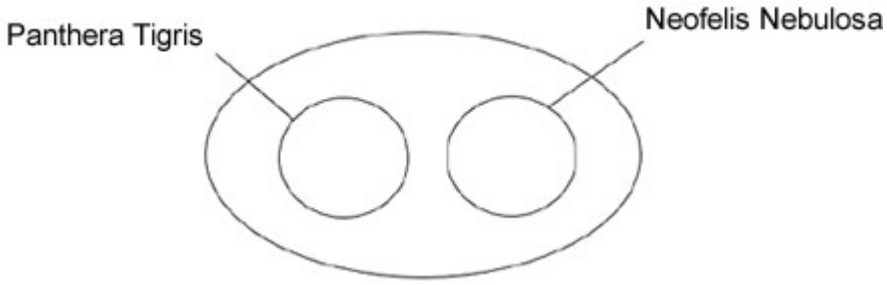
1

(c) 1. Two circles/with two inner circles with no overlap;



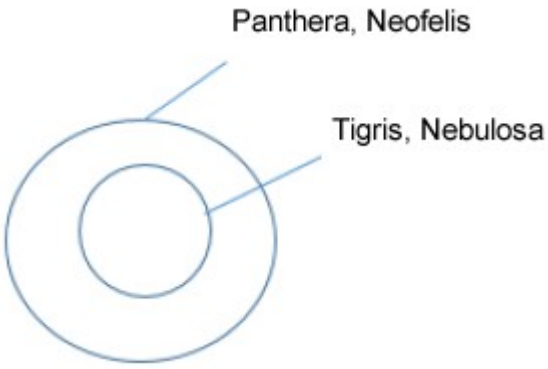
= 2 marks

OR



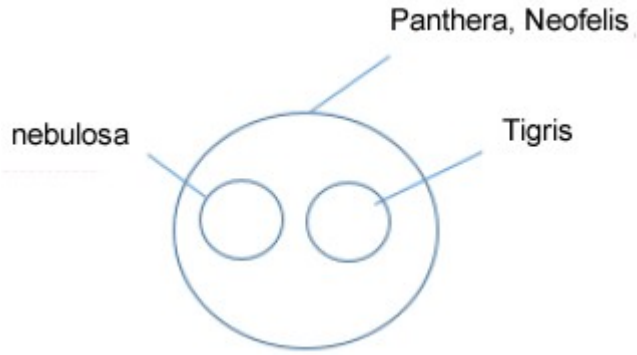
= 2 marks

OR



= 1 mark

OR



= 1 mark

2. Labels correct;

Ignore underlining / capitals

Accept: P tigris/ N nebulosa

Accept phonetic spelling

2

(d) 1. South China and Sumatran tigers share a more recent common ancestor;

Accept: more closely related (statement must be comparative)

Accept: a labelled hierarchy

2. (because) identical/same/matching (nucleotide) sequences;

Accept: converse for Siberian tiger eg Siberian is less closely related to South China AND Sumatran tigers



2

[8]

Q11.

(a) 1. Recognise / identify / attract same species;

Ignore: references to letting them produce fertile offspring

2. Stimulates / synchronises mating / production / release of gametes;

3. Recognition / attraction of mate / opposite sex;

Accept finding a mate

Accept: gender

4. Indication of (sexual) maturity / fertility / receptivity / readiness to mate;
5. Formation of a pair bond / bond between two organisms (to have / raise young).

3 max

(b) 1. Use a (real) male (with intact wings / no wing removed);

Mark ignoring reference to birds / or other types of animals

Accept: use a real cricket, since only males sing

2. Determine (percentage) response (of females compared with **L**).

*Accept: compare results with **L***

2

(c) 1. Lowest / only 30% courtship with no song / K / (or) courtship still occurred when no song played / **K**;

Note: throughout, for courtship accept response / stimulation / reaction

Neutral: references to methodology

Answer must make clear there is no song / version K

2. Reduced courtship when no ticks / M / there is some courtship when no ticks / M;

3. Reduced courtship when no chirps / N / there is some courtship when no chirps / N;

Accept: use of figures from the table <u>in an explanation</u>

4. (So) courtship must involve a visual stimulus / other factor involved;

5. Chirps more important as lowest courtship when none / N / ticks less important as similar courtship when changed / M;

Must make comparison to gain mark

6. Data only show presence and absence of chirps / 0 and 7 chirps.

Note: 'courtship still occurred when no sound played so a visual stimulus / other factor / something else (e.g. pheromone?) must be involved'

= 2 marks

4 max

[9]

Q12.

