AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.4.7 INVESTIGATING DIVERSITY

SCORE	PERCENTAGE
/ 491	%

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Q1.

(a) **Comparisons**

1. Nucleotide structure is identical;

   Accept labelled diagram or description of nucleotide as phosphate, deoxyribose and base

2. Nucleotides joined by phosphodiester bond;

OR

Deoxyribose joined to phosphate (in sugar, phosphate backbone);

3. DNA in mitochondria / chloroplasts same / similar (structure) to DNA in prokaryotes;

   Accept shorter than nuclear DNA/is circular not linear/is not associated with protein/histones unlike nuclear DNA;

Contrasts

4. Eukaryotic DNA is longer;

5. Eukaryotic DNA contain introns, prokaryotic DNA does not;

6. Eukaryotic DNA is linear, prokaryotic DNA is circular;

7. Eukaryotic DNA is associated with / bound to protein / histones, prokaryotic DNA is not;

5 max

(b) 1. Mutations change base / nucleotide (sequence);

   Reject if mutation in amino acid

2. (Causing) change in amino acid sequence;

3. Mutations build up over time;

4. More mutations / more differences (in amino acid / base / nucleotide sequence / primary structure) between distantly related species;

OR

Few(er) mutations / differences (in amino acid / base / nucleotide sequence / primary structure) in closely related species;

5. Distantly related species have earlier common ancestor;

OR

Closely related species have recent common ancestor;

Accept "order" for "sequence"

If neither MP4 or MP5 accept for 1 mark, idea of more mutations /differences as evidence of earlier common

ancestor OR converse

5

[10]

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 <u>both</u> 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. So no contamination / other bacteria;
2. So same number of bacteria transferred **to** allow comparison;

1. Accept sterilisation / kills all (bacteria)

2. Allow amount / concentration for number

2

(b) 6 000 000
OR

6×10^6;

1 mark for 3 000 000

OR

3×10^6

Allow 1 mark for 600 (in 1cm^3 of diluted culture)

2

(c) 1. (Several) values between 10 and 15 (units);
2. Repetitions of each;

1. Accept descriptions of this

Ignore repeat the investigation / repeat at 10 and 15 units.

2

[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. TEM use electrons **and** optical use light;
2. TEM allows a greater resolution;

3. (So with TEM) smaller organelles / named cell structure can be observed
OR
greater detail in organelles / named cell structure can be observed;
4. TEM view only dead / dehydrated specimens **and** optical (can) view live specimens;
5. TEM does not show colour **and** optical (can);
6. TEM requires thinner specimens;
7. TEM requires a more complex/time consuming preparation;
8. TEM focuses using magnets **and** optical uses (glass) lenses;

3. 'clearer' is not equivalent to 'detail'

4. Accept 'Only optical can view live specimens'

5. Accept 'Only optical can show colour'

7. Accept 'TEM requires a more difficult preparation'

Ignore references to artefacts

6 max

(b) 1. **W** has 4 cells / nuclei since it is at the (end of) 2nd division (of meiosis);
2. **Z** has 2 cells/nuclei since it is at the (end of) 1st division (of meiosis);
3. **W** shows haploid cells / cells containing n chromosomes;
4. (Cells in) **W** contain half the (mass of) DNA of (Cells in) **Z**;
OR
(between **Z** and **W**) chromatids have separated;
OR
In **Z** homologous chromosomes have separated;

*Ignore '**Z** shows diploid cells / contains 2n chromosomes'*

*4. Accept '**W** contains half the amount of DNA of **Z**'*

4

(c) 1. Use random sample of seeds (from each population);
2. Use (large enough) sample to be representative of whole population;
3. Indication of what size was measured e.g. mass;
4. Calculate a mean and standard deviation (for each population);
5. Use the (Student's) t-test;
6. Analyse whether there is a significant difference between (the means of) the two populations;

1. Accept described, suitable method of random sampling.

1. Reject description of inappropriate method of random sampling (e.g. random coordinates in the field / use of quadrats)

2. Accept 'running mean does not change'

*2. For representative accept 'reliable, reproducible, repeatable' **OR** a mean close to the true value.*

5. Accept 'Use 95% confidence limits'

6. Reject unqualified references to results being significant

5 max

[15]

Q6.

(a) Any **two** valid reasons;

e.g.

1. Increase in plant diversity leads to more types of food for animals;

2. Increase in variety of animals leads to increase in predator species;

3. Increase in niche / habitat

2 max

(b) 1. Repeat soil sorting for different times and record number of species collected;

2. Find optimum time / time beyond which further sorting does not lead to increase in animal species found

2

(c) 1. No data on number of individuals in each

species / diversity index $= \frac{N(N-1)}{\sum n(n-1)}$

1

(d) Principle:

1. Overlap of 2 × SD shows probability of differences (in means) being due to chance is greater than 0.95;

Allow converse of MP1

Credit MP1 wherever it appears

Agree:

2. No difference in number of earthworms and millipedes (per m^2)

3. No difference in number of species of centipedes or millipedes.

Disagree:

4. More beetles and woodlice in grassy strips;

5. More species of beetles, earthworms, woodlice in grassy strips.

4 max

[9]

Q7.

(a) 4:

1

(b) 2.68(6).

If answer incorrect:
Σn(n-1) = 242 = 1 mark
N(N-1) = 650 = 1 mark

2

(c) 1. Take more samples and find mean;
2. Method for randomised samples described.

Allow larger area = 1 mark

2

[5]

Q8.

(a) Species richness measures only number of (different) species / does not measure number of individuals.

1

(b) Trees vary in height.

1

(c) 1. Index for canopy is 3.73;
2. Index for understorey is 3.30;
3. Index in canopy is 1.13 times bigger;

If either or both indices incorrect, allow correct calculation from student's values.

3

(d) 1. For *Zaretis itys*, difference in distribution is probably due to chance / probability of being due to chance is more than 5%;
2. For all species other than *Zaretis itys*, difference in distribution is (highly) unlikely to be due to chance;
3. Because P < 0.001 which is highly significant / is much lower than 5%.

3

[8]

Q9.

(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]

Q10.

(a) 1. Draw grid over (map of) area;
2. Select squares / coordinates at random.

2

(b) 1. No emigration / immigration;
2. No losses to predation;
3. Marking does not affect survival;
4. Birth rate and death rate equal;
5. (In this case) all belong to one population.

2 max

(c) 1. Only glows brightly with UV, so doesn't make insects more visible;
2. So doesn't affect / increase predation;
OR
1. Glows brightly with UV marking visible;
2. So makes it easy to pick out labelled insects.

2

(d) 10 130.
Tolerance of ±1

$$N = \frac{M \times C}{R}$$ *= 1 marks*

2

(e) 1. Scientists removed large numbers of insects (which were not returned) from same area / same population;
2. Affecting ratio of marked to unmarked.

2

[10]

Q11.

(a) 1. Vaccine/it contains antigen (from HPV);

Term 'antigen' may be first mentioned with point 2

2. Displayed on antigen-presenting cells;

Accept named example, e.g. macrophage/phagocyte/B cells

3. Specific helper T cell (detects antigen and) stimulates specific B cell;

Accept 'helper T cell with receptor on surface' for 'specific' and B cells with receptor/antibody on surface that bind to antigen for 'specific'

4. B cell divides/goes through mitosis/forms clone to give plasma cells;
5. B cell/plasma cell produces antibody;

4 max

(b) 1. Two (doses) because got more antibody;

Accept more effective in producing antibody

2. With three doses, second dose/dose at 1 month doesn't lead to production of any more antibody (than the two-dose group)/get same/similar response;
3. Three doses would be more expensive/less popular with parents/girls (and serves no purpose);

Accept 'less painful'

2 max

(c) t-test, because comparing two means;

Mark for correct test and explanation correct

Accept 'comparing the mean'

Reject 'to show that the results/means are significant'

1

(d) 1. Compare (base sequences of) DNA;
2. Look for mutations/named mutations (that change the base sequence);
3. Compare (base sequences of) (m)RNA;

1 and 3 accept triplet/codon sequences for comparisons

Ignore references to 'introns/non-coding DNA'

2 max

[9]

Q12.

(a) 14;

1

(b) Number (of individuals) in each species (of dung beetle);

Accept: population of each species.

1

(c) 1. No overlap in standard deviations;

Accept: no overlap in error bars.

2. (Difference in mean total) significant/is not due to chance/is real;

2

(d) No bias;

Ignore: 'representative sample'.

1

(e) 1. Removes species/types of plant/insect;

Accept: decrease in plant/insect diversity.

2. Fewer food sources;

Ignore: less food.

Accept: less variety of food.

Accept: removes a food source.

3. Fewer habitats/niches;

Accept: loss/removal/destruction/ of a habitat.

Accept: no habitat.

Ignore: homes/shelters.

3

[8]

Q13.

(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;

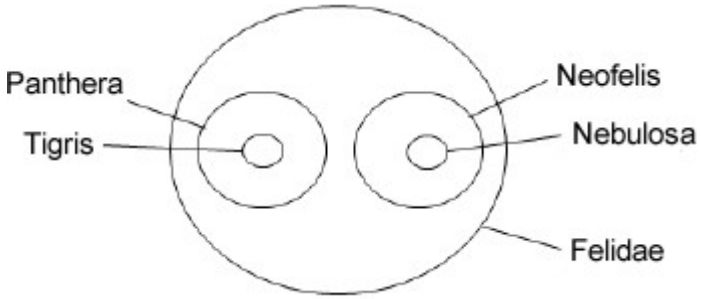
Accept: pleural answers phyla / genera / families

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

All 4 in correct order for 1 mark

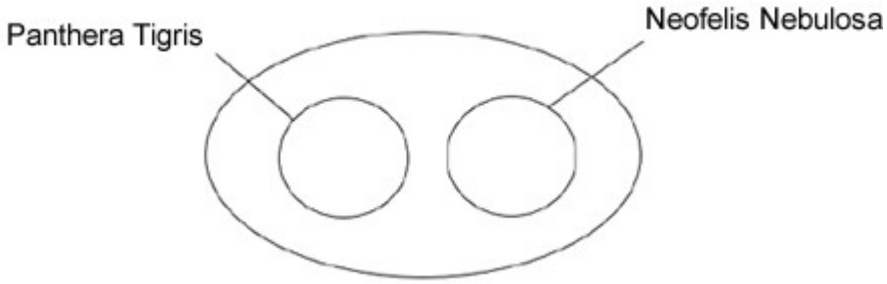
1

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



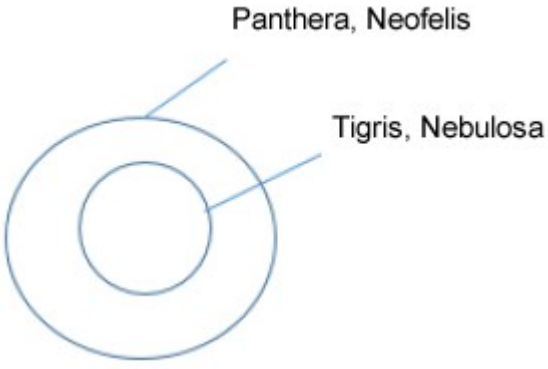
= 2 marks

OR



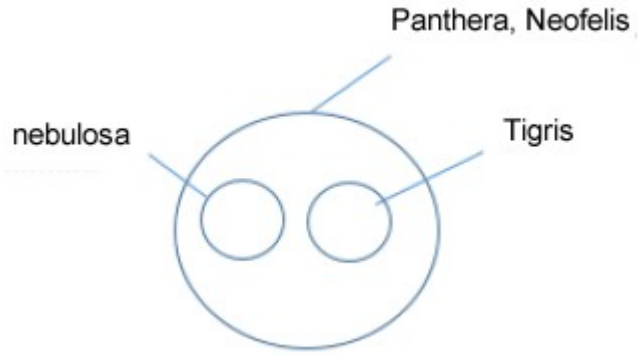
= 2 marks

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]

Q14.

