AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.7.4 POPULATIONS IN ECOSYSTEMS

SCORE	PERCENTAGE
/696	%

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Q1.

(a) 1. Method of randomly determining position (of quadrats) e.g. random numbers table/generator;

Ignore line/belt transect

2. Large number/sample of quadrats;

Accept many/multiple

Ignore point quadrat

If a specified number is given, it must be 20 or more

3. Divide total percentage by number of quadrats/samples/readings;

3

(b) 1. Beach grass is the pioneer (species);

2. Pioneers/named species change the (abiotic) environment/habitat/conditions/factors;

Must convey idea of change being caused by a species

Accept example of change e.g. more humus

3. (So) less hostile for named species
OR
(So) more suitable for named species;

4. Conifer/hardwood trees represent climax community;

4

(c) Trees block/reduce (sun)light;

Reject 'blocks' all of the light

1

(d) 1. (NPP) remains constant;

2. GPP/photosynthesis **and** respiration constant;

Accept GPP/photosynthesis equals respiration

OR

3. (NPP) low/decreases;

4. Less light so less photosynthesis/GPP;

Reject no photosynthesis

Mark in paired statements

1 and 2 or 3 and 4

2

[10]

Q2.

(a) 1. Compete (with fertile males) to mate / for food / resources
OR

intraspecific competition;

2. Do not reproduce / breed
OR
Reduces population (of mosquitoes);

1. Must convey idea of competition.

2. Accept: 'fewer mosquitoes' / 'fewer offspring'.

2

(b) 1. Capture / collect / sample, mark **and** release;

2. Leave time for mosquitoes / Aedes to disperse before second sampling / collection;

3. (Population =) number in first sample × number in second sample divided by number of marked in second sample / number recaptured;

3. Accept: correct equation.

3

(c) (Radiation) affects their 'attractiveness' / courtship / survival / life span;

*Accept: 'die / less likely to survive **due** to radiation'.*

Accept: 'disease can be transmitted by other means' (other than mosquitoes).

1

(d) To maintain number / competition as they die / have a short life span;

Accept: to replace mosquitoes that have died.

1

(e) 1. Number (of mosquitoes in treated area) is low / lower at / after 12/13/14/15/16 weeks = **2 marks**;

2. For one mark accept number (of mosquitoes in treated area) is low/lower without reference to relevant week;

Accept: amount for number.

Accept: comparison of numbers (of mosquitoes) for lower/low.

2

[9]

Q3.

(a) 1. Correct answer of 19.4 / 19.41%
OR
19.47 / 19.5% = **2 marks**;

2. Incorrect answer but shows increase of 1,048,320 **OR** 1,051,200 = one mark;

Accept: 19.46% for one mark.

2

(b) 1. Less / no acetylcholine broken down;

2. Acetylcholine attaches to receptors;

3. (More) Na^+ enter to reach threshold / for depolarisation / action potential / impulse;

1. Accept: more acetylcholine present / remains.

1 and 2. Accept: remains attached for longer = 2 marks.

3. Must be sodium ions.

3

(c) 1. Isolated **so** inbreeding / low genetic diversity / small gene pool;
2. Allele inherited (through generations) from (common) ancestor;

1. Ignore: Founder effect.

1. Accept: no interbreeding with other populations.

1. Reject: interbreeding within the population.

2

(d) 1. AD / symptoms develops late / at 49;
2. Have already reproduced;

Note: 'It' is not equivalent to AD / symptom as the question stem relates to the mutation.

2

(e) 1. Epigenetics / environment / named factor e.g. stress, alcohol, toxins, diet, exercise, smoking;
2. methylation (of genes)
OR
acetylation (of histones);

1. Ignore: gender and lifestyle.

2. If further details are provided the context must be correct e.g. increased methylation or decreased acetylation inhibit gene expression / transcription.

2

(f) 1. One person was homozygous dominant / has two dominant alleles = **2 marks**;
2. For one mark has two alleles / chromosomes;

1. Accept; homozygous dominant genotype e.g. 'one person has AA' for 2 marks.

2. Accept: is diploid or has two copies of the gene.

2

(g) 1. (GCA / triplet) is common / found in other places;
2. Would not know if it was the mutation / allele / gene
OR
Produces 'false positives'

1. Accept: Probe will bind elsewhere.

2

[15]

Q4.

(a) Correct answer of 4.92, 2 marks;
If N(N-1) = 3540, **OR** ∑n(n-1) = 720, then award 1 mark

Accept 4.916 / 4.917 / 4.9

2

(b) 1. A method of selecting sampling sites at random;
2. Use of quadrat;
3. Identify (plant) species (at site / in each quadrat)
OR
Count number of (different plant) species (at site / in each quadrat);

1. E.g. grid with coordinates selected using random number table

2. Frame or point

3. Reject refs to % cover, or counting individuals

3

(c) 1. Significant increase in species richness on Islay and Colonsay **and** (significant) fall on Harris;
2. Change in diversity on Islay not significant;
3. Greater than 0.05 / 5% probability of getting this change / difference by chance (on Islay)
OR
(For other differences) less than 0.001 / 0.1% probability of getting this change / difference by chance (for species richness on Colonsay, Harris, Islay)
OR
Less than 0.01/1% probability of getting this change/difference by chance (for diversity index on Colonsay, Harris);

2. Accept converse about significance of differences in other cases

*3. Reject **results** are due / not due to chance*

3. Ignore refs to P unqualified

3

[8]

Q5.

(a) 1. (Overall, data show an) increase in species richness / increase in species diversity / increase in total number of living organisms;

2. *Baetis quilleri* and / or *Pentaneurini guttipennis* are pioneers;

3. (Pioneers cause) named change of environment e.g. provide food for other species;

4. New species / example from data colonise once there is a change;

5. *Baetis quilleri* / *Pentaneurini guttipennis* / *Helicopsyche mexicana* decline / outcompeted / eaten as succession continues.

5

(b) Correct answer 5.5 = 2 marks;

Allow 1 mark for correct calculation of mean population growth rate per day for each species, i.e:

Cryptolabis paradoxa = 3.226

Leptohyphes packeri = 0.585

2

(c) 1. Same species present (over long time) / stable community (over long time);

2. Abiotic factors (more or less) constant (over time)

3. Populations stable (around carrying capacity)

2 max

[9]

Q6.

(a) 1. Only cleared and abandoned and introduction of non-native species make (significant) difference;

2. Because only (means of) these ± 2 SDs from zero / no change;

3. About same number / 4 to 3 increase or decrease (species) richness / biodiversity;

Accept converse for others

3

(b) 1. Non-native species out-competes / kills / eats / is a disease of native plants;

2. Some (populations of) native species become extinct (in the community);

2

(c) 1. Set up grid system with coordinates;

2. Place large number of quadrats (at coordinates) selected at random;

3. Count number of / estimate percentage cover of native plant in quadrats;

3. Repeat at same time each year (for many years);

3 max

(d) 1. Correct answer two marks – 0.0599;

1 mark for writing $\frac{\log_e(SR2/SR1)}{\text{Time in decades}}$

Award 1 mark for answer of – 5.985 or 0.290

2

[10]

Q7.

(a) (No – no mark)
Graph / bar chart only shows number of species, not the name of the species.

1

(b) (No – no mark)
1. Mutations are spontaneous / random;
2. Only the rate of mutation is affected by environment;
3. Different species do not interbreed / do not produce fertile offspring;
4. So mutation / gene / allele cannot be passed from one species to another.

Ignore references to correlation does not prove causation

4

(c) 1. Initially one / few insects with favourable mutation / allele;
2. Individuals with (favourable) mutation / allele will have more offspring;
3. Takes many generations for (favourable) mutation / allele to become the most common allele (of this gene).