(a) Aves;

1

(b) Gallicolumba kubaryi;

Must have <u>both</u> words and in <u>this</u> order

Must be capital G

If starts with k, award mark as impossible to recognise difference

Ignore: underlining

Accept: phonetic spelling

Accept: G kubaryi (must be a capital / upper case G)

1

(c) No overlap.

1

[3]

Q13.

(a) (i) 1. Groups within groups;

*Accept: idea of larger groups at the top **or** smaller groups at the bottom*

2. No overlap (between groups);

2

(ii) **3**;

1

(iii) Chordata;

Accept: if phonetically correct eg 'Cordata'

1

(b) (i) 1. (To provide) genetic variation;

Genetic variation must be directly stated and not implied

2. (Allows) different combinations of maternal and paternal chromosomes / alleles;

Accept: any allele of one gene can combine with any allele of another gene

2

(ii) 1. (Zedonk has) 47 / odd / uneven number of chromosomes;

Accept: diploid number would be odd

Reject: if wrong number of chromosomes is given

2. Chromosomes cannot pair / are not homologous / chromosome number cannot be halved / meiosis cannot occur / sex cells / haploid cells are not produced;

Accept: cannot have half a chromosome

***Q** Reject: meiosis cannot occur **in** sex cells*

2

[8]

Q14.

(a) 1. Group of similar organisms / organisms with similar features / organisms with same genes / chromosomes;

1. Accept: same number of chromosomes

1. Accept: smallest taxonomic group

1. Reject: genetically identical. Only allow 1 max if mentioned

*1. **Q** Neutral: similar genes / chromosomes*

2. Reproduce / produce offspring;

2. Accept: breed / mate

3. That are fertile;

3. Neutral: that are 'viable'

'Produce fertile offspring' = 2 marks

2 max

(b) (i) Correct answer of 6.97 to 7 = 2 marks;

One mark for 6320 as numerator or 906 as denominator;

2

(ii) 1. Decrease in variety of plants / fewer plant species;
1. Accept: reference to monoculture or description
1. Neutral: fewer plants

2. Fewer habitats / niches;
2. Neutral: fewer homes / less shelter

3. Decrease in variety of food / fewer food sources;
3. Neutral: less food
3. Accept: less variety of prey

3

[7]

Q15.

(a) (i) 1. Groups within groups;
1. accept idea of larger groups at the top / smaller groups at the bottom

2. No overlap (between groups);

2

(ii) (Grouped according to) evolutionary links / history / relationships / common ancestry;
Neutral: closely related
Neutral: genetically similar

1

(b) (i) 1. (Only) one amino acid different / least differences / similar amino acid sequence / similar primary structure;

2. (So) similar DNA sequence / base sequence;

2

(ii) 1. Compared with humans / not compared with each other;
Accept: degenerate code / more than one triplet (codes) for an amino acid

2. Differences may be at different positions / different amino acids affected / does not show where the differences are (in the sequence);

1 max

(iii) 1. All organisms respire / have cytochrome c;
Accept: converse arguments for haemoglobin
1. Accept 'more' instead of 'all'
1. Accept 'animals' instead of organisms☐

2. (Cytochrome c structure) is more conserved / less varied (between organisms);
2. Neutral: cytochrome c is conserved

1 max

[7]

Q16.

(a) 1. No interbreeding / gene pools are separate / geographic(al) isolation;

Accept: all marks if answer written in context of producing increased diversity of plants

1 Do not award this mark in context of new species being formed and then not interbreeding

1 Accept reproductive isolation as an alternative to no interbreeding

2. Mutation;

2 Accept: genetic variation

3. Different selection pressures / different foods / niches / habitats;

3 Accept: different environment / biotic / abiotic conditions or named condition

3 Neutral: different climates

4. Adapted organisms survive and breed / differential reproductive success;

5. Change / increase in allele frequency / frequencies;

5

(b) Similar / same environmental / abiotic / biotic factors / similar / same selection pressures / no isolation / gene flow can occur (within a species);

Accept: same environment

1

[6]

Q17.

(a) (i) Kingdom / phylum / class;

Accept Animalia / animal kingdom / Chordata / Chordates / Aves

Allow phonetic spelling

1

(ii) Family;

1

(b) 1. Shows the spread of the data / how data varies;

1. Reject range.

Accept varies from the mean

2. Overlap = no difference / due to chance / not significant;

2. Allow converse

2

(c) 1. Different species would have different amino acid sequences;

Accept more closely related = more similar sequence

2. Amino acid sequence is the result of DNA / alleles / base sequence;

References to incorrect statements about coding negates second mark

2

[6]

Q18.