(a) Number of species in a community;

Accept: number of species in a habitat/area/ecosystem

Accept: species richness

Accept: all the species for number of species

Ignore: variation/diversity

Reject: in a population

1

(b) 1. Number of (organisms of) each species;

Accept: 'population' for number and accept individual for organism.

Accept: 'species richness'

2. Total number of organisms (of all species) / Total number of species;

Idea of grand total of all organisms, not just number of different species

2

(c) 1. Described effect of sewage (eg oxygen depletion/is toxic/kills);

Accept: increase in BOD

Accept: eutrophication/description of eutrophication

2. Prevents some/many <u>species</u> colonising/ reproducing/remaining;

Accept: only a few species survive

3. Sewage is food source for (individuals of) some/a few/<u>species</u>;

4. (So) increase only in their numbers;

Max 2

(d) (i) 1. Results are not repeatable / are not representative / unreliable / conflict / contradict;

Accept: different / don't agree

Ignore: not valid/not reproducible/inaccurate

2. Can't make any conclusions;

2

(ii) Do repeat<u>s</u> to find a pattern/distribution/mean (of index of diversity);

Accept: use a different technique to obtain more reliable evidence;

Need idea of more than one repeat

Accept: calculate an average

Accept: at different times

Accept: statistical test to see if results differ significantly

1

[8]

Q15.

(a) 1. Type of feed affects (antibiotic) <u>resistant</u> bacteria (in animals);

Accept: null hypotheses

Accept predictions, for example

More antibiotic resistant bacteria form in animals fed with antibiotics in their food

2. (Antibiotic) resistant <u>resistant</u> infect /are passed on to animals/farmer / resistant <u>resistant</u> are passed between animals;

Accept: bird to bird/bird to human/human to human

Accept: a link (exists) between (antibiotic) resistance in animals and their keepers/farmers – as lowest level QWC

3. Incidence of (antibiotic) resistant <u>resistant</u> differs in chickens and turkeys;

Accept: a comparison, eg 'more resistant bacteria in chickens than turkeys'

4. Incidence of (antibiotic) resistant <u>resistant</u> differs in chicken farmers and turkey farmers;

Accept: a comparison, eg 'more resistant bacteria in chickens than turkeys'

Max 2

(b) (i) 1. Large(r) percentage of <u>resistant</u> bacteria in

turkeys/low(er) percentage of resistant bacteria in chickens;

Accept: E coli for bacteria

Ignore: number, eg. ignore 'more'/'fewer' turkeys/chickens

2. Large(r) percentage of resistant bacteria in turkey farmers/low(er) percentage of resistant bacteria in chicken farmers;

2

(ii) 1. (More) antibiotic in turkey feed kills (more) non-resistant bacteria / resistant bacteria survive;

Accept: antibiotic creates selection pressure

Survive must be explicit, not implied by 'reproduce'

2. (Resistant bacteria) reproduce / pass on gene for resistance;

2

(c) (Human) faeces contain pathogens;

Accept: harmful organisms

1

(d) 1. Large number of farms / farmers (surveyed) / 46;

'Reliable' is used in the question stem

2. So results are (likely to be) representative / can identify anomalous results;

Ignore: reproducible / accurate / valid / reliable

Accept valid explanation of replicates minimising effects of chance

2

(e) 1. (DNA) hybridisation (of gene for resistance in bacteria taken from bird and farmer);

2. (Identical) strands separate at high(est) temperature;

OR

3. Compare base/nucleotide sequence (of gene for resistance in bacteria taken from bird and farmer);

4. (Identical strains) have identical/same base sequences

Mark in pairs, do not mix and match.

Accept: bacteria in bird and farmer/both types of bacteria have identical base sequences = 2 marks

2

(f) 1. (Antibiotic use has) increased cases of bacterial resistance;

Accept: number

2. Transfer/horizontal transmission of (resistance) gene to pathogens/harmful bacteria;

Accept: conjugation

3. (Antibiotic) resistant bacteria cause harm / medical treatments less effective;

Accept: superbug

4. Avoids side effects on animals;

5. Increased demand for organic food;

6. Antibiotic/resistant bacteria could be present in human food;
7. High cost of antibiotics;
8. Legislation has controlled antibiotic use;

Accept: EU/government guidelines

4 max

[15]

Q16.

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

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

2

[7]

Q17.

(a) 1. Number of (individuals of) each species;

Accept: 'population' for 'number'

2. Total number of individuals / number of species;

Accept: 'species richness'

MP2 allows for other types of diversity index

2

(b) (i) (Shows) results are due to the herbicide / are not due to another factor / (to) compare the effect of using and not using the herbicide / shows the effect of adding the herbicide;

Neutral: allows a comparison

Neutral: ensures results are due to the independent variable

Reject: 'insecticide'

Accept: 'pesticide'

1

(ii) 1. (More) weeds killed **so** more crops / plants survive / higher yield /

less competition;

2. High concentrations (of herbicide) harm / damage / kill / are toxic to crops / plants;
Accept: 'pesticide'
Neutral: 'insecticide'
Accept: use of figures (eg 400+)

2

(iii) 1. Reduced plant diversity / fewer plant species / fewer varieties of plant;
Accept: 'weed' for 'plant'
Neutral: fewer plants
Accept: only one crop species remains

2. Fewer habitats / niches;
Q *Neutral: fewer homes / shelters*

3. Fewer food sources / varieties of food;
Neutral: less food

3

[8]

Q18.

(a) Succession;
Ignore any word in front of succession e.g. secondary / ecological succession.
Neutral 'forestation'.

1

(b) 1. Greater variety / diversity of plants / insects / more plant / insect species;
Neutral: more plants.

2. More food sources / more varieties of food;
Neutral: more food / more / greater food source (singular).

3. Greater variety / more habitats / niches;
Accept: more nesting sites.
Q *Neutral: more homes / shelters.*

3

(c) (i) Temperature and carbon dioxide;
Neutral: water, chlorophyll.

1

(ii) Shows (gross) photosynthesis / productivity minus respiration / more carbon dioxide used in photosynthesis than produced in respiration;
Correct answers are often shown as: net productivity = (gross) photosynthesis – (minus) respiration.

1

(iii) 1. (Shade plant) has lower (rate of) respiration / respiratory losses / less CO_2 released at 0 light intensity / in dark;

Accept use of figures.

Accept: lower compensation point.

2. Greater (net) productivity / less sugars / glucose used / more sugars / glucose available;

Neutral: any references to rate of photosynthesis.

2

[8]

Q19.

1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. Produces two glycerate (3-)phosphate / GP;

Accept: any answer which indicates that 2 x as much GP produced from one RuBP.

3. GP reduced to triose phosphate / TP;

Must have idea of reduction. This may be conveyed by stating m.p. 4.

4. Using reduced NADP;

***Reject**: Any reference to reduced NAD for m.p.4 but allow reference to reduction for m.p. 3.*

5. Using <u>energy</u> from ATP;

Must be in context of GP to TP.

6. Triose phosphate converted to glucose / hexose / RuBP / ribulose bisphosphate / named organic substance;

[6]

Q20.

(a) Push – legume

Pull – grass;

Both needed for mark

1

(b) 1. Set up tape measures on two sides of the plot / make grid of plot;

Allow 'Number each plant'. With this approach mp3 cannot be awarded.

2. Use random number table / calculator / generator;

Allow 'Select from a hat' idea.

3. To generate coordinates;

3

(c) 1. To prevent competition between the maize and the grass;

2. For light / nutrients / water;

OR

3. Idea of limits movement of pest (between grass and maize);

4. Only eating / damaging grass;

2 max

(d) 1. Nitrogen-fixing bacteria convert nitrogen (in the air) into ammonium compounds (in the soil) which are converted into nitrates / nitrification occurs;

Accept 'ammonia' for 'ammonium compounds'.

2. Maize uses nitrates (in soil) for amino acid / protein / ATP / nucleotide production;

2. Must be in the context of maize.
Ignore ionic formulae unless only these are given.

2

(e) 1. Reduced % damage to maize plants / increased maize grain yield;

2. Calculation to justify mp 1;

3. Standard deviation shows no overlap but need stats to show significance of this difference;

4. More profit / net income / greater income than additional cost (with push-pull);

5. $322 extra / 408% more / $401 v $79 profit;

Accept '$350 extra income compared to $28 extra spend'.
Mp5 gains credit for both mp4 and 5

3 max

[11]

Q21.

(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]

Q22.

(a) (i) Reliable / representative / for statistical tests;

Accept: identify anomalies

Neutral: accurate / valid / bias

1

(ii) 1. Find coordinates (on a grid) / split area into squares / number the sites;

1. Ignore references to tape measures, metre rulers etc

2. Method of generating / finding random numbers eg calculator / computer / random number generator / random numbers table;

2. Accept: numbers out of a hat / use of dice

2

(iii) 1. Breeding (of lizards);

Neutral: weather / climate / hurricanes / hibernation / migration / emigration / immigration

2. Food source / prey;

3. Predator;

4. Variation in malarial infection;

5. Temperature variation;

6. Availability of water eg drought / ☐rainy season'

2 max

(b) 1. Number in sample varies;

2. Allow a (valid) comparison;

2

(c) 1. (Overall) positive correlation (for either / both species);

Neutral: only one study / no repeats

2. Reference to (site) 5 / 300 metres;

3. Limited results for *A. wattsi* / small sample / number / percentage infected for *A. wattsi*;.

2 max

(d) (i) 1. Fewer *A.wattsi* infected / more *A. gingivinus* infected;

2. Higher number of *A.wattsi* present when higher percentage / number of *A.gingivinus* infected / no *A.wattsi* present when *A.gingivinus* has zero infection;

2

(ii) 1. Reduced immunity / increased susceptibility to disease;

1. Accept: idea that energy / resources are used to combat malaria

2. Reduced oxygen transport / uptake / respiration / reduced activity / movement;

2

(iii) 1. There is a <u>probability</u> of less than 1% / 0.01;

1. Reject: probability is / equal to 1% / 0.01;

1. Reject 0.01% / 5% / 0.05 / 0.05%

2. That result(s) / correlation / it is due to chance;

2. Allow correct interpretation using above (incorrect) figures eg there is a probability of less than 5% that the results are due to chance =1 mark

OR

3. There is a <u>probability</u> of more than 99% / 0.99;

4. That result(s) / correlation / it is not due to chance;

Note: there is a probability of more than 5% that the results are due to chance =0 marks

3. Reject: probability is / equal to 99% / 0.99;

3. Reject 0.99% / 95% / 0.95 / 0.95%

4. Allow correct interpretation of above figures ie 0.99% / 95% / 0.95 / 0.95% but reject if less than

2

[15]

Q23.