3

[8]

Q8.

(a) Community;

1

(b) (Less) competition for food/resource;

Ignore: competition for niche/habitat.

Accept: space/named resource.

Reject: intraspecific competition.

1

(c) 1. Correlation **but** does not mean a causal effect;

Ignore: positive/ negative (correlation).

2. Other abiotic/biotic/named factor involved;

Accept: due to presence/absence of fish.

Reject: 'other factors' unless further qualified.

3. Variation in numbers of beetles species at same/similar particular pH;

Accept: same number of beetles at different pHs.

Accept: 'scattered results' / 'anomalies' / 'spread of results'.

4. Large sample;

Max 3

(d) Fish feed on predator/consumer of water beetle;

Accept: beetles feed on fish/faeces.

1

[6]

Q9.

(a) 1. Respiration/metabolism/ammonification;

2. (Releases/produces) heat;

Reject: 'produces energy'.

2

(b) 1. SD is spread of data around the mean;

Accept: variation around the mean.

*Accept: range is difference between highest and lowest values/extremes **or** range includes anomalies/outliers.*

2. (SD) reduces effect of anomalies/ outliers;

Reject: (SD) removes anomalies/outliers.

3. (SD) can be used to determine if (difference in results is) significant/not significant/due to chance /not due to chance;

Ignore: reliability/accuracy/validity.

2 max

(c) 1. Distributes heat / prevents 'hot' spots;

2. Distributes microorganisms;

3. More enzyme-substrate complexes;

4. Increases rate of decomposition;

Accept: increases nitrification/ammonification or 'breaks down waste faster'.

5. Aeration/provides oxygen;

2 max

(d) 1. Microorganisms change the abiotic conditions/temperature/organic waste /provide

nutrients;

Must refer to microorganisms or bacteria/named bacteria causing the change.

Ignore: change the environment.

2. Less hostile conditions;
3. Decline in Cocci **and** increase in rods;

Accept: 'decrease in cocci, others are going up'.

Accept: decrease in cocci and increase in either rod type or increase in both types.

4. Gram positive outcompete / better competitors;

Accept: rods outcompete (cocci) / better competitors.

3 max

[9]

Q10.

(a) 1. (Use) coordinates / number the rocks/sites/squares;

Ignore: references to grid, tape measures, metre rulers etc.

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

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

2

(b) Difficult/too many to count / individual organisms not identifiable / too small to identify/count / grows in clumps;

Ignore: easier/quicker/representative/ more accurate, unless qualified.

1

(c) Any suitable factor with valid explanation = 1 mark

1. Wave action - firmer grip on rock is necessary (at either site);
2. Wind/air movement/less humid - more evaporation at site A / more (physical) damage;
3. Light – (linked to) photosynthesis (at either site);
4. Temperature – (linked to) photosynthesis/respiration/enzymes/ evaporation (at either site);
5. pH – (linked to) enzymes/proteins;

Note: other common factors include salt (salinity) linked to water potential / named nutrient e.g. nitrate linked to protein/DNA.

Ignore: carbon dioxide/oxygen/pollution/rainfall/food/nutrients.

Reject: biotic factors e.g. predation.

2 max

(d) 1. Greater variety of food / more food sources;

Ignore: more food.

2. More/variety of habitats/niches;

Ignore: homes/shelters.

Accept: different habitats.

2

(e) (i) 1. (So they were) hungry/not full;

Accept: description of hunger e.g. appetite / 'empty stomach'/'so they eat'.

2. (Allows) comparison;

2

(ii) 1. Alga without consumer/named consumer/animal;

Accept: repeat experiment without consumer.

Accept: in separate tank / in tank where not eaten.

2. (Find change in mass) in dark;
3. For 50 hours;

Accept: 'same time as in experiment'.

Accept: For lower time period then scaled up to 50.

3

(iii) 1. For *Laurencia pacifica* **and** *Cystoseira osmondacea* (difference in results) significant /reject null hypothesis / not due to chance / less than 5%/0.05 probability due to chance;

Accept: for Laurencia pacifica 'less than 1%/0.01 probability'.

2. For *Egregia leavigata* **and** *Microcystis pyrifera* no significant (difference in results)/accept null hypothesis / is due to chance/more than 5%/0.05 probability due to chance;

Accept: 'insignificant' for 'no significant difference'.

3. (Difference in results) for *Laurencia pacifica* is the most significant;

Note: reference to probabilities on their own is not sufficient.

1, 2 and 3. Accept: abbreviations for all species.

3

[15]

Q11.

(a) 9 (hours);;

If multiply 75 by 0.11 and 0.23 but wrong answer, then 1 mark

*Accept for **one** mark if multiply 75 by two wrong proportions near to 0.11 ± 0.01 and 0.23 ± 0.01 or multiply by the difference between the two (wrong) proportions*

2

(b) (Yes because)

1. Both/Each species (mean) time spent looking around greater where many predators;
2. Differences (appear to be) significant because SDs do not overlap;

(No because)

3. Wildebeest spend same (mean) time looking around where many predators as impalas where few predators;
4. Don't know what they are looking for (when heads up);
5. Habitats might be different in different areas (which

could affect the behaviour);

Accept 'mean proportion' means 'time'

1. Require idea of both, not just quoting numbers

2. This point must be in the context of point 1

2. Do not accept results significant

2. Accept 'because bars do not overlap'

2. Do not accept SE for SD

3. Accept overlap in SD as equivalent to same time

5. Ignore 'other factors' unqualified and discussions of experimental variables

4 max

(c) 1. Less time spent feeding
OR
More energy lifting head/looking round;

2. (So) less food/biomass for respiration
OR
less energy for growth/reproduction/care of young;
OR

3. Raising head makes them more visible to predators;

4. So more likely to be attacked/eaten/killed;

2. Accept any appropriate suggestion of less energy for something to do with life of the herbivore

2. Allow less food/biomass for growth/reproduction

2. Ignore references to energy for respiration

2

[8]

Q12.

(a) (i) Unit of energy / mass, per area, per year.

1

(ii) 1. Less light / more shading / more competition for light;

Neutral: references to animals

2. Reduced photosynthesis.

Accept: no photosynthesis

2

(b) 1. Pioneer species;

2. Change in abiotic conditions / less hostile / more habitats / niches;

Accept: named abiotic change or example of change e.g. formation of soil / humus / organic matter / increase in nutrients

Neutral: reference to change in environment unqualified

Neutral: more hospitable / habitable / homes / shelters

3. Increase in number / amount / diversity of species / plants / animals.

Accept: other / new species (colonise)

3

(c) 1. Net productivity = gross productivity minus respiratory loss;

2. Decrease in gross productivity / photosynthesis / increase in respiration.

2

(d) 1. Conserving / protecting habitats / niches;
2. Conserving / protecting (endangered) species / maintains / increases (bio) diversity;
3. Reduces global warming / greenhouse effect / climate change / remove / take up carbon dioxide;
4. Source of medicines / chemicals / wood;
5. Reduces erosion / eutrophication.

Accept: tourism / aesthetics / named recreational activity

1 max

[9]

Q13.

(a) 1. Geographic(al) isolation;

2. Separate gene pools / no interbreeding / gene flow (between populations);

Accept: reproductive isolation

This mark should only be awarded in context of during the process of speciation. Do not credit if context is after speciation has occurred.