(a) (i) *Synodontis batensoda / S. batensoda;*
Ignore spellings

1

(ii) *Mochokus niloticus;*
Ignore spellings

1

(b) 5;

1

(c) (i) Fertile offspring produced;
Allow suitable description of offspring being fertile.

1

(ii) 1. Attracts / recognises same species;
Attracts mate of the same species = two marks.

2. Attracts / recognises mate / opposite sex;

3. Indication of sexual maturity / fertility / synchronises mating;
Allow 'ready to mate'.

4. Stimulates release of gametes;

5. Form pair bond;

2 max

[6]

Q19.

(a) Banding pattern changes as cheetah gets older / difficult to judge as tail is short / fluffy;

1

(b) (i) Mean not (always) a whole number;
Standard deviation not (always) zero;

2

(ii) Movement of tail / angle of sight / confused it with another band / subjective estimation;
*Accept reference to **Figure 1***
E.g. Bands 2 and 3 have same thickness but look different

1

(c) Band width not the same on both sides of tail;

1

(d) Offspring of the same family will be more similar genetically;
As have same mother (and father) / parent;
Expect to see more differences in randomly chosen cheetahs;

3

[8]

Q20.

(a) (i) Phylum, Class, Order, Genus;

Mantophasma (M) / (Mantophasma) zephyra;

2

(ii) Groups within (larger) groups;

No overlap;

2

(b) Comparison of / look for similar features / structures / appearance;

1

[5]

Q21.

(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]

Q22.

(a) Table completed as below:

Kingdom	Animalia / Animals	
Phylum	Chordata	
Class	Mammalia	
Order	Rodentia	
Family	Caviidae	
Genus	*Cavia*	Column 1 correct;
Species	*porcellus*	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]

Q23.

(a) group of organisms with similar features;
can (interbreed to) produce fertile offspring;

2

(b) directional selection;
any TWO from
selection against one extreme / for one extreme;
against broadest beaks in B and narrowest beaks in **A** / for narrowest in **B** and broadest in **A**;
whole distribution / range / mean / mode / median is shifted towards favoured extreme;

3 max

[5]

Q24.

(i) Taxon **A** - there is more than one level / taxon below it / genus only has species / only has one level / taxon above it;

(ii) Taxon **C** - there is more than one level / taxon above it / phylum only has kingdom / only has one level taxon above it;

[2]

Q25.

(a) (i) there are no fertile hybrids found in the overlapping regions;

1

(ii) even if mating took place, there would be no fertile hybrids / different chromosome number / gene pool / evolutionary history / many morphological / biochemical / serological differences;

1

(b) (i)

Kingdom	**Animalia / Animals**
Phylum	Chordata
Class	Mammalia
Order	Xenarthra
Family	Dasypodidae
Genus	***Dasypus***
Species	***(D.) novemcinctus***
1 mark per correct column	

2

(ii) Family, as all three belong to different genera;

1

[5]

Q26.

(a) phylum, class, order;
species, *Acinonyx jubatus;*

2

(b) larger groups containing smaller groups;

1

(c) (i) do not interbreed to produce fertile offspring / different DNA / different niches;

1

(ii) fossil record;
evolutionary history / phylogeny;
biochemical differences e.g. DNA / proteins / cytochromes;
homologous features / named feature;
karyotype / number and form of chromosomes;
(discount any example credited in (i))

2

[6]

Q27.

(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]

Q28.

(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]

Q29.

(a) large groups are divided into smaller groups;
(*not just 'hierarchical'*)
members of a group have features in common based on anatomy / fossils / embryology / DNA / specific aspect of cell biology / homologous structures;

reflects evolutionary history;

3

(b) fungi and animals;

1

(c) (insects and fungi) have common ancestor;
they diverged a long time ago / before others referred to in phylogenetic tree;

2

(d) those with similar sequences put in same groups / are more closely related;

the greater difference in amino acid sequence the longer ago the groups diverged;

2

(e) A - present in all (eukaryotic) species or organisms / quantifiable;
D - extinct species not considered / no timing of events available / only limited number of amino acid sequences / can't include prokaryotic species

2

[10]

Q30.

(a) principle of sequential multiplication (0.9×0.6×0.75×0.67);
0.27;

(correct answer 2 marks)

2

(b) (i) similar sequence / actions / sign stimuli;

1

(ii) additional action in sequence(species A) / scissor wings blocks sequence in B;

1

(c) (acts as) sign stimulus;
responds only to species-specific sound;

2

[6]

Q31.