(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]

Q24.

(a) Removes bias;

1

(b) (i) 1. 1.28 / 1.29 / 1.285 / 1.3
1. Ignore more than 3dp

2. Answer incorrect but shows clear understanding of Σ
2. Σ = 318250. Allow mark if denominator written out. Incorrect denominator but evidence of understanding gains mark

2

(ii) Diversity index would be lower (NO MARK)
Assume wheat field if site unspecified

1. Fewer species / Beech aphid / Large white butterfly / 7-spot ladybird absent / only three species / species diversity lower / mostly one species / mostly bird-cherry aphid;
1. Allow species richness in context of few species

2. Fewer plant species;
2. Allow one type of food source if clearly plant

2

(c) For:

1. Data support the claim / evidence supports claim;
1. Ignore reference to correlation / causation

Against:

2. Only wheat field / only comparing with wood / one type of habitat / only insects considered;

2 max

(d) 1. Greater variety of plants;

2. Another habitat / more habitats / places to live / niches / another food source / more food types;

2. Answers referring to 'more food' should not be credited. Allow reference to either animal or plant as foods

2

[9]

Q25.

(a) 1. Carbohydrate / sugar / named carbohydrate;

2. Minerals / named mineral ion;

Accept alternatives for mineral such as inorganic substances / ions. Accept symbol for ion. Accept incorrect symbols providing that answers are not ambiguous.

3. Amino acids / protein;

4. Vitamins;

2 max

(b) 1. Shake / stir / mix;

2. Even distribution of yeast / cells;

Accept other terms with a similar meaning for both points

2

(c) Two marks for correct answer of 20 / 20.2 / 20.22;;

One mark for incorrect answer in which student clearly shows increase as 8.912 – 7.413 or as 1.499;

Ignore references to 10^6

2

(d) 1. More competition;

2. Less oxygen;

3. Less glucose / sugar / carbohydrate / respiratory substrate;

4. Ethanol / alcohol becomes toxic / inhibits respiration / inhibits reproduction;

5. Fall in pH;

2 max

[8]

Q26.

(a) 1. Closer the (amino acid) sequence the closer the relationship;

2. (Protein structure) related to (DNA) base / triplet sequence;

Amino acid sequence is related to (DNA) base / triplet sequence = two marks;

2

(b) 1. Reference to base triplets / triplet code / more bases than amino acids / longer base sequence than amino acid sequence;

Different (base) triplets code for same amino acids = 2

marks;

Degeneracy of triplet code = 2 marks

2. Introns / non-coding DNA / degeneracy of code / more than one code for each amino acid;

Ignore reference to codon.

2

[4]

Q27.

(a) (i) Produces a more reliable mean / average / makes sure sample was representative / reduce effect of extreme values / identify anomalies;

Ignore references to chance

1

(ii) Removes bias;

1

(b) Two marks for correct answer of 5.8;

One mark for incorrect answer that clearly shows denominator as 216;

2

(c) 1. Increase in variety of plants / shrubs / grass;

2. More habitats / niches;

3. Greater variety of food sources / more food sources;

Answers only referring to 'more food' should not be credited

3

[7]

Q28.

(a) Greater variety / different foods;

More habitats / niches;

Answers only referring to 'more food' should <u>not</u> be credited but allow 'more food sources'.

2

(b) Also measures number of individuals in a species / different proportions of species;

Some species may be present in low / high numbers;

First marking point can only be awarded if there is a reference to species.

2

(c) (i) Large surface area to volume (ratio) / permeable / thin (outer layer);
Correct reference to diffusion;

Accept (Eggs) cannot move (out of water) for 1 mark

2

(ii) Concentration (of pesticide) is increased;

1

[7]

Q29.

(a) Two marks for correct answer, 41.9 / 42 ;;
One mark for incorrect answer of 0.42;

2

(b) Increases proportion of crop that is used / greater proportion is grain / reduces proportion of crop that is not used / is not grain;

1

(c) Quadrats from different parts of field;
Biotic / abiotic factors / named biotic / abiotic factor different;

2

(d) Water (in plants and grain);
Varies;

2

[7]

Q30.

(a) Greater when treated with herbicide **G**;
Same number but total biomass larger;
Can be shown by figures

2

(b) Fewer weeds left to produce seeds;
Less contamination of crop (by weeds); / fewer weeds to separate from crop; / less competition (between crop and weeds);

2

(c) **Advantage**
Weeds growing fast / photosynthesising fast so effect will be seen /
will have large effect;

Disadvantage
No information about winter / other seasons /
weeds not growing fast /
could kill (beneficial) insects /
crop may be harvested before effects noticeable;
One mark for advantage and
one mark for disadvantage

2

(d) **Limitations of investigation**
1. No control / untreated field;
2. Amount of herbicide may be different;
3. May be differences between fields; Eg soil Nutrients / fertiliser added Type of weed Microclimates
4. May be different number of weeds (at start);

Limitations of results
5. No replicates / one set of data;
6. Field size may vary / not specified;

Scientific Research

7. Scientific research / example of scientific research has led to greater yield;

When marking please number the marking points

e.g. 5✓ *means a mark award for point 5*

5 max

[11]

Q31.

(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]

Q32.

(a) Number of a / each (species);

Accept answers expressed differently providing they convey this information.

Ignore extra information if it does not contradict answer.

1

(b) 1. Lower diversity of plants / few species of plants / less variety of plants / few plant layers;

2. Few sources / types of food / feeding sites; / few habitats / niches;

3. Fewer (species of) herbivore so few (species of) carnivores;

3

(c) (i) Cannot predict / do not know intermediate values;

1

(ii) To see what would happen / compare <u>with</u> no management work / to see if numbers fell anyway / To show that it was not a factor;

Management as a term not required. Allow explanations.

1

(d) 1. Total <u>number</u> of birds along ditch B / ditch with one side cleared greater

than along ditch A / ditch with both sides cleared;

2. But only gives data for all birds / does not give data for species / data not about diversity;

3. Single ditch / single occasion / not repeated / no control;

Principles:

Correct from evidence

Total number not diversity

Flaws in technique

3

[9]

Q33.

(a) (So results) can be compared / so measurement is the same each time / because eye is not perfectly round / uniform;

Accept eye opens to different amounts

1

(b) (i) 1. Eye (diameter) is smaller and antennae longer;

2. Antennae detecting touch;

3. Data only refers to shrimps / data may not apply to all animals / only in one area;

The principle here is that candidate has recognised that both features confirm suggestion. Exact wording does not matter.

2 max

(ii) 1. Standard deviation gives a measure of spread / variation;

2. More standard deviations overlap, the less likely it is that differences are real / significant / the more likely they are caused by chance;

Do not accept range

Accept converse.

Although we are looking for the idea of significance, we cannot require this term.

2

(c) (i) Qualitative statement about

difference in size /

difference in variation /

overlap in size;

Quantitative statement about

difference in size /

difference in variation /

overlap in size;

Supported by relevant two sets of figures from graph;;

Note simplistic answer involving a quantitative statement gains 1 mark.

More specific answer involving quantitative information gains 2 marks.

2

(ii) (No) for same body length, antenna are longer / antenna are shorter / some with longer body have short antennae / some with shorter body length have longer antennae;

OR

(Yes) positive correlation in open / in cave;

Habitat not critical as a term.

Must refer to idea of same habitat

Accept description

1

(d) More alleles of each gene / shrimps in open have all the alleles;

Candidates are required to use the information from the table. Must therefore refer to alleles.

1

(e) 1. A small number of shrimps were / went into the cave;

2. All / high proportion of shrimps had allele L;

3. Cave population descended from these / these reproduce;

3

(f) (i) 1. Cross shrimps from two sites / watch courtship;

2. Breed young together / observe mating;

3. Allow 1 mark for any method of improving quality of results e.g. carry out reciprocal crosses / large number of crosses / isolate beforehand;

Other valid equivalent suggestions should be accepted.

(ii) If same species the shrimps would breed, producing fertile young / courtship species specific;

Accept any form of evidence – mating / laying eggs / giving birth to young.

3

[15]

Q34.

(a) Most closely (related) to chimpanzee / most recent common ancestor;

1

Least (related) to dogfish / least recent common ancestor;

Allow 'chicken is second' to chimpanzee as equivalent to second mark point.

Allow answers which compare similarity in DNA / genetic

material.

Marks should not be awarded for answers which only compare amino acid sequences without any indication of relationships.

Allow 'monkey' for chimpanzee and 'fish' for dogfish

1

(b) Is present in all eukaryotes;

1

(c) Reference to base triplet / triplet code / more bases than amino acids / longer base sequence than amino acid sequence;

Introns / non-coding DNA; / same amino acid may be coded for / DNA code is degenerate;

Reject different amino acids are formed / produced.

Ignore reference to codon.

2

[5]

Q35.

(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]

Q36.

(a) Recognition of same species;

Stimulates release of gametes;

Recognition of mate / opposite gender;

Indication of sexual maturity / fertility;

2 max

(b) (i) Internal fertilisation / fertilisation occurs in pouch / limited area;

Q *The term fertilisation is not required in the answer but must be implied.*

1

(ii) Protection from predators (developing in pouch);

1

(c) (i) Less stress caused to seahorse / quicker / more accurate method / body is curved / head is linear;

Q *Do not accept "easier" unless qualified.*

1

(ii) Head length proportional to body length / or described;

1

(d) Positive correlation between head / body lengths of male and female / female and male with similar head / body lengths pair together;

1

(e) Use line of best fit;

And extrapolate / extend line as required;

2

(f) (Compare) DNA;

Sequence of bases / nucleotides;

Compare same / named protein;

Sequence of amino acids / primary structure;

Immunological evidence – not a mark

Inject (seahorse) protein / serum into animal;

(Obtain) antibodies / serum;

Add protein / serum / plasma from other (seahorse) species;

Amount of precipitate indicates relationship;

Q *The marks awarded for reference to DNA and sequence of*

bases / nucleotides must be in a different context to DNA hybridisation.

6 max

[15]

Q37.

(a) (i) Method of positioning quadrats,
E.g. Find direction and distance from specified point / find coordinates on a grid / split area into squares;

Method of generating random numbers;

E.g. From calculator / telephone directory / numbers drawn from a hat;

Last point represents minimum answer

Q *Do not credit any method that relies on throwing a quadrat*

2

(ii) Calculate running mean / description of running mean;

When enough quadrats, this shows little change / levels out (if plotted as a graph);

Enough to carry out a statistical test;

A large number to make sure results are reliable;

Ignore terms that are not incorrect
Regards large numbers as 10 / 10% +

Need to make sure work can be carried out in the time available;

2 max

(b) Coppice different parts of the wood at different times;

As data show many daffodils flowering 4 / 5 years after coppicing;

Q *Second point needs specific reference to the graph, numbers and time after coppicing. Accept any correct answer that does this.*

2

(c) Positive correlation between rainfall and flowering / the higher the rainfall, the more daffodil flowers;

Negative correlation / the higher the temperature the fewer daffodils in flower;

All statistically significant so not likely to be / not due to chance;

2 max

[8]

Q38.