3. Variation due to mutation;
4. Different selection pressures / different abiotic / biotic conditions / environments / habitats;

Neutral: different conditions / climates if not qualified

Accept: named abiotic / biotic conditions

5. Different(ial) reproductive success / selected organisms (survive and) reproduce;

Accept: pass on alleles / genes to next generation as equivalent to reproduce

6. Leads to change / increase in allele frequency.

Accept: increase in proportion / percentage as equivalent to frequency

6

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

4

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

Neutral: less photosynthesis

3. In light net uptake of carbon dioxide / use more carbon dioxide than

produced / (rate of) photosynthesis greater than rate of respiration;

4. Decrease in carbon dioxide concentration with height;

More carbon dioxide absorbed higher up

Accept: less carbon dioxide higher up / more carbon dioxide lower down

5. (At ground level)
less photosynthesis / less photosynthesising tissue / more respiration / more micro-organisms / micro-organisms produce carbon dioxide.

Neutral: less leaves unqualified or reference to animals

5

[15]

Q14.

(a) 1. No / few consumers / pests / pathogens;

Accept: No / few predators.

Accept: description of competition for a named resource with reference to 'other species'.

Accept: More resistance to disease.

2. Outcompetes / better competitor for resources / light / CO_2 / abiotic factor / ideal niche;

Neutral: competition for food.

2

(b) 1. (Cost of) control / removal;

2. (Cost of) restoring habitat / conservation;

3. (Loss of income) from fishing;

4. (Loss of income) from boating / tourism / recreation;

Accept: any valid recreational activity e.g. canoeing.

2 max

(c) (i) 1. Removes water;

2. Water content can vary in sample / plant;

Note: Reweighing / constant mass indicates all water removed = 2 marks. ;

2

(ii) 1. 0.5 is not effective / has little effect / 1.0 is less effective (than 5.0) / concentrations below 5.0 less effective;

Accept: for first 3 mark points effect on growth / biomass as a measure of effectiveness.

Accept: references to 'this concentration' = 5.0.

Accept: 5.0 is the minimum effective concentration.

1. and 2. 5.0 is the minimum effective concentration that reduces growth = 2 marks.

2. At 5.0 biomass / growth is reduced;

3. Small difference between using 5.0 and 25.0;

4. Using 5.0 is cost effective / using 25.0 is expensive / high concentrations may affect the environment / other organisms / chemical may remain in habitat / bioaccumulation;

Accept: any impact on the habitat e.g. contaminate water supply.

4

(d) (i) To compare / see effect with / without fungus / fluridone / control agent / s;

Neutral: for comparison on its own.

Neutral: to see effect of variables / results / treatments / factors without further qualification.

1

(ii) 1. Is specific / grows / survives in Hydrilla / habitat;

Accept: 'known to work'

2. Can reproduce / only one application required;

3. Does not become a pest;

2

(iii) 1. Fluridone / chemical acts quickly / quickly reduces Hydrilla;

2. Fungus / biological control keeps Hydrilla in low numbers / fungus / biological control works over a long time / can reproduce / resistance does not develop against fungus / biological control;

2

[15]

Q15.

(a) (i) (Organisms that) can breed together / interbreed **and** produce fertile offspring;

Need both aspects. Reject 'inbreed'

Reject viable offspring

1

(ii) Same number (organisms) in each region / (organisms) equally spread;

Allow other ways of expressing 'region' or 'equally spread', eg not clumped together, same number per unit area

1

(b) $P = \frac{AS}{R}$;;

2 marks for correct answer

*1 mark for having **A** on top of equation (recognises that total population related to total area)*

Note:

P = A × S / R or
P = A / R × S

are also correct.

Allow 1 mark for

$$\frac{S}{P} = \frac{R}{A}$$

2

(c) (i) *In mark–release-recapture (technique)*

Accept converse by considering assumptions of proportional sampling

1. No assumption that organisms are uniformly distributed;

2. Size of total area / size of sampled region not required;

Marking point 1 or marking point 2 do not have to start with the same technique

In this case, allow difference by implication i.e. do not penalise if the two techniques are not compared

2

(ii) Animals are from / all part of the same population;

1

[7]

Q16.

(a) *Ulva lactuca*;

Reject: Ulva on its own

Accept: lactuca on its own

Accept: Incorrect spelling

1

(b) (i) Difficult / too many / too many to count / individual organisms not identifiable / too small to identify / grows in clumps;

Neutral: easier / quicker / representative / more accurate, unless qualified

1

(ii) Any described feature of concrete eg texture / flat / composition chemicals / nutrients etc;

Neutral: not natural / man made / are different, without further qualification

1

(c) 1. Pioneer species / *Ulva* increases then decreases;

1 and 4. Growth / reproduces = increases. Dies = decrease

2. Principle of a species changing the conditions / a species makes the conditions less hostile;

2. Accept description of change in conditions eg soil / humus forms, nutrients increased

3. New / named species better competitor / previous / named / pioneer species outcompeted;

Pioneer species grows, dies and forms humus = 2 marks

G. coulteri / Gelidium outcompetes other / named species = 2 marks

4. *G. coulteri / Gelidium* increases <u>and</u> other / named species decreases;

4

[7]

Q17.

21 – 25	Extended abstract Generalised beyond specific context	Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question. Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained. No significant errors or irrelevant material. For top marks in the band, the answer shows evidence of reading beyond specification requirements.
16 – 20	Relational Integrated into a whole	Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained. Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology. Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.
11 – 15	Multistructural Several aspects covered but they are unrelated	Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.
6 – 10	Unistructural Only one or few aspects covered	Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or,

		irrelevant topics.
1 – 5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	**Definition**
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. ‘Several’ here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular

	words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at A-level standard.

Please note that to obtain full credit, students must use information to show **the importance of the many different types of relationships and interactions between organisms**.

Topics

1.P	Pathogens and effects on host
2.T	Taxonomy
2.C	Classification and evolution.
2.I	Inheritance and evolution
2.Gc	Genetic code, universal
2.B	Behaviour
2.Ev	Populations and evolution, variation between individuals within a species
3.BP	Relationships within ecosystems − eg predator / prey
3.E	Energy transfer in ecosystems
3.N	Nutrient cycles, the organisms involved
3.S	Succession, biodiversity, species and individuals in a community
4.H	Human impacts on the environment and its effect on relationships between organisms − including farming
4.Gt	Gene technology and GMO and selective breeding
4.Ar	Antibiotic resistance

Examiners are free to select other letters if they wish

The emphasis in answers should be on the relationships and interactions between organisms not just the topics themselves

Breadth, one mark for use of an example from each of the following approaches − 3 max:

1. Pathogen and host

2. Evolution (related topics)

3. Ecological

4. Human intervention in relationships

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q18.

(a) (i) 1. No overall pattern / pattern (of right or left most common) is not the same for all islands;

Allow expression in other ways e.g. three islands show left on top is more common

2. For **(B) C** and **E** there is little difference;

3. Large differences on **A** *and* **D** *and* opposite ways (to each other);

Need both aspects but allow other expressions of 'opposite ways'

2 max

(ii) 1. Can record all individuals on (small) islands;

2. (So) no / less sampling error;

3. (Maybe) different rates of mutation / different selection pressures / different environmental conditions;

4. Inbreeding / breeding with close relatives (more likely);

5. (Little) gene flow / (more chance of) genetic drift;

Accept reference to either of these ideas for this point

2 max

(b) 1. If R is recessive, R × R parents cannot produce L offspring;

Accept use of genetic diagrams to illustrate points 1 and 2

2. If L is recessive, L × L parents cannot produce R offspring;

Accept right arm on top as R etc.

3. R × R **and** L × L parents produce both types of offspring;
Need reference to two parent crosses for this mark

3

(c) Both L and R in a set of twins / (some) twins show different arm-folding;

1

[8]

Q19.