(a) (i) Order, Family, Genus.

(all correct = 2 marks; 2 correct = 1 mark)

2

(ii) 3 concentric circles in Carnivora, labelled Felidae, Panthera and L;

1

(b) (i) large groups split into smaller groups (which do not overlap);

1

(ii) (phylogenetic) based on evolutionary history;
shows ancestry of groups / points of divergence / example, e.g. reptiles and birds separated after mammals / reptiles and birds more closely related than mammals;
(hierarchical) based on shared characteristics (seen today);

3

[7]

Q32.

(a) phylum, class, family, genus;

1

(b) (i) more recent common ancestor / DNA in common;

1

(ii) mutation causes variation;

genes (coding) for protein / cytochrome c with different structures;
EITHER
individuals with a modified cytochrome c have a selective advantage / are selected for / these individuals are more likely to survive

to have offspring / have more offspring;
(must link a comparison of survival to reproduction)

gene / allele frequency changes over generations / time;
OR
changed structure does not affect protein function;
these structural differences accumulate over time;

4

[6]

Q1.

Students had clearly either learned or not learned what a hierarchy is for (a) – just under 60% of students scored zero. A similar picture emerged for the taxonomic groups tested in (b), with half getting it correct, and half incorrect. Surprisingly, many students correctly identified the taxonomic groups, using the letter f, g and s in the diagram, but then failed to convert the “f” into family in their answer.

Question (c) was well answered, with 85.8% of students scoring at least one mark. Errors included not using **Figure 2** as asked, simply stating they are different, but not giving a difference, and many did not understand what the term frequency means, mistaking it for amplitude.

In question (d), only 3.4% of students scored two marks, but 57.1% scored one mark. Mark point 2 was very rarely seen; again, students did not use **Figure 2**, and did not understand that courtship is a behaviour that stimulates, causes, or leads to mating. Students mostly stated that the female ‘knew’ that it was another female.

Q2.

67.1% of students could answer question (a), a test of recall from section 3.4.6 of the specification. Once again, many students confused the terms population and community, and the terms species richness and an index of diversity.

Question (b) was the first opportunity on the paper for students to interpret scientific evidence and demonstrate Assessment Objective 3 skills. The question, ‘Do the data in the figure support these conclusions?’, should have demonstrated that careful use of these data would be required in the answer. Both conclusions were comparative statements, natural habitat being the *most* favourable and town habitat being the *least* favourable, and so the marking points were linked to comparative statements between the habitats. A description of one habitat alone was, thus, not sufficient to gain credit. Numbers were provided on the axes and so quoting days of the year was expected in the answers. This question provides a good example to demonstrate the importance of using and quoting the correct evidence from the data when trying to support the conclusions. It is also a good example of how times from the x-axis of the graph should be used to illustrate where observed trends begin and end. Some 76.6% of students were able to gain at least one mark; only 7.9% scored four marks.

In part (c), the majority of students appreciated that the bees should not be harmed and so gained the first mark. Many students got confused with mark-release-recapture techniques but, since no population estimate was being made in this investigation, this was not relevant.

Question (d) was designed to test practical skills with the command ‘suggest and explain’, so an improvement with a specific explanation of how that change would improve the data was required. It was hoped that A-level students could be specific about why collecting more data would be beneficial. For example, they were told that these graphs were drawn following collection from four data points – students should be aware from their graphical work that this would not result in an accurate line of best fit, or that intermediate points could not be determined from these few data points. Similarly, statements related to the improved *accuracy* of the (mean) data were few and far between; simple statements referring to collecting from more sites, or for more years, are not sufficient to gain marks when asked to give an explanation. Students should be encouraged to use an appropriate term from the published glossary – “to make the results reliable” was not sufficient to gain

credit. Very, very few students could use their knowledge of section 3.4.6 to point out that these data would have been more meaningful if numbers of each species had been counted so that an index of diversity could be calculated. Worryingly, 71% of students failed to score here; less than 2% gained both available marks.

Question (e) was answered well, with most students (62.1%) understanding the binomial system for naming of species and linking it to their evolutionary relationship. Some students suggested that the two *Andrena* species were unrelated to *Peponapis pruinosa* and that they did not share a common ancestor – this was not creditworthy.

Q3.

In answering question (a), the majority of students were able to define a species, but simpler answers just stated "can make offspring", rather than **fertile** offspring. Far fewer were able to define species richness. Some gave the definition of the index of diversity, and many stated the number of species in a population.