(a) (i) Will work in all weather conditions / hairs will stick to it even if shrew / animal is wet / withstand rain;

1

(ii) So shrews come into contact with glue;

1

(b) Avoids bias / allows statistical tests to be carried out;

Allow description

1

(c) (i) Increases the reliability of the measurements;

If measurements are repeatable, differences less likely to be due to measurement / personal error / anomalies unlikely;

Accept advantages of repeatable results. E.g. identifying anomalies / remove errors

2

(ii) Plot graph / scatter diagram of one set of results against the other;

***Q** To gain first marking point, candidates must say what has been plotted.*

Expect to see points lying close to line / Line should slope upwards / show positive correlation;

If what is being plotted is not clear, second point cannot be awarded.

OR

Plot measurement against hair number;

Look for overlying / corresponding points;

2

(d) (i) One mark for a valid explanation based on individual shrews entering more than one hair tube / many hairs from same shrew / shrews enter without leaving hair;

1

(ii) Rules out differences due to changes in population / changes in environmental conditions;

That could be produced by births / deaths / migration / specific example of environmental conditions affects results;

2

(e) (A statistical test) determines the probability of results being due to chance;

Enables null hypothesis / description of null hypothesis to be accepted / rejected / determines whether correlation / result is significant;

2

(f) (i) (Curve / line of best fit shows) positive correlation / description of positive correlation;

1

(ii) Curve / line of best fit (almost) parallel to x-axis / horizontal / level / no correlation / index is independent of number of shrews;

Hair tubes with positive results when no shrews trapped;

Small size of shrews means shrews may not trigger traps;

2 max

[15]

Q39.

(a) 1. Large surface area provided by lamellae / filaments increases diffusion / makes diffusion efficient;;

Q Candidates are required to refer to lamellae or filaments. Do not penalise for confusion between two

2. Thin epithelium / distance between water and blood;

3. Water and blood flow in opposite directions / countercurrent;

4. (Point 4) maintains concentration gradient (along gill) / equilibrium not reached / as water always next to blood with lower concentration of oxygen;

5. Circulation replaces blood saturated with oxygen;

6. Ventilation replaces water (as oxygen removed);

6

(b) Mixing of air and water (at surface);

Air has higher concentration of oxygen than water;

Diffusion into water;

Plants / seaweeds near surface / in light;

Produce oxygen by photosynthesis;

2 max

(c) Not much oxygen near sea bed;

Toadfish haemoglobin (nearly) saturated / loads readily at / has higher affinity for oxygen at low <u>partial pressure</u> (of oxygen);

2

(d) The chimpanzee and the bonobo are more closely related (than to the gorilla);

They have identical amino acids / one of the amino acids is different in the gorilla;

2

[12]

Q40.

(a) Randomly collected / collected from many ponds / same species / same time of year;

Accept other answers providing they might reasonably impact on data

1

(b) 9;

1

(c) Curve / line of best fit;

Shows upward slope / positive correlation / description of positive correlation;

Correlation does not necessarily mean causation;

Some other factor might be involved;

Some ponds had no worms but had frogs with deformed legs;

Q *No mark awarded for "yes" or "no"*

4 max

(d) (i) Sample too small to establish a pattern / to be representative / to identify anomalies;

1

(ii) Must compare like with like / must be a fair test;

Note that fair test is acceptable if used in context defined in How Science Works glossary

Some factors differ in mountains / named factor differs in mountains;

2

(e) 27% of the frogs had deformed legs in pond 2;

Agricultural run-off and cage mesh diameter of 500 μm;

2

(f) Worms cause deformed legs;

Deformed legs in 500 μm mesh cages / deformed legs when worms in cage;

Run off (on its own) does not cause deformed legs;

No deformed legs with run off and 75 μm mesh / no worms;

When run off present makes effect of worms worse;

Quantitative statement e.g. increased by factor of 7 to 8 times;

4 max

[15]

Q41.

(a) To enable (valid) comparison;

Bigger / smaller tomatoes could compress more easily;

2

(b) SD bars do not overlap ;

Difference (in ripeness) is real;

More variation in normal tomatoes (than in GM tomatoes);

2 max

[4]

Q42.

(a) Increase in number of species;

Increase in numbers of some species;

2

(b) Initial environment hostile / few organisms adapted;

These organisms change the environment / suitable example;

More niches / more habitats;

Allowing other organisms to become established;

max. 3

[5]

Q43.

(a) deforestation removes many habitats / niches fewer species / fewer types of organisms;

(do not credit just fewer organisms);

2

(b) 1. nitrate ions in fertiliser available / absorbed immediately;
2. ammonium converted to nitrate by nitrifying bacteria
3. fertiliser would provide only the initial release of nitrate / potassium nitrate;

3

[5]

Q44.

(a) Samples collected at random;
Method for choosing random sites – random coordinates / position from tables / calculator / other suitable means;

Other named factor constant e.g.:

Same size of net / same width of opening of net / use of one quadrat / Quadrats of same size / of stated size / same area disturbed / collect each
Sample for same time;

3

(b) *Caenidae* in deep water – because highest standard deviation / 'S.D.= 7.92'

1

(c) (i) An organism's role / in the ecosystem / community;
[ALLOW refs. To trophic levels / named]

(IGNORE refs. To habitat)

1

(ii) *Caenidae* found mainly in deep water AND *Baetidae* in shallow water / one family mainly in deep water AND the other in shallow water;

1

(iii) Reduces competition for named factor – e.g. food / shelter / O_2 ;
To ensure both types survive / otherwise better adapted type displaces other type;
OR

Ref. to 'Competitive exclusion principle' = 2 marks

max 2

[8]

Q45.

(a) (i) EITHER: Correct answer: 3.45 / 3.44 / 3.4 = 2 marks
OR: Understanding of ∑n(n-1) / use of 134 / (2 + 90 + 12 + 30)
+ wrong answer = 1 mark

max 2

(ii) Takes account of number of individuals / abundance / population size (as well as number of species);

1

(b) The species at A / *F.spiralis* loses less water / loses water less rapidly / loses less mass;

The species at A / *F.spiralis* better adapted to / can survive where exposed for longer / to drier conditions;

The species at A / *F.spiralis* avoids competition For named aspect – e.g. light / substratum / space / CO_2;

ACCEPT converse argument re. F. serratus

3

[6]

Q46.

(a) Tapes / string / axes laid out at right angles / grid area;
Method of obtaining random co-ordinates;
Do not allow "Use random number generator"

2

(b) (i) Decrease then remain constant;
From 200 cm / over 150 cm;

2

(ii) Oxygen decreasing because soil becomes more compacted / not replaced;
Decrease in oxygen leads to fewer aerobes surviving;

2

(c) Anaerobic bacteria replace aerobic as oxygen decreased by aerobic bacteria;
Remove competition;
Aerobic bacteria no longer able to survive in these conditions;

3

(d) (i) Near the surface / in top 50 cm;
Table shows decrease with time at greater depths;

2

(ii) Decrease;
Fewer aerobic bacteria with depth;
Oxygen concentration decreases / less oxygen at depth;

3

(e) Probability greater than 95% / 0.95;
Results are not due to chance / results are significant;
Because bars do not overlap;

3

(f) Plot as graph;
Draw line of best fit;
Read off appropriate value;

3

[20]

Q47.

(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]

Q48.

(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]

Q49.

(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]

Q50.

(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]

Q51.

(a) (i) transect line may not go through representative areas / may avoid certain areas;

1

(ii) large sample;
how random coordinates are generated / how random places chosen;

2

(b) (i) spread of values around the mean height of the plant;

1

(ii) smaller plants at higher altitude;
greater the altitude the lower the standard deviation ;

reference to figures to make a comparison;

2 max

(iii) the plants measured were grown under uniform conditions;

1

[7]

Q52.

(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]

Q53.

(a) generation of random co-ordinates;
use of 10 or more quadrats;
collection of all dog whelks in quadrat;

3

(b) greater variation for sheltered population / population A;
range / spread around the mean;

(or converse)

2

(c) (i) smaller ratio means relatively larger foot / population B has relatively large foot;
better able to grip;
larger / longer shells have greater area exposed / are subject to greater force;

(ii) wave action limits the max. L / A ratio / extremes;
valid point about age, e.g. greater age range on sheltered shore / live longer on sheltered shore;

(allow shell size marking point in either (c)(i) or (c)(ii) but only credit once)

4 max

[9]

Q54.

(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]

Q55.

(a) random sampling method;
use of large numbers / many / 10 or more quadrats in each area;
counting daisies and dividing by area;

3

(b) the cutting has no effect;

1

(c) daisy, dandelion, buttercup show (statistically) significant differences;
no significant effect on plantains;
comment on relative significance of daisy / dandelion / buttercup;
regular cutting linked to significant increase in density of daisy / dandelion;
linked to significant decrease in density of buttercup;
(no marks if significance idea omitted)

3 max

[7]

Q56.

(a) angle, moisture and pH
(all required)

1

(b) system for subdividing quadrat into, e.g. many squares;
method of estimating cover in small squares, e.g. counting those where cover over 50%, or cover at points (of intersection);
(not just 'count squares with vegetation' unless very small)

2

(c) increasing vegetation cover is related to increasing moisture content
(allow 'affects' moisture content or vice versa, not 'causes);

correlation is significant / not due to chance / can reject null hypothesis
/ only 1 in 20 / 5% probability that the correlation is due to chance;

2

(d) factor; and linked effect e.g.

wind-blown particles trapped;
accumulation of soil;
OR
accumulation of organic / dead / decomposed matter / humus;
increase in mineral ions / improved water retention / improved soil structure;
OR
nitrogen fixation;
increased nitrate concentration / improved soil fertility;

2 max

[7]

Q1.

In question (a), it was clear that some students had been taught how to respond to the command ‘compare and contrast’. They produced well-organised answers, although these largely concentrated on the differences between the two types of DNA and seldom referred to similarities. Students who wrote lists about each type of DNA and did not make clear comparisons and contrasts, did not gain marks. A significant number of students compared prokaryotic cells with eukaryotic cells (such as “DNA floats in the cytoplasm, but in eukaryotes it is contained in a nucleus”) or they compared DNA with RNA. Misconceptions were common; for example, “prokaryotic DNA is single stranded”, “it contains uracil”, “it is not replicated semi-conservatively”, “it contains ribose”, “viruses are prokaryotes”, “DNA is an alpha helix”, “all prokaryotes have plasmids”. Very few students (0.3%) achieved five marks and not many (1.9%) got four marks. Many answers showed little evidence of knowledge beyond GCSE level; for example, “DNA consists of four named bases”, “DNA is made of a sugar, a phosphate and four bases”. Knowledge about nucleotides was given in very few answers. The low quality of answers (the mean mark on this question was only 0.79 out of 5), along with evidence of frequent misconceptions, gave examiners a sense that section 3.4.1 of the specification about DNA structure is not well understood.

In (b), it was evident that students had difficulty with this topic and many answers (56.4%) gained no credit. Some students were diverted because the question referred to haemoglobin, and went into long detail on levels of protein structure and physiological adaptations to different oxygen environments; for example, mammals at different altitudes. Those who discussed evolutionary relationships often gave vague answers that referred to sharing a common ancestor or being related, rather than use ideas like more differences would indicate a more distant relationship and an earlier common ancestor. Very few students considered what caused the differences in the primary structure of haemoglobin, consequently little mention was made of mutation, which is the process underpinning species change in evolution. Few considered why these differences accumulated over time. Many answers achieved two marks, and rarely more than three marks. The mean mark on this question was only 0.46 out of 5.