(a) 1. Decrease in (percentage cover) of bare ground / water linked to more plants / species / increase in plant coverage;
*Allow **one maximum mark** for answers which describe all three changes **without** a suitable explanation for any change*
Must be idea of more / increase not just change in species / plants

2. Change in diversity / number of plant / species / named (species) as abiotic conditions altered / due to competition / more soil / less hostile;
Accept pioneer species replaced due to competition
Accept description of change in species
Accept 'more suitable' = less hostile

3. Increase in depth of soil as plants die / humus formed;

3

(b) 1. Greater variety of food / more food sources;
'More food' = neutral

2. More / variety of habitats / niches;
Ignore 'more homes' or reference to 'shelters'

2

(c) (i) 1. Marking is not removed / marking does not affect survival / predation;

2. Limited / no immigration / emigration;
Accept 'migration' and descriptions of immigration / emigration
2. and 4. Increase / decrease in population is not sufficient – there must be a reason

3. Sufficient time for (marked) individuals to mix (within the population);
Accept – 'For mixing to occur between samples'

4. No / little births / deaths / breeding;

5. Sampling method is the same;
Ignore 'random sampling'

2 max

(ii) Correct answer of ...34 = 2 marks;
***Allow one mark** for an answer of 51 as candidate has misinterpreted the second sample as being = 30*

Incorrect answer but shows correct formula in words or numbers e.g. 17 × 20 ÷ 10;

Reject correct formula multiplied by 100

2

[9]

Q20.

(a) 0.8;

1

(b) (i) 1. Aerobic respiration;

1. Allow description e.g. respiration using oxygen

1. Accept 'oxidative phosphorylation'

2. Increase in uptake (of oxygen) with growth / reproduction / division of yeast cells;

3. Glucose / nutrients / oxygen decreases / becomes limiting / cells die / ethanol / toxins form / heat produced / anaerobic respiration occurs;

3. Ignore any reference to time

3. Accept decrease in oxygen being linked to oxygen being 'used up' or equivalent

3

(ii) 1. (Ethanol produced) by anaerobic respiration / from pyruvate in anaerobic conditions;

1. 'Fermentation' is not enough on its own

2. (Ethanol / anaerobic respiration) increases as oxygen (uptake / concentration) decreased / decreases as glucose is used up / ethanol kills cells;

2

(c) 1. Oxygen uptake decreases / stopped;

2. Oxygen is final (electron) acceptor / combines with electrons (and protons);

3. Ethanol produced sooner / more ethanol produced;

3. Accept ethanol produced at any specified time before 16 hours

3

[9]

Q21.

(a) Crabgrass;

Reject: grass or grassland

Reject: crabgrass if another organism is also included

1

(b) 1. Species / plants / animals change the environment / conditions / add humus / nutrients etc. / less hostile (habitat);

Accept 'they' for species / plants in mark points 1 and 2

2. Species / plants better competitors;

2

(c) (Only) plants which can photosynthesise with less light (remain);

Accept converse but do not award mark for idea that plants cannot photosynthesise and die because there is no light

Answers must be in context of being or not being able to photosynthesise with less light

1

[4]

Q22.

(a) All / group of species / all / group of populations / all the organisms;

Accept equivalent terms for group.

*Answers which only refer to organisms must have idea of **all** the organisms not just a group of organisms*

Reject answers which include 'environment' or abiotic factors as part of the definition

1

(b) (i) 7.2 - 8.4 (metres);

Accept answer of 1.2

1

(ii) 1. Food / prey / oxygen;

Do not accept 'resource' for mark point 1 unless this is qualified as food / prey / oxygen

2. Less / no competition;

Reference to light and CO_2 as a resource negates mark point 2

Ignore intraspecific / interspecific for mark point 2

2

(c) 1. Increase in depth linked to decrease in temperature / decrease in depth linked to increase in temperature;

Accept increase or decrease in temperature is related to 'higher depth' or 'lower depth' due to ambiguity of these terms

2. Correlation / relationship between temperature and fish distribution does not indicate a causal effect;

Ignore any reference to correlation unless it is clearly in context of temperature and fish distribution

3. Overlap in ranges / different fish / species occupy same depth;

Temperature does not determine fish distribution is not sufficient for idea of causal effect

4. Other abiotic / biotic / named factor involved;

Reject: 'casual' for mark point 2

Reject 'other factors' for mark point 4 unless further qualified

3 max

[7]

Q23.

(a) 1. Quadrats placed at intervals along transect;

2. Number of seeds counted per quadrat to calculate seeds per m^2;

2

(b) (i) 1. Wind from North East;
Accept blowing to South West

2. Seeds blown further;

2

(ii) 1. Seeds have different distances to fall / seeds have different times in air;

2. Blown by wind a different amount;

3. (Candidates investigation) shows that seeds travel further when dropped from higher;
Supported by reference to candidate's investigation

2 max

(c) (i) 1. Produces large number of seeds / produces seeds blown by wind;

2. Greater probability (of colonising);
Accept greater chance

2

(ii) 1. Small size;

2. Too little food in seed to become established;

3. Not enough light for photosynthesis;

2 max

[10]

Q24.

(a) (i) Each treatment occurs in each row <u>and</u> each column;
Ignore references to random

1

(ii) 1. Different environments or different variables in the field / in different plots / variables change across rows / down columns / from one side to another;

2. Minimises / removes the effect of variables;

2

(b) Standardising any two relevant factors, for example:
To gain credit here, factor must be something that the scientists could do and must relate to field conditions

1. Water;

2. Fertiliser / manure / soil nutrient;

3. Weed killer;

4. Soil pH;

Reject answers such as keep light / carbon dioxide / temperature constant

2 max

(d) (i) 1. Survival falls as time increases;

2. Survival falls as sowing density increases;

3. Up to 15 / 25 seeds per m^2 all survive / above 250 seeds per m^2 survival falls rapidly;

3

(ii) 1. Intraspecific competition / competition between bean / soya plants / for water / nutrients / light;

2. Greater as plants grow / increase in size;

2

[10]

Q25.

(a) 1. Competition (from) parent tree;

2. (From) large number of seeds;

3. For light / nutrients / water;

3

(b) 1. Few seeds / young plants;

2. Interspecific competition / unsuitable conditions means not all survive;

2

[5]

Q26.

(a) 1. Place transect up / down shore / transect from low to high tide;

Must give direction

2. Use quadrats at regular / measured / known intervals;

3. Repeats / more than one quadrat at each interval;

3

(b) 1. *U. pertusa* will be uncovered for most of the day / *M. yendoi* is covered by sea water most of the time;

2. Thick walls will allow *U. pertusa* to withstand desiccation / thick walls will reduce damage / thick walls will provide support;

Accept description of desiccation.

3. *U.pertusa* better competitor / better adapted in uncovered areas;

3

[6]

Q27.

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

Must indicate all / every species.

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

1

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

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

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

3. Take second sample and count marked organisms;

May be awarded from equation if not given here.

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

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

3 max

(ii) One suitable reason;

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

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

1

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

Catches more food and gas exchange are neutral

2. Competition between species / interspecific competition is reduced;

Reject intraspecific

2

[7]

Q28.

(a) 1. Transect / lay line / tape measure (from one side of the dune to the other);

1. & 2. Reject random in context of placing transect / quadrats

2. Place quadrats at regular intervals along the line;

Accept references to stratified sampling / different seral stages

3. Count plants / percentage cover / abundance scale (in quadrats)

Accept abundance scale

OR

Count plants and record where they touch line / transect;

3 max

(b) 1. Stabilises sand / stops sand shifting;

2. Forms / improves soil / makes conditions less hostile;

Allow credit for example of making conditions less hostile such as:

Adds nutrients

Improves water retention

2

[5]

Q29.

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

Do not accept named factor unless general answer given.