Two-thirds of students answered question (b) correctly; those who failed to score did not understand what the mode is.

Question (c) was far more challenging for students, with 62% failing to score any marks. Students failed to understand what had been asked and what the data showed, for example stating "68% from one sample is not fair; all sample sizes should be the same". Many students also stated that sample A could have been **all** of the same species, which was not possible. Once again students were trying to apply generic ideas about experimental design without comprehending what had been asked. Commonly seen answers included "only one area", "no repeats", "no statistical tests", "not representative", "not a fair test", "correlation does not mean causation". Students failed to understand what species richness is, stating that "the number of different species is not given". Only 0.2% of students scored all three marks.

Q4.

This question is based on sections 3.4.5 and 3.4.7 of the specification. For question (d), only 14% of students could name the three comparisons that are stated in the specification for investigating genetic diversity (other than the observable characteristics that had been used to generate Classification **X**). Although this method is no longer in the specification, DNA hybridisation was accepted as a method of comparing DNA base sequences.

Q9.

(a) There were some rather vague responses that made an attempt to suggest why it was important the birds were of similar age but did not really fulfil the marking points. For example, mark point 4 needed to refer to the feathers and references to "producing UV light" were generally not of an equivalent standard.

(b) This was well answered by the vast majority, although some answers simply stated "use a random number generator" without really explaining how this would be used to select the birds.

(c) Many good suggestions were made for the assumptions the scientists made.

(d) Although there were many very good responses to this question, there was still evidence of some confusion, for example, between the nucleotide sequence and the amino acid sequence. Mark point 3 required reference to the amino acid sequence as a whole, not just to a change in a single amino acid.

(e) Creditworthy “Yes” responses were more common than “No”. Students who carefully studied both resources and used information from both in their responses were the most successful. Poor phrasing and terminology meant some responses did not achieve mark points 2 or 3; the idea of difference in the results was required for mark point 2 and mark point 3 had to refer to error bars not standard deviation.

Q10.

(a) (i) Only about two thirds of students were able to define successfully the term ‘phylogenetic group’. Many explained why organisms are placed into an individual group without defining the term.

(ii) A majority of students achieved both marks for the definition of ‘species’. That members of the same species produce fertile offspring is well understood, although some students regarded ‘mating’ as equivalent to ‘reproduction’, which cost them a mark.

(b) Ordering of the phylogenetic groups is very well understood, with very few failing to achieve a mark. Phonetic spellings of these common biological terms was frequent.

(c) Students demonstrated a good understanding of the non-overlapping nature of genus and species groupings by drawing concentric circles with no intersect. Many failed to draw a separate circle for each genus so achieved only a single mark because they had not made full use of all the information given in the table.

(d) Most students used the information on base sequences correctly to identify the closer phylogenetic relationship between Sumatran and South China tigers without always stating clearly that their common ancestor was more recent or the tigers are more closely related. Some gained no mark by making a comparison in which they said the nucleotide sequences were ‘similar’ rather than ‘identical’.

Q11.

(a) There were many good answers to this part and nearly half of students obtained all 3 marks.

(b) This part also produced many correct responses, with most referring in some way to using a real or intact male in an experiment and recording female responses. Those who failed to score often tried to find alternative ways to use the recorded songs described in the question but without success.

(c) Very few students obtained all 4 marks in this part. This was rarely due to errors but rather to writing at length about only one or two points on the mark scheme. Many noted that courtship occurred when no song was played, or there were no chirps, or no ticks. Others went into a lot of detail about why ticks seemed to be less important than chirps. Many obtained one mark for one or more of these ideas being evidence for some other factor being involved.

Q12.

It was pleasing to see that most students obtained the marks in this part.

Q13.

Given that this question was targeted at grade E, it was surprising that parts (a)(i), (b)(i) and (b)(ii) proved to be good discriminators.

(a) (i) Half of students were aware that a hierarchy contains groups within groups, with no overlap. However, the 'no overlap' concept was often missed. Similarly, it was disappointing that nearly 30% of students failed to score, considering that a simple definition from the specification was required. Weaker responses often referred to the idea of ranking, dominance or importance.

(ii) Most students gave the correct answer of **3**.

(iii) Most students gave the correct answer of **Chordata**.