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.

For question (a), only 7.6% of students scored two marks. Most students were able to explain the purpose of boiling the agar, though the most common error was to copy the stem and state "so it could be poured". Explaining the purpose of transferring the same volume of liquid culture onto each agar plate was beyond most students. Some did not understand the term 'culture', thinking it just meant food. There were many generic answers, such as "to make it a fair test", "to control variables", and "so only the independent variable affects the dependent variable". The words valid, reliable, accurate and precise were also thrown at the answer.

Question (b) was not a difficult maths question; it simply involved multiplying three numbers together. Despite this, only 15.6% of students scored two marks.

For question (c), over half of the students were able to access the first marking point, but very few scored the second. There were not any real mistakes with mark point two; it was just omitted.

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.

Q5.

(a) The command word here was **contrast** and so statements showing clear differences between the use of the two microscopes were required to gain credit. Most students demonstrated sound knowledge of the optical and electron microscopes, but few

managed to gain all six marks for relevant contrasting statements. Many suggested that no organelles could be seen with an optical microscope, rather than only larger organelles being visible. Some referred to SEMs and 3D images; neither was relevant here.

(b) There were many good answers here, with over 70% of students scoring 2 marks and over 40% gaining 3 marks. Mark point 4 was the least often awarded. Students often failed to gain mark point 3 because they stated that **W** contained half the genetic material of **Z**, rather than specifying half the DNA. Several students discussed these cells as if they were human cells rather than plant cells, mentioning 23 pairs of chromosomes originally, or 23 chromosomes in cells in **W**. Some students named stages of meiosis in their answer. These were ignored as this is not expected knowledge; we were only looking for the outcomes of 1st and 2nd meiotic divisions.

(c) The full range of 0 – 5 marks was seen in similar proportions here (although slightly fewer with full marks). The main reason for the discrimination was how fully each student used the information from the question stem. The two groups of seeds to be investigated had been collected already, and the investigation that was needed was simply to find out if there was a difference in size of these seeds. Many students gave extensive answers relating to how to collect the seeds from the environment, and how to measure the pollution – neither of which was relevant to the question. Many students selected an inappropriate statistical test or listed several options, which could not be given credit, even if t-test was amongst the list of possibilities (see note about the 'list rule' in the final paragraph of "General Comments" above).

Q11.

Question (a) was a very good discriminator. 19% obtained all four marks, 14% failed to score and equal percentages obtained one, two or three marks. Many students had the idea that a vaccine contains antigen and knowledge of antigen-presenting cells was common. There were also many correct statements about plasma/B cells releasing antibodies. Fewer students had the idea of a B cell dividing to form plasma cells. Not many students were able to express clearly the idea of a specific helper T cell or B cell detecting, or responding to, a specific antigen. Quite a few students got confused between the roles of T cells and B cells. Some students wrote at length about memory cells and secondary responses, neither of which was required to answer the question. As in some other questions, this inclusion of irrelevant material often generated additional pages and wasted time that could have been spent on other questions.

Most students obtained one mark in (b) for suggesting greater antibody production with two vaccinations. Almost none went on to make any other suggestion.

In the mathematical requirements section of the specification (pages 62-66), selection and use of a statistical test is not emboldened and so is required content for both AS level and full A-level. This is different from the legacy specification and answers to (c) indicated that most students had not learnt this. Only 6% of students could name the t-test and give the reason as testing the difference between means. Further guidance about teaching statistics is provided in the support materials on the AQA website.

The examiners were expecting statements from the specification in answers to (d). In 'Investigating diversity' (section 3.4.7), genetic diversity is compared (amongst other ways) by looking at base sequences of DNA and base sequences of mRNA. Very few students (3%) came up with both of these but some (27%) managed to express one of them.

Q12.

(a) 70% of students correctly gave 14 as the answer. Some students used **Figure 2** rather than **Figure 1** or provided a definition of species richness.

(b) Surprisingly, less than 50% of students obtained this mark. Many students suggested that the additional information required was the total number of all dung beetles rather than the number of individuals in each species.

(c) Almost two thirds of students failed to obtain a mark on this question. It was evident that many students did not fully understand what was meant by standard deviations. Also a large number of students used the results in **Figure 1** rather than **Figure 2**. Most students who did refer to no overlap in standard deviations were able to relate this to there being a significant difference in mean total to obtain both mark points.

(d) Three out of every four students correctly explained that choosing sites at random would prevent bias. Responses failing to gain credit often referred to 'controlling variables' or 'a fair test'.

(e) Most students obtained at least one mark usually by referring to the removal of a habitat for the birds. A significant number of these students then gained a second mark by referring to a decrease in food sources. Very few students obtained maximum marks as they did not relate the removal of hedges to the loss of plant/insect species. Often students showed understanding but did not gain credit due to the use of imprecise terminology and/or poor quality of communication. Common examples of this included, 'less food', 'less homes' and 'less shelters'. A small minority of students misinterpreted this question and discussed reduction in genetic diversity.

Q13.

(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'.

Q14.

(a) Almost as many achieved this mark as did not, so the definition of species diversity is not well known. Some confusion exists between species diversity and genetic diversity. Many students referred incorrectly to diversity within a 'population' so

missed completely the point that the definition focussed on a collection of species. Instead of using ‘number’ in their definition, some students mentioned ‘range’ to suggest that they regarded diversity as a measure between two extremes.

(b) Most students achieved a mark for demonstrating they knew that the number of each species is relevant in the calculation, but, for many, their poor quality of written communication prevented the award of a second mark. For example, a common error was to refer to ‘number of species’ rather than make clear the importance of a ‘grand total of organisms’.

(c) Many students showed a good appreciation of the principles of diversity and density and achieved both marks. The imprecise use of terms prevented some from achieving any marks, eg, ‘organism’ rather than ‘species’; ‘thrive’ rather than ‘reproduce’ and ‘hostile’ rather than a precisely described effect of sewage.

(d) (i) The principle that repeatable results are a requirement in order to be able to draw conclusions was well understood. Unfortunately, some students only offered a comment about the observed difference in results and did not go further to state that it prevented the scientist from coming to a conclusion. Others gave an imprecise comment about the scientist being less able to draw a conclusion or they gave reasons why the two investigations might have produced differing results or they offered suggestions on how to improve the quality of findings.

(ii) Very few students gained the mark here either because they referred only to making a ‘single repeat’, or they repeated the investigation by changing the independent variable, and hardly any went further to confirm what the repeats would need to show before conclusions could be made.

Q15.

(a) Most students demonstrated a sound understanding of the principle that a hypothesis is a statement that is tested by an investigation. Predictions were most often given and many gave null hypotheses. Marks were missed when students failed to make any reference to ‘resistance’ in the context of bacteria, and it was not uncommon for the resistance to be linked to the animal or human rather than to *Escherichia coli*.

(b) (i) Many students showed good skill and precision by selecting the right information from the table and made careful references to ‘percentages’ and ‘resistance’ to gain full marks.

(ii) The principle of natural selection is well understood, but often marks were missed because of a misconception that antibiotics cause mutations. Imprecise expressions were common, such as ‘bacteria thrive’ or they ‘grow’ rather than they ‘reproduce’.
Occasionally, students wrote that ‘resistant alleles survived’, with no role implied for the bacteria that contained them.

(c) Approximately a quarter of students achieved the mark on this question because they made a clear link between human faeces and contaminating pathogens. Many mentioned *Escherichia coli*, which the question explicitly told them not to do, and poor written communication was evident in answers suggesting that what is spread is a ‘disease’ rather than an ‘agent of disease’.

(d) The principle of measuring the reliability of the design of an investigation is very well understood, with the majority of answers gaining two marks. Some students misread

the question because they suggested changes in the design to increase reliability, and others did not notice 'reliability' was given in the question's stem so it should not have been included as an answer.

(e) This question differentiated well. Students made appropriate suggestions using either DNA hybridisation or nucleotide sequencing to address the context of this question; some wrote at length about both of these techniques. A minority of responses discussed using antibodies to compare the similarities, possibly they think DNA is a kind of protein.

(f) Few students achieved more than three marks on this question because many tended to dwell far too long on giving a full explanation of how natural selection increased cases of resistance; they did not look to give broader reasons relating to society's view. Contamination of the human food chain, avoiding adverse side effects, the generation of superbugs, and high costs were common answers, although students giving more than any two of these was rare. Very few answers contained suggestions about changes in legislation and, although prevention of the horizontal and vertical transmission of genes conferring resistance was often cited, it was rare for students to make clear the principle of avoiding transmission of resistance into other harmful bacteria, so this marking point was not often awarded.

Q16.

(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.

Q17.

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

(a) 70% of students scored full marks. Those who scored one mark often gave both alternatives of the second mark point. Weaker responses often lacked clarity; for example, 'number of individuals' and 'different species within a population'. Students who failed to score often thought that the 'size of the area' and 'standard deviation values' are needed to calculate an index of diversity. It should be noted that although the specification requires students to be able to calculate one specific index of diversity, the mark scheme was amended so that other types of index of diversity could be credited.

(b) (i) Most students were aware that the purpose of the control fields was to ensure that the results are due to the herbicide, or not due to another factor. Those who failed to score typically gave stock How Science Works responses, which

could apply to any investigation. These usually referred to comparing groups or results, ensuring that the results were due to the independent variable, or simply that these fields acted as controls. Students should be reminded of the need to relate their answers to the specific investigation or context outlined.

(ii) Half of students scored one mark and this was usually for appreciating that the herbicide killed more weeds, which led to less competition. However, the ability to explain the effect of high concentrations of herbicide, in terms of damage to the crop, proved to be a good discriminator. Unfortunately, many students did not read information in the introduction carefully enough. They thought that the herbicide killed insects, which meant that fewer crops were eaten. The weakest responses usually went no further than to describe the graph.

(iii) Just under half of students scored at least two marks. This was usually for 'fewer habitats' and 'fewer food sources'. It was only the best responses that referred to 'fewer plant species' being present. Similarly, the ability to express these ideas discriminated well. Weaker responses often referred to 'less food' and 'less plants', which were not credited. As mentioned in part (i), some students wrongly thought that the herbicide killed insects, which directly led to a decrease in their index of diversity.

Q18.

(a) Over 95% of students correctly named the process as succession. Speciation was the most common incorrect response.

(b) Most students obtained at least one mark, usually for stating that more habitats would be available. Many of these students also referred to a greater variety of food sources although a significant minority simply stated there would be more food, which was not credited. Approximately a third of students gained all three marks by also indicating that as the woodland developed there would be an increase in the variety of plants.

(c) (i) 50% of students correctly gave temperature and carbon dioxide as the two limiting factors. Most who did not referred to water rather than temperature. However, humidity, mineral ions / nutrients, oxygen, pH, light intensity and chlorophyll were also given as limiting factors. Only rarely were two incorrect factors selected.

(ii) Most students referred to the uptake of carbon dioxide in photosynthesis and its release during respiration but did not fully explain net productivity. Some students got the use / production of carbon dioxide in photosynthesis / respiration the wrong way round. Almost a third of students did gain this mark, almost invariably by stating that net productivity = gross productivity minus respiration.