1

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

Reject altitude / height

Water

Named soil factor

Not "soil" / "weather"

Light

Carbon dioxide

Accept Oxygen

Incline / aspect

Wind / wind speed

1

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

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

OR

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

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

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

Principles

Comparing day and night / light and dark

1. Explanation in terms of photosynthesis / respiration

2. Effect on carbon dioxide production / uptake

Comparing leaves with ground level

3. Explanation in terms of photosynthesis / respiration

4. Effect on carbon dioxide production / uptake

2 and 4 must relate to why the change occurs

4

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

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

2. Allow "advantage so able to survive"

3. Greater reproductive success;

4. Allele frequencies change;

4. Reject gene / genotype

3 max

[9]

Q30.

(a) 1. Breeding less successful;

2. Feathers in poor condition;

3. Less energy for breeding / reproduction / stated aspect of reproduction;

1. Reject cannot breed.

2. Ignore "wings damaged".

2 max

(b) (i) 1. Avoids bias / data representative / choice of nest not influencing results;

2. Allows use of statistical tests / named statistical test;

2

(ii) Accept general statements or statements based on data that make the required points.

1. Correct statement about range of 0 – 15;

2. Correct statement about 0;

3. Correct statement about 170;

4. Correct statement about gap between 15 and 170;

1. e.g. No pattern / no correlation between 0 and 15.

2. e.g. Birds with no feather mites did not have (the) high(est) breeding success / 86%.

3. e.g. Highest number of feather mites linked to lowest breeding success.

4. e.g. No data between 15 and 170.

3 max

(c) (i) There is no correlation between the number of feather mites and breeding success / the number of feather mites does not affect breeding success;

These specific variables must be stated.

Reject difference between feather mite and breeding success.

1

(ii) Breeding success decreases as feather mites increases / negative correlation between feather mites and breeding success;

Accept reproductive or breeding success.

1

(d) (i) 1. The larger the size of the oil gland the larger the number of feather mites;

2. Positive correlation;

3. (Wide) scatter of points / points not on line;

3. Accept any answer that conveys the idea of a wide spread.

Ignore any reference to anomalies.

2max

(ii) No mark for effect on reliability, marks are for explanation.

1. Oil gland size / number of mites could vary;

2. At different times of the day / due to preening;

Ignore responses that state oil gland affects numbers of mites.

Allow preening affects mite numbers / size of oil gland.

2

(e) 1. Improve health of birds / reduces disease / reduces harm;

2. Healthier birds may find more food for young / do not pass on disease / have greater specified aspect of breeding success;

1. Ignore death of birds.

2. Specified aspect can include longer breeding life.

2

[15]

Q31.

(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]

Q32.

(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]

Q33.

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

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

2

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

2. Justification by using values;

100% with wheat but less when grown with ryegrass

3. Competition between shoots had a greater effect than competition

between roots;

4. Justification by use of values;

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

When marking please number marking points

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

4

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

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

Wheat and ryegrass affected to a different extent;

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

2 max

[8]

Q34.

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

1

(b) (i) Produce null hypothesis;

Carry out Spearman Rank correlation test / find correlation coefficient;

Use values to show P < critical value / find probability of results being due to chance;

Accept valid example

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

2 max

(ii) May be another factor / named factor (that also inhibits germination);

e.g. amount of water in extract

1

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

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

2

(ii) Scientists crushed plants to get extract;

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

These substances might get broken down in the soil;

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

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

solution;

3 max

[9]

Q35.

(a) (i) Decrease in spadefoot toad;

Decrease in southern toad up to 4 newts per pond, then increase (at 8 newts per pond);

Allow one mark for answers stating decrease in both toad species

2

(ii) Predators / newts eat / feed / prey on toad (tadpoles);

Less competition more food / resources / fewer toads feeding on frogs;

Allow first mark if reference is made to either toad species being eaten.

For first mark candidate must clearly indicate that the newts are feeding on the toads. Answers simply stating that newts are increasing and toads are decreasing are not sufficient.

2

(b) Fewer toads / tadpoles (as number of predators increases in Figure 1);

More food, so are larger / grow more / increase in mass;

If candidate clearly indicates fewer frog tadpoles survive, negate the first marking point. However, accept decrease in overall number of tadpoles which may include frog tadpoles.

2

[6]

Q36.

(a) 1. (Colonisation by) pioneer (species);

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

3. Enables other species to colonise / survive;

4. Change in diversity / biodiversity;

5. Stability increases / less hostile environment;

6. Climax community;

Example of change e.g. formation of soil / humus / organic matter / increase in nutrients;

Do not accept genetic diversity for mark point 4.

5 max

(b) 1. Geographical isolation;

2. Variation due to mutation;

3. Different environmental / abiotic / biotic conditions / selection pressures;

4. Selection for different / advantageous, features / characteristics / mutation / / allele / differential reproductive success / (selected) organisms survive
and reproduce;

5. Leads to change in allele frequency;

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

5

[10]

Q37.

(a) Two marks for correct answer of 59 / 60;;

One mark for incorrect answer clearly derived from figures of 18, 28 and 38;

Ignore: any figures after decimal point.

2

(b) (i) Population changes;

Reject: population decreases

As young birds leave nest / join population;

Reject first point if (young) birds are leaving population / migrating

2

(ii) (Would be likely to) catch all birds (again) in second sample / sample sizes are the same;

Neutral: references to breeding

Birds (in territories and) not mixing with population;

Accept: idea of the population is divided

Accept only estimates number of birds in territories sampled / territory sample not representative (of population) for 1 mark

2

(c) (Recording) DNA / base sequence is like marking (animal) / wouldn't need to mark;

(Finding identical / same base sequence) would show animal has been caught / recorded before;

2

[8]

Q38.

(a) (Increase in) dead organisms / humus / decomposition;

Leading to (increase in) nitrification / ammonia to nitrate / activity of nitrifying bacteria;

2

(b) (i) Bare soil temperatures fluctuate;

Reject: environmental temperature
Accept: converse

More bare soil, early / at start of succession / when few plants;

2

(ii) Plant will grow / survive in the shade / when overshadowed (by taller plants) / when receiving less light;

Effect on plant with reason for effect
Ignore reference to competition

1

(c) (Grassland consists of) small / annual plants which will be replaced by / outcompeted by woody plants;

Must be in the context of grassland

Need idea of replaced not just an increase in percentage cover

So these (woody plants) must be removed / have growth checked / grazed;

2

[7]

Q39.

(a) (i) Fewest people at site R as mean is lowest;

Accept use of mean values to show 2.2 is the lowest

Standard deviations do not overlap so significant / not due to chance;

Accept use of values / description of standard deviation even in wording 'standard deviation' is not used

2

(ii) There was a probability of less than 0.05 / 5 in a hundred / 5%;

In the context of less than
Accept converse: probability of more than 95%

That the difference was due to chance;

Look for idea of difference (between sites)

2

(b) (i) (Would not be reliable as) number of species is still increasing;

Accept: has not reached peak / maximum or if shown by values

1

(ii) Idea of curve has flattened / no more species found so no benefit / no point / takes unnecessary time / takes unnecessary effort / can get same results with fewer quadrats;

Basic idea is of minimising effort.

If values used reward idea rather than accuracy of numbers

1

(c) Combustion / would burn / cause loss of substances (other than water) / named substance / cause loss of <u>dry</u> mass;;

Accept: <u>only</u> want water to be lost

Ignore: reference to decomposition

1

(d) Seaweeds / plants are producers / lower / first trophic level / animals are consumers / higher trophic level / feed on seaweeds;

Accept relevant position in food chain as trophic level

Loss of energy between trophic levels as a result of respiration / as heat;

Accept: energy transfer is inefficient

Accept: description of trophic levels

Accept: not all seaweed / eaten

2

(e) (i) The site / site U with most people / 34.6 has the largest ratio / 3.24;

Accept: as number of people increases, ratio increases

(Large value of ratio due to) large biomass ÷ small number / large size ÷ small number / biomass greater than abundance;

Explanation of seaweed ratio

2

(ii) 1. Fewer larger animals / more smaller animals where more people / more disturbance;

Principle

2. 0.09 linked to 34.6 / appropriate link between row 4 and row 1;:

Use of data

3. Larger animals affected by human activity;

Accept: converse

4. Smaller animals are young animals;

Accept: converse

5. Fewer species of seaweed (with disturbance);

Accept if shown by figures

6. (So) fewer niches / habitats (for large animals);

Accept idea of disturbance / damage to niche / habitat

4 max

[15]

Q40.