(b) (i) Just over half of students scored at least one mark. This was usually for relating independent segregation to genetic variation. Better responses showed an appreciation of how this is achieved. Typically, these referred to different combinations of maternal and paternal chromosomes, or the random arrangement of homologous chromosomes. Commonly seen responses that lacked the required precision included 'provides variation' and 'allows different combinations of chromosomes'. A minority of students failed to score due to writing about crossing over. The role of independent segregation in producing haploid cells was rarely seen.

(ii) One-third of students scored full marks. However, a number lost marks through a lack of precision; for example, 'there would be the wrong number of chromosomes' or 'they are different species so the offspring would be infertile'. The most common misconceptions seen were that 'the offspring would have 94 chromosomes' and 'meiosis would not be able to occur *in* the sex cells'.

Q14.

This question was targeted at grade E. It is again surprising that all parts proved to be good discriminators.

(a) Two-thirds of students gained full marks. This was usually for mentioning that organisms of the same species can produce fertile offspring. However, some students failed to gain the mark for replacing the word 'fertile' with 'viable'.

(b) (i) Seventy percent of students correctly calculated the index of diversity within the range of 6.97 to 7. Of the other thirty percent, most gained one mark for calculating a correct numerator or denominator.

(ii) Nearly all students gained at least one mark, typically for 'fewer habitats'. Similarly, reference to pesticides or machinery decreasing species diversity was common. Compared with the previous series, it was pleasing to see a greater percentage of students refer to 'less food sources' or 'less variety of food', rather than simply 'less food'. Relatively few students linked clearing the forest to a reduction in the number of plant species.

Q15.

Parts (a)(i), (a)(ii) and (b)(i) proved to be good discriminators.

(a) (i) One-third of students were aware that a hierarchy contains groups within groups, with no overlap. However, the 'no overlap' concept was often missed. Similarly, it was disappointing that nearly forty percent of students failed to score, considering that a simple definition from the specification was required. Weaker responses often referred to the idea of ranking, dominance or importance. There were also some very confused responses, which focused

on predators and prey in the context of a pyramid of numbers.

(ii) Half of students were aware that a phylogenetic group is based on evolutionary links or history. Students who failed to score often focused on one syllable of the word 'phylogenetic'. Consequently, the responses 'a group within a hierarchy' and 'has similar genes' were often seen.

(b) (i) Almost all students scored at least one mark for recognising that animal **A** has the least number of differences in the amino acid sequence. However, the ability to go back one step and relate this to a similar DNA sequence discriminated well. Weaker responses often lacked detail, eg 'similar DNA' and 'similar genes'. Similarly, a minority referred to the 'amino acid base sequence' or thought that DNA is made of amino acids.

(ii) Most students gained the mark for recognising that the amino acid sequences were compared with humans or not with each other. Fewer mentioned that different amino acids may be affected in each sequence. Similarly, responses that referred to the degeneracy of the genetic code were rare. Weaker responses usually relied on vague, stock *How Science Works* phrases in relation to possible flaws in the methodology. They usually referred to a lack of repeats, the inability to control certain variables or the absence of a control group. Again, a minority of students confused DNA and protein structures.

(iii) One-third of students were aware that all organisms respire, or that fewer organisms have haemoglobin. Some were given benefit of the doubt in terms of haemoglobin structure varying more due to the environment. This was accepted in terms of evolutionary change, rather than the effects of pH or pCO_2. Students who made a direct reference to these factors causing the structure of haemoglobin to vary more did not gain credit. Weaker responses often stated that haemoglobin would vary less than cytochrome c, or that cytochrome c was the same in all organisms.

Q16.

(a) This question was the most effective discriminator on the entire paper. The best answers used all the information provided to describe how geographic isolation could cause a very high diversity of bird species. At the other extreme, speciation was ignored and a description of succession was given. Most answers did attempt to explain speciation but often did not make sufficient use of the information provided to gain high marks. Usually these accounts only gained the marks for geographic isolation and for describing differential reproductive success. Poor use of terminology was also clearly evident in these weaker responses. References to different selection pressures and changes in allele frequency were often only mentioned in better responses.

(b) Surprisingly, almost fifty percent of students failed to gain this mark. Common incorrect response referred to a climax community being formed, or mutations not occurring. Students gaining this mark often mentioned no 'isolation☐ or 'a similar environment☐.

Q17.

(a) (i) Almost all students gained this mark.

(ii) Again, almost all gained this mark, with many writing a mnemonic of one form or another in the margin.

(b) Most students gained the first mark for a simple definition of standard deviation in terms of the spread of the data. A few failed to gain the mark by using the word ‘range ’ as an alternative to ‘spread’. The interpretation of standard deviation in terms of overlap was less well understood, and very few students suggested that a low standard deviation was related to closely grouped and therefore reliable data.