(iii) This question was not answered well. Very few students were able to use the information in **Figure 2** to explain how the shade plant is better adapted to gain both marks. The lower rate of respiration was recognised but the lower release of carbon dioxide was usually described at low light intensities rather than at 0 or in the dark. The idea of greater productivity in the shade plant was less frequently described. Most answers related to photosynthesis and many students gained no marks. As in part (ii), the uptake and release of carbon dioxide was sometimes wrongly assigned to respiration and / or photosynthesis. The surface area of the leaves, amount of chlorophyll and number of stomata were also incorrectly used as part of some students'

explanations.

Q19.

This question was well answered by most students, with over 75% of students obtaining four or more marks. The most commonly awarded marks were; carbon dioxide combining with RuBP, the formation of 2GP from this reaction, the reduction of GP to TP and the formation of a named compound, usually glucose or RuBP from TP. Approximately one in every four students specifically mentioned that ATP provides the energy for the reduction of GP to TP. A much higher percentage of students stated that reduced NADP is essential for the reduction of GP to TP. However, there was a significant minority of students who referred to reduced NAD rather than reduced NADP.

Q20.

(a) This question was intended as a gentle introduction to ensure the students had read and thought through the resource material and 95% of students gained this mark.

(b) This was a high-scoring question, with 65% of students gaining all three marks and 95% gaining two or more. Students who failed to obtain a third mark usually numbered each individual plant, rather than using a coordinate system, or missed out the first step of generating a grid.

(c) Students struggled to suggest why bare ground was left. If they thought about competition, they generally answered successfully and scored marking points 1 and 2. The idea of there being less movement of the pest between the maize and grass was rarely expressed clearly.

(d) Very poor understanding of the nitrogen cycle was frequently seen. Many students had the N-fixing bacteria providing ‘the plant’ with proteins, demonstrated poor understanding of nitrogen fixation and the use of nitrates by plants or failed to distinguish between the legume and the maize.

(e) Most students achieved marking point 1, for identifying a trend in the data. Fewer went on to use the data in a calculation to justify the trend they had reported. Many had the idea of an improved profit, although some expressed this very poorly, but few used the data to calculate the actual increase in profit in order to gain marking point 5. Virtually no students made reference to the standard deviations shown in the data.

Q21.

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.

Q22.

(a) (i) Almost eighty percent of students obtained this mark, usually by stating that this method helps to make the samples 'representative' or 'reliable'.

(ii) The vast majority of students gained at least one mark for referring to using coordinates or dividing an area into squares. Most of these students gained a second mark for describing a method of generating random numbers. Some students incorrectly referred to the mark, release and recapture method.

(iii) Almost fifty percent of students gained two marks for providing two valid reasons for changes in the population of lizards at different times of the year. Breeding, predators, prey and temperature changes were common correct responses. Responses such as 'weather' or 'climate' were not credited and limited most of the other students to one mark.

(b) This was generally answered well, with many students gaining both marks. The most common scoring point was the idea of allowing a valid comparison. Some students failed to note that the numbers in the samples vary and obtained one mark. Incorrect responses often referred to reliability.

(c) Considering the data provided were not particularly complex, it was disappointing to note that forty percent of students scored zero for this question. The most common scoring mark point was for referring to the results at site 5 for *A. gingivinus.* Relatively few students gained a second mark by referring to a positive correlation or to the limited results for *A. wattsi.*

(d) (i) The vast majority of students gained one mark for stating that more *A. gingivinus* than *A. wattsi* are infected. Many students then tried to explain why this might be the case (more die so less competition for food etc), rather than trying to give further explanations of how they reached the conclusion. As a result, very few students obtained two marks.

(ii) A significant minority of students did not use the information provided on the destruction of blood cells and gained zero marks. Students who did use this information often referred to the increased susceptibility to disease due to destruction of white blood cells. There were slightly fewer marks gained for the effects caused by a reduction in red blood cells.

(iii) Less than fifty percent of students obtained both marks. Although students understood that the P value represented probability, the less than symbol < was often interpreted as 'is' or 'equal to'. Other errors included referring to 0.01% rather than 1% probability or the correlation not being due to chance (with 0.01/1%). Some students correctly used a probability of more than 99% / 0.99 that the correlation is not due to chance.

Q23.

(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.

Q24.

(a) This question was generally answered well, with the better students able to explain the importance of random collection in the context of the investigation rather than simply turning out the phrase 'avoiding bias'.

(b) (i) Most students understood the summation process even though they made mistakes in another part of the calculation. A significant number of answers went up to 5 or 6 decimal places which, although not penalised, should be avoided. The mathematical requirements of the specification do state the 'use of an appropriate number of significant figures'. A significant number of students use the space available as rough working rather than for setting out the logic by which they arrived at the answer. A tangled mass of numbers did not always allow the examiners to credit incorrect responses for an understanding of underlying principles.

(ii) Most students made reasonable attempts at this section. Most correct references were to the reduction in species number and to the predominance of the bird-cherry aphid. Incorrect references were made to totals of all organisms and totals of all species. Weaker students assumed that the fewer organisms in total, the lower the biodiversity. Some wrote, incorrectly, about genetic diversity.

(c) Instead of evaluating the conclusion given, a significant number of students wrote their own conclusions about the effects of farming on the environment and the mechanisms by which these were brought about. Answers were often vague and did not refer to the data provided.

(d) Generally answered well; almost all students offered responses, often with good explanations relating to increasing variety of habitats and food sources.

Q25.

(a) This question produced many excellent responses in which students identified appropriate types of nutrient. Where marks were not awarded it was generally for duplication as in suggesting both glucose and sugars or nitrates and phosphates, or for lack of precision with answers such as nitrogen and carbon.

(b) Answers based on bias, accuracy and reliability suggested to the members of the moderating team that many students attempted to adapt poor recall of existing marking guidelines to the requirements of the question. Those who thought about this particular investigation appreciated, however, that a suspension of yeast cells would be inclined to settle and would therefore need to be stirred.

(c) Although most students calculated the percentage increase in yeast cells correctly, working was not infrequently poorly set out and extremely difficult to follow. If there had been errors, it would have been very difficult on such scripts to have awarded credit for demonstrating the principles involved.

(d) The commonest reason for failing to gain full credit here was because of insufficiently detailed responses. As Question (a) asked for two types of nutrients present in the apple juice, rather more than “lack of nutrients” was required by way of response.

Q26.

(a) Over 40% of students failed to score on this question. Many of these students suggested that proteins consist of bases and the confusion between bases and amino acids pervaded their responses. Although a number of students did correctly refer to the sequence of amino acids, only better students linked the similarity of the amino acid sequence with a close evolutionary relationship between different species.

(b) This question also proved challenging with less than 50% of students gaining any marks. However, a significant number of students did gain one mark for reference to the triplet code and students appreciating the degeneracy of this code were able to gain both marks. Some students gained credit by referring to introns or non-coding DNA.

Q27.

(a) (i) Slightly more than half the students obtained this mark, often for mentioning the idea of identifying anomalies or that the sample would be representative of the population. Answers failing to gain credit often lacked sufficient detail with responses such as 'to make the results reliable' or 'to calculate an average' being commonplace.

(ii) Almost 95% of students gained this mark by mentioning the removal of bias.

(b) Two thirds of students correctly carried out the calculation and obtained both marks.

Approximately 5% of students obtained a principle method mark having calculated an incorrect answer.

(c) This question proved to be a fairly effective discriminator. Surprisingly, a significant minority of students suggested that there would be a decrease in the variety of insects on the golf course despite the stem of the question indicating that diversity would be higher. However, most students did mention an increase in habitats for one mark. Many also appreciated there would be an increase in the variety of food sources although references to 'more food' were not credited. Only the very best students mentioned an increase in the variety of plants.

Q28.

(a) This proved to be a very effective discriminator with almost equal numbers of candidates scoring two, one or zero marks. A significant number of candidates referred to ‘more food’ rather than a greater variety of foods. Vague terms such as ‘more shelter’ were not accepted as an alternative to more habitats.

(b) Very few candidates obtained both marks in this question. However, almost half the candidates gained one mark for indicating that the index of diversity measures the number of species and the number of individuals. Better candidates used this information to explain that an index of diversity would be more useful where some species were only present in low or high numbers.

(c) (i) This proved a very demanding question with two thirds of candidates scoring zero. Despite the cue that ‘these eggs are small’ relatively few candidates correctly linked this to a large surface area to volume ratio. Only a small percentage of these candidates then referred to diffusion. It was very disappointing to see responses describing pesticides moving by osmosis.

(ii) The majority of candidates appreciated that evaporation of water would increase the concentration of the pesticide.

Q29.

(a) The Harvest Index was calculated correctly by most candidates.

(b) It was relatively uncommon to encounter convincing answers to this question. Although most candidates implied that a greater proportion of the crop would be grain, they did not always make the point with sufficient clarity. Problems arose over use of the word “crop” which was variously used to mean anything from grain to the entire plant.

(c) This question generated some good responses and most candidates were able to suggest that a named abiotic factor varied. Many, however, failed to complete their answers by referring to sampling taking place in different parts of the field.

(d) Most candidates were able to gain full credit for their answers to this question although some failed to mention that content would vary.

Q30.

(a) There were many excellent and clearly focused answers to this question.

(b) Most candidates were able to point out that the herbicide would reduce the number of weeds and suggest that this would lead to reduced competition for a specified resource.

(c) Candidates found this question challenging. In discussing advantages, arguments were often based inappropriately on the rate of growth of the crop rather than that of the weeds. Acceptable disadvantages were seldom suggested and many answers were based on incorrect climatic generalisations.

(d) Many candidates wrote lengthy answers that focused on experimental design in general terms rather than on the design of this particular investigation. Such responses usually identified the lack of a control, small sample size and the possibility of confounding variables. Those who followed the procedure through, and considered each step carefully, were often able to make further points.

Q31.

(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.

Q32.

(a) Those candidates who could explain with sufficient clarity that it was necessary to determine the number of each species present were able to gain credit. A surprising number of candidates knew that an equation was involved and could quote it with some degree of accuracy. Many revealed, however, little knowledge of what the various terms represented.

(b) Part (a) should have indicated to candidates that the thrust of this question was species diversity. Unfortunately the term diversity triggered many candidates to respond in terms of selection, genetic bottlenecks or the founder effect. The approach to this question was further influenced by a poor understanding of the concept of a species with many candidates apparently of the impression that all insects are members of the same species. Better candidates however approached the question in an appropriate way, and although they did not always appear to appreciate that clearing forest and planting crops would lower the plant diversity and hence the variety of available food, they were able to make worthwhile comments.

(c) In part (i), many candidates showed an unfamiliarity with the idea that joining points on a graph with straight lines indicated uncertainty over the reliability of intermediate points. Answers to part (ii) were rather better with most candidates clearly understanding the nature of controls even if they enjoyed less success in explaining why a control would be necessary in the investigation described.

(d) The best candidates understood the requirements of a question requiring evaluation

and were able to link the changes in breeding birds shown on the graph with species diversity. They also indicated that the data referred to total number of birds and not diversity and point out the shortcomings at arriving at conclusions based on limited data. Those who did not gain significant credit, not infrequently failed to read the axes with sufficient care or did not appreciate why the points had been joined with straight lines. Evaluate was occasionally regarded as having the same meaning as Explain. Explanations gained little if any credit.