Lay tape / rope at right angle / perpendicular to road;
Take samples at regular / stated intervals;
Using a quadrat;
Count numbers / percentage cover of dandelions;
Use several transects;

4 max

[4]

Q41.

(a) 1. Evidence for red oak is reliable because 100% healthy and large sample size / evidence for paper birch unreliable because sample size too small;

2. Other species show injury so may not be tolerant;

3. Amount of injury is subjective so not reliable;

4. Paper birch is 100% healthy with high chloride in tissues so may be tolerant;

4

(b) (Resource B suggests that) sodium chloride decreases the percentage germination (of barley);

(Resource C suggests that) sodium chloride decreases the yield of some grasses / named grasses / named crops;

(Resource D suggests that) the damage in susceptible plants / trees is associated with chloride accumulating in the tissues;

Some plants / trees are able to prevent chloride from entering the tissues and are not damaged;

4

[8]

Q42.

(a) To see if a difference in hours of sunshine was present / because it is necessary to monitor factors which cannot be controlled;
So that they could eliminate this factor from affecting the yield (with /without extra carbon dioxide);
OR
Duration of light influences length of time for photosynthesis / temperaturein glasshouse;
Higher photosynthesis results in higher yield / more carbohydrates /sugars / proteins produced;

2 max

(b) Named factor;
Explanation of why the factor is important;
E.g.
Density of planting;
Competition for named resource;
or
Same variety of tomato;
Yield will vary with different varieties / with different genotypes;
or
Water (application);
Water needed for expansion of fruit / maintain leaf turgidity / maintain stomatal opening / replace water lost in transpiration / water used in photosynthesis;

For named resourceaccept 'nutrient' but not 'food'

2

[4]

Q43.

(a) Shows trend of mean temperature rise;
Higher temperatures more frequent since 1984 (in January and February);
Considerable variation in temperature from year to year;
Which may be due to chance;

No mark for yes or no Do not penalise candidates who state there is no trend

2 max

(b) Construct null nypothesis;
Use Spearman rank (and calculate test statistic);
Look up in table (to find critical value of P = 0.05 / 5 %);
Use figure (in table) to accept or reject null hypothesis;

3 max

(c) (i) (Particular daylength) always occurs at same time of year / valid example;
Birds do not start laying eggs when period of warm weather occurs early in year;
Synchronises breeding behaviour;
Sufficient foraging time for food collection for young;

2 max

(ii) Birds able to respond to changing climate;
Food availability (mainly) determined by temperature;
As insect / invertebrate development temperature-dependent;

2 max

(d) A correlation does not indicate a causal relationship;
As may be due to another factor / named factor;

2

(e) Visits could be up to 5 days apart;
Date of egg-laying may be inaccurate by 5+ days;

2

[13]

Q44.

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

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

2

(b) (i) The further north / higher the latitude, the higher the percentage (of white snow geese);

1

(ii) Snow lying longer / melts slower further north / at greater latitudes;

White geese better camouflaged (further north);

Predation linked to survival / reproductive success;

Q *In order to gain the last marking point, candidates must explain how survival or reproductive success is affected.*

3

(c) Snow melts earlier / snow melts further north / less snow;

White geese decreasing as less well camouflaged / at disadvantage / blue geese increasing as better camouflaged / at an advantage;

2

(d) (i) Stabilising;

Do not accept stable

1

(ii) Few geese survive at the extremes / most survive from the middle of the range;

1

[10]

Q45.

(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]

Q46.

(a) Vegetation consists mainly of low growing species / herbs / annuals / no / few trees;

Species **X** has high rate of photosynthesis at high light intensity;

*Do not credit Species **X** is first tree*

Species **X** grow fastest at high rate of photosynthesis / at high light intensities and will outcompete other species **Y** / **Z**;

3

(b) Produces shade / reduces light intensity;

Species **Z** grows best / photosynthesis best / in low light intensity /
Species **Z** does not grow well / low rate of photosynthesis in high light intensity;

Accept answers in terms of CO_2 absorption

2

[5]

Q47.

(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]

Q48.

(a) (i) ecosystem is (self-supporting) system in which all organisms / community interact with physical environment / community + environment / biotic + abiotic;

1

(ii) A + B + E + F + G + I;

1

(b) pygmy weed competes for CO_2 / light / nutrients; reduction in numbers of original plants;
some of original plant <u>species</u> lost;
loss of habitats / niches / shelter / food sources;
consumers die / some migrate;

3 max

[5]

Q49.

(a) (i) decomposers convert (nitrogen in organic compounds) into ammonia / ammonium; suitable example of "organic nitrogen" - protein / urea / amino acid etc. (e.g. linked to process); nitrifying bacteria / correctly named convert ammonium to nitrate; via nitrite;

3

(ii) convert nitrogen (gas) into ammonium / ammonia / amino acids;
add usable / available nitrogen to an ecosystem / eq.;

2

(b) (i) 1. numbers of dispersed bacteria increase as they <u>feed</u> on organic matter;

2. numbers of free-swimming protoctistans increase because number of bacteria increase;

3. dispersed bacteria decrease as amount of dispersed organic matter decreases / due to lack of food / as organic matter is converted to flocs / are preyed on by free-swimming protoctistans;

3

(ii) 1. (in a succession) organisms (enter an area and) change the environment / conditions creating new niches / habitats;

2. allows different species / different types of organisms to enter / be successful;

3. dispersed bacteria change dispersed organic matter to flocs;

4. presence of flocs allows crawling protoctistans to enter / to increase / to be successful;

4

[12]

Q50.

(i) Population is the total number of organisms / individuals of a species / tigers in an area (at a given time);

1

(ii) (Deforestation involves) habitat destruction / destruction of niches;

Some prey animals move out or die / fewer suitable prey for tiger / less food for tiger; Reduces tiger population if prey biomass falls below 600 (tonnes per km^2);

3

[4]

Q51.

(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]

Q52.

(a) (i) *Selecting the nettle plant*:
Random number table avoids bias in placing of quadrat;
'Nearest centre' avoids bias in choosing plant to measure;

1 mark for "method avoids bias"

2

(ii) *Measuring the sixth leaf:*
To allow valid comparison / so as not to introduce another variable;
Reduces / avoids influence of growth / age / light / shading;

2

(b) Definition of range + SD / effect of outliers on range + SD;
Ranges are similar in both areas;
Suggests that variation within populations is similar;
SD smaller in area of high light intensity;
Shows that area of high light intensity is a more uniform population;

4

(c) 1.164 / 1.16 / 1.2 , however derived = 2 marks
0.83 – 0.86 / 1.1, however derived = 1 mark

Evidence of correct use of both sets of figures, but inappropriate answer = 1 mark

2

[10]

Q53.

(a) collect a sample (of insects in each area) and mark unobtrusively / in a way not harmful to insects;
release and allow time <u>to re-integrate</u> with rest of population / eq.;
collect second sample and count number marked;
number in population estimated by:

$$\frac{S1 \times S2}{\text{Number marked in } 2^{nd} \text{ sample}} \quad /$$

$$\frac{\text{Total marked}}{\text{Number marked in } 2^{nd} \text{ sample}} = \frac{\text{Population}}{\text{second sample}} ;$$

4

(b) (i) 1;

1

(ii) (p =) 0.05 / 5%;
(ignore 95%)

1

(iii) value for χ^2 <u>exceeds</u> critical value / 125.8 > 10.8 ;
Results unlikely to be due to chance / have a biological cause;
P < 0.1% / < 5% ;

2 max

(c) (i) biomass respired / GPP – respiration = NPP;
biomass lost as CO_2;

2

(ii) more food for insects;

1

[11]

Q54.