(c) The majority of low marks gained in this question resulted from students failing to respond to the question ‘ …these sequences (i.e. the amino acid sequences) could provide evidence … ’and going on to describe how different DNA base sequences would give different proteins. Although students seemed to appreciate that different species have different amino acid sequences in the same protein, few could link this to differences in the DNA base sequence. Students seemed unclear about the relationships between the DNA base sequences and the amino acid sequence, and the use of incorrect terminology made their answers even more opaque.

Q18.

(a) (i) Very few students failed to identify *Synodontis batensoda* as the species of catfish most closely related to *Synodontis membranacea*.

(ii) Similarly, less than 4% of students failed to identify Mochokus niloticus as the species of catfish most distantly related to *Synodontis membranacea*.

(b) This proved to be more demanding with over a third of students failing to determine that the number of different genera shown in the diagram was five.

(c) (i) The vast majority of students obtained this mark. Students who failed to gain credit often stated that 'viable offspring' would be produced without indicating that the offspring would be fertile.

(ii) This question was very well answered with the majority of students gaining both marks. The importance of courtship in attracting the opposite sex, allowing species recognition and as an indicator of sexual maturity were common scoring points.

Q19.

(a) There was widespread recognition that tail band width would be likely to change with age.

(b) In part (a), many candidates lacked the mathematical understanding to appreciate that a mean which had a value with decimal places suggested that measurements of the same band must differ. Likewise, they did not appreciate that a standard deviation with a value other than zero indicated variation in the measurements of the same band. However in part (b), having read the description of the procedure, most recognised that viewing an animal's tail through binoculars from a moving vehicle was likely to give rise to inconsistent data.

(c) Most candidates correctly used the data about the width of bands from the left and right sides of the tail as evidence that rings of equal width were not found.

(d) The most frequently awarded mark was for showing an understanding that unrelated animals would be expected to show more variation than animals from the same family. It was less usual to find a link to the idea that members of one family are genetically closely related, or a reference to the animals’ parentage.

Q20.

(a) (i) The vast majority of candidates gained at least one mark for completing the column relating to taxonomic group. Completing the genus and species rows proved more troublesome with a significant number of candidates including 'gladiator' in their answer.

(ii) It was clearly evident that many candidates had no idea of what *hierarchy* means in terms of classification and attempted to give a non scientific definition. However, almost a third of candidates gained one mark for various descriptions of 'groups within groups'. Very few candidates referred to no overlap between the groups resulting in less than 10% of candidates gaining both marks.

(b) Most candidates gained this mark often by explaining that similar features could be compared.

Q21.

(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.

Q22.

(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.

Q23.

(a) Nearly all candidates knew that members of the same species can reproduce to produce fertile offspring. Fewer, made the additional point that they shared similar features.

(b) Responses to this question were disappointing and were most likely due to candidates not really looking carefully at the evidence and realising that the means and ranges of beak depth of the two species on island 3 had shifted in opposite directions. A majority of candidates thought that the changes in distribution of beak depths of the two species on island 3 were an example of disruptive selection. It is likely that these candidates focused on the third graph, saw two distributions and assumed that there had been selection in favour of the two extremes of one distribution. Some even went as far as to say that sympatric speciation had occurred.

Q24.

This representation of the relationship between taxa was clearly new to most, but a good number were able to apply their understanding of taxonomy to deduce that A could not be a genus and that C could not be a phylum. Some found it difficult to explain their reasons, but most made it clear that this was because a genus can only contain one lower taxonomic level, whilst a phylum has only one higher taxonomic level.

Q25.

(a) (i) A good number of candidates spotted that where the ranges of the three armadillos overlapped, no fertile hybrids had been found and recognised that this suggests that they are, in fact, different species. Others just suggested that because their ranges overlap, they must be different species.

This is clearly insufficient evidence to make this deduction.

(ii) Those who realised in (i) that the absence of fertile hybrids was evidence of the armadillos being different species, sometimes went on to suggest that their absence from controlled breeding would be more conclusive proof of this. Others correctly suggested that difference in chromosome number or significant morphological or serological differences could provide further evidence. Some of those who suggested in (i) that overlapping ranges was evidence in itself of the armadillos being different species went on to suggest that the absence of fertile hybrids in those overlapping areas was further evidence, and this was given credit, although it had been the intended response for (a) (i).