Q33.

(a) Although a considerable number of candidates gained credit for their answers to this part of the question, others offered inappropriate suggestions. Many of these were yet again centred on the converse and attempted to explain why they did not measure the minimum diameter.

(b) There was evidence from the answers to part (i) that many candidates still fail to absorb material presented in the stem of a question or look critically at data in tables and graphs. Thus, although most appreciated that shrimps that lived in caves had smaller eyes and longer antennae than those that lived in the open, they were unable to point out either that the antennae were responsible for detecting touch or that these data only referred to shrimps. More limited candidates often suggested that shrimps either had eyes or sense organs. Those candidates who avoided explaining standard deviation in terms of range, generally gained at least one mark for part (ii). Better candidates were also aware that overlap in the values of standard deviation was important in indicating whether differences were attributable to chance or were significant.

(c) In part (i), most candidates made an appropriate qualitative statement about the body lengths of the shrimps concerned but few supported this with data from the graph. Some appeared distracted by antennal length and failed to identify the thrust of the question. Part (ii) was generally well answered.

(d) Most candidates appeared to have understood the information in the graph but could not always explain this with sufficient clarity to gain credit. Thus, although an answer relating to cave shrimps and ocean shrimps (interpreted as shrimps living in open streams) could be awarded credit, one that merely referred to shrimps in streams could not. There were also many sweeping statements such as that “the percentage of shrimps was higher in the open for all alleles”. This was clearly not correct. More credit might have been awarded had candidates based their wording more carefully on that supplied in the column headings in the table.

(e) One of the key phrases in this question was “Use your knowledge of the founder effect”. This should have indicated that candidates were required to apply this concept to the example provided in the question. A significant number failed to do this and opted instead to discuss the difference in percentages in terms of either natural selection or genetic bottlenecks. Such approaches rarely gained credit. Others offered extremely general explanations that made no reference either to shrimps or to allele L. These accounts often incorporated volcanic eruptions and hunting to extinction. Answers were further marred by imprecise language with the term “species” used in a variety of ways that had an adverse effect on the sense of the argument presented. Some candidates again turned the question round and attempted unsuccessfully to use their knowledge of the founder effect to explain the percentage of shrimps with the allele L in the open.

(f) Candidates who answered this question successfully either suggested breeding cave shrimps with those living in the open to see if fertile offspring were produced, or looking at whether courtship behaviour led to successful mating. Although both of

these approaches were acceptable, those based on DNA hybridisation and protein analysis were not. Those candidates who chose to discuss crossing shrimps often suggested procedures that would not have guaranteed the relevant parentage. Attempts were made to add detail and there were some valid comments about repeats and carrying out reciprocal crosses. However, there was much discussion about the ethics of experimental work and the perceived cruelty of such experiments that could not be given credit.

Q34.

(a) Most candidates obtained at least one mark for stating that humans are most closely related to chimpanzees. Approximately half the candidates also gained the second marking point by indicating that humans are least closely related to dogfish.

(b) Many candidates used the stem of the question to state correctly that cytochrome is found in all eukaryotes. Incorrect responses usually referred to cytochrome being present in all species.

(c) Many candidates did refer to the base triplet code and gained a single mark point. Better candidates referred to introns or to different base triplets coding for the same amino acid. However, a significant number of candidates failed to gain any marks, often describing a base triplet as a gene.

Q35.

(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.

Q36.

(a) Most candidates had little difficulty obtaining at least one mark often for stating that courtship behavior enables recognition of the same species. Over a third of candidates gained a second mark. These candidates often linked courtship behaviour to sexual maturity or to the release of gametes. Most candidates failing to gain two marks often provided only one suggestion or there was a lack of clarity in their answers.

(b) (i) Almost two thirds of candidates gained this mark. Most candidates used the information in the stem of the question to explain that fusion between gametes would be more likely within a limited area.

(ii) Less than half the candidates obtained this mark by indicating that developing within the pouch protected young seahorses from predators.

(c) (i) Most candidates gained this mark often by stating that the curved tail made it difficult to obtain an accurate measurement of body length.

(ii) This proved slightly more difficult with a number of candidates providing the same answer as in (c)(i). Nevertheless, over 60% of candidates did obtain the mark by suggesting that body length is proportional to head length.

(d) The vast majority of candidates obtained this mark by describing the trend of seahorses with similar head/body lengths pairing together.

(e) This was generally well answered with most candidates obtaining the first marking point by referring to drawing a line of best fit. Over 50% of candidates gained the second mark by explaining how extrapolation of the graph could be used to predict the total head length of selected mate.

(f) This question proved an excellent discriminator. The vast majority of candidates described how DNA hybridisation could be used to find out if the two species of seahorses are closely related. Not surprisingly, the quality of the descriptions of DNA hybridisation varied considerably and a variety of alternative methods were credited. Most candidates gained a couple of marks for naming the technique and for the principle of mixing the DNA strands of the two species. Many candidates also appreciated that a higher temperature would be required to separate hybrid strands from closely related species. A maximum of four marks was available for a full description of DNA hybridisation.

Other methods described included; comparing DNA base sequences, comparing amino acid sequences and immunological studies. There was considerable confusion between the first two methods with many candidates referring to ‘amino acid sequences of DNA’. Few candidates appreciated that the same or a named protein should be studied when comparing amino acid sequences. Descriptions of immunological investigations were relatively infrequent and apart from some notable exceptions, were generally of poor quality displaying little understanding of even the basic principles. Nevertheless, over a third of candidates obtained four or more marks for this question with many providing outstanding detailed descriptions of the various methods involved.

Q37.

The first part of the question was based the requirement for candidates to carry out fieldwork as detailed in the section titled Investigative and practical skills. The question progressed to consider the application of elementary statistical analysis to the results obtained from such an investigation.

(a) Part (i) was targeted at grade E candidates and there were many correct answers involving some method of creating a grid and the use of a random number generator. Those who did not gain full credit usually failed to indicate how they might turn the random points that they had obtained into areas that would be sampled. Two approaches to part (ii) were acceptable. Some of the best candidates had clearly encountered the use of a running mean and were able to describe the underlying principles with sufficient clarity to gain both of the available marks. The other approach was to discuss the compromise between reliability and time available. Many answers, however, ignored the question requirements and simply suggested what they considered would be a suitable number of quadrats to "collect representative data".

(b) Many of the less able candidates demonstrated either an inability to make use of information provided or a failure to apply common sense. Thus there were significant references both to coppicing the daffodils and to felling the whole wood at improbably frequent intervals. Those who understood the concept did not always read the graph with sufficient accuracy and described daffodil numbers rising to a peak at 3 years or there being more plants between 3 and 6 years.

(c) The requirement for candidates to be able to apply elementary statistical analysis to the results of ecological investigations should have ensured a degree of familiarity with the concepts of a correlation coefficient and statistical significance. All that was really required here was to identify the positive correlation between the number of daffodils in flower and total rainfall, and the negative correlation with monthly mean temperature. Some candidates foundered because they misinterpreted the correlation coefficients as mean values. Others failed to link the climatic factors with the flowering of daffodils with the result that many of the statements made were vague and imprecise.

Q38.

Unit 4 will test the principles underlying *How Science Works* with a question that will be similar in format to this. In order to provide a genuine test of the objectives involved and the appropriate degree of stretch and challenge, candidates must expect to encounter investigations with which they are unfamiliar. While it was encouraging to note that most candidates responded well to the unfamiliar, many failed to gain credit for those parts of the question that depended rather more heavily on basic factual knowledge.

(a) Many candidates appreciated the way in which the hair traps worked and offered sensible suggestions to both parts of this question.

(b) The importance of random selection in avoiding bias was appreciated by many.

(c) Most candidates clearly had some appreciation of the importance of checking the repeatability of the measurements. There were frequent, and acceptable, references in part (i) to reliability. Better candidates also wrote of avoiding measurement and personal errors. Part (ii) created more in the way of difficulties, partly because it was unclear in many instances as to precisely what had been plotted. Very few candidates appeared to have encountered scatter diagrams with many responses being based on plotting the two sets of measurements and then comparing the positions of the pairs of points that resulted. An alternative approach, suggested by many, was to construct histograms and compare these. As the question specifically called for using a scatter diagram, this approach could not be given credit.

(d) The many candidates who answered part (i) in terms of the difficulty of establishing the relationship between the number of hairs and the number of visits by a shrew were able to gain credit. Part (ii) proved more challenging and a considerable

number of candidates misinterpreted the question. They considered “setting traps immediately after using the hair tubes” in a geographical rather than a temporal sense. Others embarked on lengthy discussions of the advantages of using the mark-release-recapture technique and produced responses which had little if any relevance to the question asked. The very best candidates, however, linked time to population change and produced appropriate answers.

(e) Although many candidates discussed specific statistical tests in their answers to this question, it was clear that they had little understanding of the role of such tests in determining the probability of an event being due to chance. There were frequent references to greater accuracy and reliability and even to the use of statistical tests being “more scientific. It was also disappointing to note the many responses that referred to neither or only a single one of the terms specifically required in the response.

(f) It was clear from the many correct answers to part (i) that candidates had clearly understood the bubble plots despite their unfamiliarity. A significant number, however, introduced the term “correlation” without making it clear that in this case a positive correlation existed between the hair tube index and the number of shrews trapped. The absence of correlation in the case of the pygmy shrews was usually indicated, and better candidates pointed out that the hair tube index indicated that hairs were present even when shrews had not been caught in the traps.

Q39.

(a) Candidates showed a good understanding of the adaptations of gills for efficient gas exchange. Although there were some who wrote in very general terms about ‘gills’, most candidates linked surface area to the possession of gill filaments or lamellae and to diffusion. The principle of counter-current flow was frequently mentioned and it was clear that most candidates had an excellent understanding of this concept. Some illustrated their answers with diagrams and these were occasionally very helpful.
Candidates should be aware, however, that marks can only be awarded for diagrams that are properly labelled. There were numerous sketches on which were written figures that might have represented anything. Some points were made less frequently or less convincingly. There was relatively little mention of the roles of ventilation and circulation in maintaining the concentration gradient and many struggled to describe the short diffusion path in sufficient detail to gain credit. There were also a number of frequent misconceptions. These included references to air passing over the gills; to diffusion only being able to take place in water, and to the presence of carbon dioxide being essential for the diffusion of oxygen.

(b) Successful responses to this part of the question usually referred to photosynthesis or to the diffusion of oxygen from the higher concentration in the air. There were many answers, however, that involved fanciful ideas about generation of oxygen at depth and this bubbling to the surface, or incorporated the concept of need, such as that there was less oxygen at depth because the toadfish did not need it.

(c) This answer illustrated a common failing among less able candidates in answering questions that involve application of knowledge. They were often inclined to rely on recall and, while most were able to indicate that the toadfish environment was low in oxygen, they not infrequently related this to high altitude. There was also a tendency to give answers that were too brief, omitting reference to the context of low partial pressure when describing the high affinity of toadfish haemoglobin for oxygen.

(d) Answers to this question tended to fall into two categories. Either candidates gave very good answers that made the points in the mark scheme succinctly, or they

wrote at length about the three organisms without ever quite answering the question. However, it was encouraging to see many excellent answers to a question set in a context which is new to the specification.