(a) Fertilisers / detergents / slurry / manure / sewage / faeces;

1

(b) (31 – 5) / 31 x 100% / single error in otherwise correct method;
83.87 / 83.9 / 84%;

2

(c) Have continuous data for phosphate but not for biomass;
Effect of named factor explained;

2

(d) 1. Increased phosphate causes increase in plant growth / algal bloom;
2. Plants (cover surface and) block out light so plants (under surface) die;
3. Increase in (aerobic) bacteria / decomposers (which break down plants);
4. Bacteria / decomposers use up oxygen / reduce oxygen conc. in water;
5. In respiration;
6. Plants unable to photosynthesise so less oxygen produced;

max 6

[11]

Q55.

(a) Population – organisms of one species in an ecosystem / habitat / area;
Community – organisms of all species / all populations in an ecosystem / habitat / area;

2

(b) (i) No immigration / migration (Ignore references to emigration);
No reproduction *(Ignore references to death)*;
Idea of mixing;
Marking does not influence behaviour / increase vulnerability to predation;
Sample / population large enough;

max 2

(ii) $\frac{96 \times 77}{11}$; 672;
Correct answer (however derived) scores 2 marks
Incorrect answer with evidence of correct method scores 1 mark.

2

(c) Principle of randomly placed quadrats and method of producing random quadrats; *(Reject 'throwing')*
Valid method of obtaining no. dandelions in given area (mean per quadrat / total no. in many quadrats);
Multiply to give estimate for total field area;

3

(d) (i) Niche of A – 1;
Niche of B – 3;
Too small for B / too hot for A – 4;
Too large for A / too cold for B – 2;
All four correct = 2 marks; any 2 correct = 1 mark

2

(ii) Original population living in one area / 2 species evolved in the area;

Idea of genetic variability;
Concept of reproductive isolation;
Possible mechanism;
Gene pools become increasingly different;
Until interbreeding does not produce fertile offspring;

max 4

[15]

Q56.

(a) 1. Occurs in an unchanging environment;

1

+

2. Selection against extremes / selection for the mean / mean / median / mode unaltered
3. Range / S.D is reduced
4. Increasing proportion of populations becomes well adapted to environment;

4

(b) 1. All plants are acyanogenic below –4 °C and (most) cyanogenic above +10 °C;
2. Cyanogenic plants' cells freeze below –4°;
3. Releasing cyanide (into their own tissues) / damaging / killing plants / disrupting metabolism;
4. Selective advantage not to produce cyanide at –4 °C;
5. Slugs present at higher temperatures / not usually present / inactive at lower temperatures and cyanide production kills / deters slugs;

5

[10]

Q57.

(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]

Q58.

(a) Gg / suitable equivalent;
Grey : black about 3: 1;
[Note: Can be in table / diagram]

2

(b) To determine the probability;
[Accept: Likelihood]
Of the results being due to chance;
[Accept: Coincidence]

2

(c) (i) both alleles will be expressed (in the phenotype);

1

(ii) 0.25 / 25%; = 2 marks
C^N = 250 / 1000; = 1 mark

2

(iii) P^2 = $(0.25)^2$ / 0.0625 / square of calculated figure for C^N; = 2 marks
$p^2 + 2pq + q^2 = 1.0$; = 1 mark
= 31.25 / 31;
[Accept: Derived from either p^2 or q^2]

3

[10]

Q59.

(a) (i) change in community over time;
either due to change environmental / abiotic factors / change is due to species present;

2

(ii) stable community / no further succession / final community;

1

(b) (increased) interspecific competition;
for light / nutrients / named nutrient / water;

2

(c) fewer leaves / lower surface area / shading of leaves so less photosynthesis to produce new biomass / glucose / growth; competition with other species for nitrates / named nutrients so reduced synthesis of protein or named compound; ratio of

leaves to woody parts and roots decreases so higher respiration relative to photosynthesis;

3

[8]

Q60.

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

6

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

2

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

4

[12]

Q61.

(a) species present change the habitat / named change;
other species able to colonise;
new species better competitors;

3

(b) D - as more species present;
more complex food webs;

or

change in one species will have little effect on others;
as alternative food sources;

2 max

(c) sand drains easily / low water retention;
(sunken stomata) <u>reduce</u> transpiration;
as pocket pf saturated air trapped near stomatal pore;
this reduces diffusion / water potential gradient;

3 max

(d) series of changes over a distance / gradient of environmental factor / named environmental factor / cline present / ensures sampling of each community;

1

[9]

Q62.

(a) use of random numbers to place quadrats;
number of individuals counted in large number of quadrats;
little variation random, large variation - clustered;

3

(b) less competition;
for water / nutrients;

2

[5]

Q63.

(a) 1 shore crab rapidly colonises / rapid growth;
2 ability to live different environments / no natural predators / will have similar / overlapping niche with native species / valid example / shore crab may be carrier of disease;
3 shore crab better competitor / more aggressive;
4 decreased population of prey species;
5 ecosystem less stable;

5

(b) between A and B water potential of blood rises as water potential of blood rises as water potential of surrounding water rises, after B rise in water potential less rapid / at C no further change occurs;

1

(c) No – as blood is isotonic with surrounding water / blood and surrounding water have same water potential;

1

(d) (i) water potential of blood maintained;
so (blood) cells not destroyed (by osmosis);

OR

replaces ions / salts lost diffusion;
ions / salts required for named metabolic process;

2

(ii) rate of respiration decreases;
less ATP made;
insufficient to maintain water potential of blood when in estuary;
isotonic in sea so no need to transport salts;

OR

sea temperature higher than river;
higher metabolic rate / higher enzyme activity;
advantage of this crab e.g. still able to escape from predators;

3 max

[12]

Q64.

(a) (i) true indication of growth / water mass may vary;

1

(ii) intraspecific;

1

(iii) the denser the planting the greater the yield;
above a planting density of approx 30 competition for named resource / named limiting factor / population density not limiting;

(accept nutrients / space reject food)

2

(b) use genetically identical plants / clones / asexual reproduction / tissue culture; maintain identical environmental conditions / named condition; reference to density of planting;

2 max

[6]

Q65.

(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 <u>mean</u> 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]

Q66.

(a) populations of different species;
living in the same environment / habitat;
(often) named after dominant plant / example;

(one mark for principle:all the species living in the same place)

2 max

(b) more species / diversity (in the field);
more niches / habitats;
more feeding opportunities (range of types available);

3

(c) one method named, e.g.:
mark, release, recapture;
sweep netting / kick sample;
pitfall traps;
light trap;

1 max

[6]

Q67.

(i) normal virus reduces area eaten by 40cm^2
genetically engineered reduces by 64 cm^2
64 – 40 = 24

$\frac{24}{40} \times 100$ = 60% more effective

1 mark for principle of calculation;
60% more effective = 2 marks;

or

$\frac{64}{40}$ = 1.6 times more effective

1 mark for principle of calculation;
1.6 times more effective = 2 marks;
(if only difference in area eaten given, 1 mark)

2

(ii) toxin kills the caterpillars faster than just the virus;
so less time for leaves to be eaten / energy for eating;

2

[4]

Q68.