(b) (i) Many candidates completed the first column of the table correctly, but fewer completed the second column correctly. The commonest error was to reverse the generic and specific levels of the binomial Dasypus novemcinctus.

(ii) Generally, only better candidates realised (from their binomials) that the three armadillos belong to different genera and that, therefore, the lowest taxonomic grouping that the three could share is that of family.

Q26.

Although only a few candidates obtained maximum marks on this question, most candidates were able to gain between two and four marks.

(a) Most candidates correctly filled in phylum, class and order, however, weaker candidates often put common names such as cat or cheetah in the species box.

(b) Approximately half the candidates gained this mark. Most candidates who did not, either provided definitions which were too vague or referred to ‘different sizes’ of organisms.

(c) (i) Most candidates obtained this mark by referring to the breeding of organisms to produce fertile offspring.

(ii) Very few candidates gained two marks with the majority simply referring to different diets, colours or behaviour. Correct answers usually referred to fossils, evolutionary history or biochemical differences.

Q27.

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.

Q28.

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.

Q29.

(a) Often not well done and answers were generally poorly expressed. Many candidates did not answer the question set and just described the classification system involving Kingdom, Phylum, etc. or gave the definition of a species. Often there was no mention of putting organisms into groups with similar characteristics. Those who did mention characteristics often did not mention the standard methods and chose any characteristic which could be different such as method of feeding. References to cell or anatomical differences were often vague.

(b) About half the candidates gave the correct two answers. Many candidates just listed the groups at the top of the tree and many included Protoctists in their answer.

(c) Most candidates stated that fungi and insects had a common ancestor, but only a few were able to give a full answer. Many stated that insects had evolved from fungi, or were closely related.

(d) There were many unclear answers which used poor language. Although many put organisms with similar sequences in the same branch, they did not develop their answer any further. There were many references to protein or DNA structure instead of amino acid sequences.

(e) This was often poorly answered, although many scored the marks relating to eukaryotes/prokaryotes.

Q30.

(a) Candidates gave variable answers. Only the better candidates were able to apply their knowledge and score high marks. Candidates failed to gain credit for vague answers lacking scientific rigour with poor use of terminology.

(b) (i) A pleasing number of candidates understood how to work out probability. Common mistakes included incorporating 0.5 into the calculation and adding up the figures.

(ii) Most candidates gained the first mark. Only the better candidates referred to the absence of scissor wings for the second mark, most candidates simply quoting the difference in probabilities.

(c) Reticence to use the term ‘sign stimulus’ prevented many candidates from gaining both marks.

Q31.

Classification continues to be a problem area for many, and candidates from many centres appeared to have little knowledge or understanding of the principles.

(a) (i) Often the only marks obtained in the question were for naming the groups. Despite the fact that similar questions have been asked before, a considerable number of candidates could not remember the names, and quite often resorted to giving only the first letter from the mnemonic, or offering an alternative such as ‘field’ for family or ‘group’ for genus.

(ii) Only the better candidates completed this successfully, suggesting that even those who knew the names of the groups did not understand the principles. It was, for example, quite common to spread the names ‘Felidae’, ‘Panthera’ and ‘leo’ into three separate circles, instead of forming a new set of circles within the Carnivora.

(b) Candidates from some centres gave good answers based on the section in the specification. Many, however, simply based their answers on what they could glean from the diagrams. A common answer to part (i) was that in a hierarchy organisms are placed in groups, but without reference to the idea of sub-division into smaller groups. In part (ii), many simply described the different appearance of the diagrams; comments about the phylogenetic system ‘having more layers’ or being ‘more complex’ or ‘like a staircase’ were common. It was often suggested that the phylogenetic system is ‘based on genetics’ without further qualification, presumably using the name as a guide. A surprising number of weak candidates thought that the diagrams represented food webs.

Q32.

(a) The vast majority of candidates answered this question correctly.

(b) (i) Many candidates answered this question correctly by stating similarities between genes or DNA. Few considered recent ancestry. A significant number referred only to phenotypic similarities or they used a definition of species to suggest that the organisms would fail to produce fertile offspring.

(ii) Most candidates picked up marks for referring to mutations and for an understanding of variation, although a significant proportion stated that the mutation occurred in the structure of the protein, or implied that cytochrome was an organism. Unfortunately, most candidates failed to link their answer to cytochrome c and relied on generalisations about ‘natural selection’ and ‘survival’ without focusing on why differences in the protein would be the basis of evolutionary change. Also, very few candidates either considered time or multiple generations in their explanation about a change in allele frequency; in many answers, evolution occurred in a single step.