Q40.

(a) Most candidates gained credit for their answers to this part of the question.

(b) There were many incorrect responses to this straightforward calculation. The answers to this part, and to others within this question, suggested a very limited understanding of the concept of percentages.

(c) Most candidates correctly recognised the positive correlation between the percentage of frogs with deformed legs and the mean number of parasitic worms per frog but some, despite the length of their answers, were unable to progress beyond this point. Many, however, pointed out that correlation does not necessarily mean causation and supported their answers with references to the involvement of other factors, or to the fact that there were frogs with deformed legs in ponds where there were no parasitic worms.

(d) Most responses to part (i) recognised that very few ponds meant that the sample was small but then went no further than to rewrite the question and explain that this meant that the scientists involved could not draw reliable conclusions. Answers to part (ii) were generally better, and most were able to suggest that there would be factors that might apply specifically to mountainous areas. Only the better candidates pointed out the need to compare like with like before valid conclusions could be drawn. Among less able candidates there was concern about the risk to biologists working in mountainous regions and much philosophical discussion over whether a pond that was studied by a biologist could be said to be free of human influence.

(e) One of the purposes of this question was to help candidates to understand the complex table. Very few were able to describe the information in the shaded box in terms of the column and row headings. There were two particularly disconcerting approaches. Many candidates saw the figure as representing an anomaly, even going as far as to suggest that the scientists shaded the box to show that the figure was anomalous. Many of the candidates who approached the question in the right way failed to note that this figure was a percentage and referred to 27 frogs having deformed limbs.

(f) This question was targeted at the more able candidates and, in view of this, it was extremely encouraging to note that many of those whose ability was more limited were able to make a number of pertinent observations for which they gained credit. The weakest candidates, however, made little progress, usually because they failed to note that this was a properly designed investigation. They resorted to a stock answer that would have been more appropriate in answering part (c). There was, however, widespread recognition that the parasites caused deformities and most candidates were able to support this with appropriate evidence. Better candidates also recognised the role of run-off in increasing this problem. Candidates were awarded credit for supporting their statements with calculations based on the data provided. It was disturbing to note the number who treated percentages in a totally inappropriate way, totalling the figures or calculating means.

Q41.

Many weaker candidates produced vague responses, simply suggesting that by using tomatoes of the same size, it would be a fair test. These answers were not credited. Better

candidates were aware that variation in size would affect the amount that tomatoes flattened. However, relatively few mentioned that this would enable a comparison to be made.

Q42.

Candidates were not always selective in choosing the material to answer this question. They sometimes wrote at length about succession in part (a) (which concerned diversity), and then found they had nothing new to say in part (b), which did concern succession.

(a) Good candidates were able to state, clearly and unequivocally, that an increase in the index of diversity means that the number of species has increased, as has the number of individuals within each species. Weaker candidates sometimes wrote all they knew about succession here or sometimes just wrote about “an increase in the organisms“, failing to distinguish between new species and existing species.

(b) Most candidates were able to describe the role of pioneer species in colonising a harsh environment and the ways in which they might change this environment. Better candidates then went on to say that these changes allowed new species to become established with the creation of new habitats for still other species. However, too many could not resist following the development right through to the climax and describing the nature of this condition. Clearly, given the question, this was not necessary and could have wasted valuable time for some candidates.

Q43.

(a) Nearly all candidates knew that habitats would be lost, and a good number also knew that this would reduce the number of species in the area.

(b) Better candidates realised that both potassium nitrate and ammonium nitrate would release nitrate ions into the soil immediately, and that the ammonium ions in ammonium nitrate could be nitrified by nitrifying bacteria to provide a secondary release of nitrates. Many candidates, however, just did not apply their knowledge to the problem and merely recited chunks of the nitrogen cycle, with some confusion between nitrifying and nitrogen-fixing bacteria.

Q44.

(a) In this section, candidates often concentrated on either the method of achieving randomness in the sampling or on how other variables might have been controlled: both aspects were required for a complete answer.

(b) Most realised that mayfly nymphs belonging to the family Caenidae and living in the deep water showed the greatest variation as this sample had the highest standard deviation. Some were less specific.

(c) A simple definition in terms of an organism’s role in the ecosystem or community was required to explain the meaning of the term *ecological niche*. Some candidates’ answers could equally well have been applied to the term ‘habitat’. However, there were few problems in recognising that one family of mayfly nymphs living mainly in deep water and the other in shallow water indicated that they occupied different ecological niches. Also, most candidates appreciated that the occupancy of different niches would result in reduced competition for some environmental resource (food being the most common correct suggestion), although some should have thought more carefully about the given situation before suggesting competition for ‘light’ of for ‘mates’ (the two groups of mayflies were from different families). Some confused *intraspecific* and *interspecific* competition – only the latter being applicable here.

Q45.

(a) Most candidates were able to substitute the data in the formula and calculate the index of diversity correctly. There were occasional arithmetical errors. Many appreciated that the numbers of individuals had been used in the calculation of the index of diversity, or pointed out that the influence of rare species would be minimised. Weaker candidates frequently thought the index of diversity was good for comparing two areas (although why this should be an advance on just comparing the numbers of species present was not made apparent).

(b) Some candidates were confused and seemed to regard the results as having been derived *in situ* on the shore rather than being produced using a balance in a laboratory. Many confused cause and effect and ignored information provided earlier in the question, insisting that *Fucus spiralis* must have been located on the lower shore as it lost less water due to having been exposed for a shorter time. Those who did realise that *Fucus spiralis* in fact lost less water because it was better adapted to life on the upper shore, very rarely went on to suggest that living in this location (seemingly rather hostile) would result in reduced competition between it and the other species.

Q46.

(a) Most candidates clearly appreciated that the samples would best be obtained by using random numbers to determine co-ordinates, although they were not always specific as to how these numbers would be generated. There were, however, frequent references to “throwing” a quadrat, a technique which does not give rise to a genuinely random distribution.

(b) In part (i), candidates revealed considerable difficulty in recognising the trend of a decrease followed by stabilisation from a depth of around 200 cm. The most frequent response was to ignore the change in gradient and refer simply to the population falling. Where a genuine attempt was made to offer an explanation for the difference in numbers in part (ii), answers were usually correctly related to the decreasing concentration of oxygen available for respiration.

(c) There was obvious confusion in the minds of some between the concepts of ecological succession and natural selection. While some of those who made this distinction produced excellent answers, others lost their way in rambling anthropomorphic accounts of bacteria “not finding conditions to their liking” or being “happier” with conditions at other depths. There were also many general references to “bacteria”. These lacked the necessary precision to gain significant credit.

(d) Part (i) was generally well answered and there were many accounts based on correct references to the surface layers being the only ones where numbers of aerobic bacteria increased. Part (ii) also produced some sound responses although candidates were inclined to embellish their answers with irrelevant detail relating to the anticipated change with time. Once again, a failure to gain marks most commonly stemmed from imprecise use of the word “bacteria”. In both parts (c) and (d) there was a need to refer them as being either aerobic or anaerobic.

(e) There was encouraging evidence of a good understanding of standard error and many candidates were able to show some appreciation of this demanding concept. However, answers were seldom targeted at explaining what the error bars revealed about the difference in activity at the times given. In spite of the wording of the last sentence of the question, the terms probability and chance were seldom incorporated into the explanation.

(f) The most frequent approach to this part of the question was to produce a mass of

figures supporting a complex but inappropriate calculation. With these data the best approach was to construct a graph and draw a line of best fit. The likely number of bacteria could then have been established by reading off the appropriate value from the curve.

Q47.

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.

Q48.

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.

Q49.

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.

Q50.

(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.

Q51.

(a) (i) Few gained credit, as most candidates incorrectly focused on transects which would only sample a small number of plants or suggested that it would be too difficult practically. They frequently missed the point that the transect would

miss out representative areas.

(ii) It was pleasing to see that most candidates could describe a random method of selecting plants to prevent bias, with thankfully very few candidates describing techniques involving throwing a quadrat over their shoulders. However, few mentioned the need to carry out the method many times in order for it to be representative.

(b) (i) Most candidates were able to describe the meaning of standard deviation with only the weaker candidates referring vaguely to it as a range from minimum height to maximum height with no reference to the mean.

(ii) Many recognised that the mean plant height decreased with altitude but only the better candidates recognised that the standard deviation was also lower at higher altitudes. Very few supported their answers by using data from the diagrams.

(iii) A relatively small proportion of candidates used the information given in the stem of the question, that the seeds were not grown at different altitudes but in a laboratory under the same environmental conditions.

Q52.

(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.

Q53.

(a) This question proved a good discriminator with a surprising range of answers being produced. Candidates appeared not fully to appreciate the question, with many having difficulty applying a standard technique to an unfamiliar situation. A number of candidates described setting up transects without reference to the random nature of the sample to be obtained, references to counting were common and many failed to suggest a sufficient number of quadrats. A few resorted to throwing the quadrats over their shoulder, some doing so even after describing how to produce random co-ordinates.

(b) This question was generally well answered with most candidates gaining two marks. Weaker answers confused the data with probability values.

(c) (i) This was generally poorly answered. Most gained a mark for linking the foot or aperture size with grip but few answers were clearly expressed, with only the best candidates discussing both aperture and shell size. There were confused ideas attributing smaller shell size to erosion by waves.

(ii) Answers to this question were disappointing with few candidates being able to amplify their understanding of standard deviation. Only the better candidates recognised the point of the question and were able to appreciate the effect of wave action on limiting the range of sizes. The idea of size being age-related and linked to situation was rarely given.

Q54.

(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.

Q55.

This question tended to be centre-based in terms of the marks awarded. There were some very good answers indicating a clear understanding of the statistics while in other cases a lack of appreciation of the outcome of the statistical test was apparent.

(a) Few candidates gained full marks. The most common omission was to appreciate the need for a large sample. Very few were able to explain how to obtain the mean population density, often suggesting the determination of percentage cover or simply counting the daisies to produce the data.

(b) Most gave a satisfactory answer to gain the mark.

(c) This produced a complete range of answers from no marks for a lack of any reference to significance to very good discussions on relative significance and explanations of the p values. Many simply described the results in the table with no reference to p values. A common mistake was to confuse the p values of 0.05 and 0. 5 or not appreciate the value at which data are statistically significant and to assign significance of the plantain data.

Q56.

(a) The majority of candidates showed that they were aware of what is meant by an abiotic factor and many correctly identified all three.

(b) Candidates showed little evidence of having actually carried out fieldwork. Several misread the question and simply gave the standard answer relating to the random positioning of quadrats. Few could give a reasonable description of how to obtain a measure of the percentage cover. Better answers suggested subdividing the large quadrat into smaller squares, or counting whether vegetation was present at a large number of points. Several candidates merely subdivided the quadrat into 10 small squares, and candidates then recorded presence or absence of vegetation, which

clearly could only at best give a value to the nearest 10%.

(c) Most candidates were aware that the correlation was unlikely to be due to chance, and several expanded their answer to point out there was only a 1 in 20 probability of its being a chance result. Some, however, stated that the result showed that moisture in the soil caused the increase in vegetation, or vice versa.

(d) Most could suggest some factor that might change, such as increase in humus, but few gave a clear explanation of how the physical environment would be changed as a consequence.