(a) there is no difference between the number of lichens growing on the walls (facing different directions);

1

(b) 36, 36, 36;

1

(c) 2;

1

(d) p less than 0.05 so reject the null hypothesis;
the difference is not due to chance / significant difference;
the direction the wall faces does have an effect on the population of lichens;

3 max

(e) algae photosynthesise / produce organic molecules / named;
fungus anchors the lichen / absorbs water which is available to the algae / prevents dehydration of alga / absorbs mineral ions / phosphates / nitrates;

2

[8]

Q69.

(a)
1. colonisation / pioneering;
2. microscopic plants at start;
3. death / decomposition;
4. named change in environment e.g. increase in organic matter / stabilisation;
5. new species colonise once there is a change;

6. increase in number of species / diversity / increase in total amount of living material / biomass / more niches / increase in nutrient availability / change from more extreme conditions / more stability;

6

(b) marking principles:
one mark – direct result of removing forest cover;
e.g. soil erosion / leaching
one mark – specific effect on organisms in lake;
e.g. more sediment / nutrients (for plants to grow)

2

(c) 1. named nutrient availability;
2. numbers of producers providing energy (for a food chain) / light intensity affecting the rate of photosynthesis;
3. disease killing (weaker) members of species / predation described;
4. space for nest building / niches;
5. competition for a named limited resource / (intra and interspecific) competition explained;

5

[13]

Q70.

(a) very long / deep roots, to reach water deep in the soil / nitrogen-fixing bacteria, to provide a source of nitrogen for growth in poor soil;

1

interspecific;

1

(b) (mesquite) proteins / amino acids (ploughed) into soil / nodules ploughed in and (decomposers) bacteria / fungi feed on these;
excrete ammonia;
nitrifying bacteria convert these to nitrites / nitrates;
absorbed by roots of grasses and increase their growth;
accept increases recycling of other ions / phosphate / potassium;

3

(c) control organism a parasite / predator;
specific to pest;
population varies with population of pest;
controls size of pest population but does not kill all;
keeps pest population low enough to prevent significant (economic) damage;

3 max

[8]

Q71.

With hormone (third column) cadmium produces large / significant / 45% fall in enzyme production;
without hormone (second column) no significant effect on enzyme production with cadmium;.

2 max

[2]

Q72.

(a) (i) (collect and) dry all above ground plant material;
(reject collect one / small sample / whole plants)
in an oven at or just below 100 °C;
weigh and repeat until constant mass;
other precaution, e.g. cooling in desiccator;

3 max

(ii) large number of sample areas / repeats;
randomly selected;

2

(iii) drying destroys plants, so different samples needed;
large area, so difficult to get representative samples;
difficult to measure biomass of trees;
variability in growing conditions;
variability of abiotic conditions in different areas of forest;

2 max

(b) (i) 1:25

1

(ii) most of the plants are trees / large with high proportion of dead / non-photosynthesising biomass;
herbs grow rapidly / small so large percentage increase / herbs have higher productivity, so ratio lower at 10 years;

2

[10]

Q73.

(a) pioneers / suitable example colonise land;
example of change in environment;
enables change in species;
<u>conditions change further / example</u> to favour trees;

4

(b) stable community / no further succession / final community;

1

(c) <u>roots</u> unable to respire (aerobically);
active transport of minerals / other metabolic effect stops;

2

(d) action of bacteria / decomposers inhibited / fewer bacteria / decomposers;
acid conditions <u>inhibits</u> enzymes / enzymes denatured / changes active site;
H^+ ions affect active site;
anaerobic conditions;

3 max

[10]

Q74.

(a) (i) the non-living / physical part (of an ecosystem / environment);

1

(ii) density-independent, with named abiotic factor and a specific effect;

1

(b) capture, count and release;

carefully mark to avoid detection;
recapture, count marked and unmarked;

(information from an equation is valid)

3

[5]

Q75.

(i) idea of rise and fall;
peak and trough later than those of larvae / idea of time lag;
(*allow correct line drawn on the graph*)

2

(ii) reduction in leaf area / size decreases photosynthesis;
less food reserves available for production of new needles;
OR
feeding larvae damage more growing points;
takes time for tree to recover / less growing time for needles;

2

[4]

Q76.

(a) (i) tips colonised by short-lived plants / short lived plants are pioneers;
short-lived plants fast growing / spreading / distribute seeds quickly;
short-lived plants change the environment e.g. make conditions more favourable for long-lived plants;
valid reference to competition;

(ii) long-lived plants compete with each other;
death of some long-lived plants;
more niches / leaving spaces / areas for growth of short-lived plants; short-lived plants recolonise;

6 max

(b) control of named variable e.g. light, water-content, nutrients;
large numbers of both species / 10+ individuals;
range of different concentrations of zinc;
valid measurement of growth, height / leaf area / root growth / numbers / mass / % germination;
statistical analysis / correlation between the two sets of data;
OR
large number of samples taken (in the field);
principle of determining zinc concentration of soil;
valid measurement of growth, height / leaf area / root growth / numbers / mass / % germination;
statistical analysis / correlation between the two sets of data;

3 max

[9]

Q77.

(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]

Q78.

(a) 10

(reject: 9.76)

1

(b) isolation (on islands);
variety of habitats / conditions different from origin / other islands;
differing pathways of natural selection;
leading to organisms too different to interbreed.

3 max

[4]

Q1.

(a) This question proved to be more demanding than expected, with less than 7% of students obtaining maximum marks. Most of the students did not appreciate that a large number of quadrats should be used. Reference to a method of randomly determining the position of quadrats was the most frequently credited marking point. However, a significant number mentioned randomly positioning quadrats without suggesting a method for this. There were some responses which suggested randomly throwing quadrats! Students often spent time describing how the percentage cover in a single quadrat could be determined without explaining how the mean percentage could be calculated. A significant number referred to counting numbers rather than determining percentages.

(b) This question proved to be an effective discriminator in terms of students using the information provided in **Figure 1**. Just over 20% of students scored zero as they often provided a description of succession with little, if any, reference to the information provided on the exam paper. Only 7% of students gained maximum marks. Students who did gain credit usually identified beach grass as the pioneer species. Students varied considerably on how they progressed from this point. The idea of the pioneer (or named) species changing the abiotic environment in some way was often understood, though not always stated clearly enough to gain the mark. The idea of a 'less hostile' environment was not often stated and, if it was, it was not often linked to a named species. There were extensive descriptions of competition between species without linking this to the changes in the biotic environment. There were also descriptions of secondary succession which is not on the specification. Surprisingly, relatively few students suggested that the hardwood and confer trees represented the climax community. In fact, a significant minority of students suggested the conifers and hardwood trees were the pioneer species and seemed to be reading the x-axis of the graph from right to left.

(c) Two-thirds of students were able to explain that the conifer and hardwood trees reduced the percentage of light reaching the ground. Incorrect answers either omitted to mention trees or just referred to plants or larger species reducing the light.

(d) Approximately 72% of students stated that the NPP would decrease or remain constant to gain one mark. Less than a third of these students could explain why. The most common response to gain two marks linked the low/decreased NPP with reduced light for photosynthesis. Students who suggested that NPP would remain constant usually did not gain a second mark for explaining that photosynthesis/GPP would equal respiration. A significant number of students thought the NPP would increase, either because there were more plants photosynthesising or because there was more light absorbed by the trees for photosynthesis, with the same respiratory losses.

Q2.

(a) The idea of reducing the success of reproduction of the mosquito was well understood by the vast majority of students. Any reference to competition was far less often included, resulting in only approximately 10% of students gaining both marks. A significant number of students thought that being infertile prevented sterile males from passing on the virus.

(b) This question also proved to be a very effective discriminator. Although over 50% of

students obtained at least two marks, less than half of these students went on to gain full marks. The most common omission was not mentioning leaving sufficient time for the mosquitoes to disperse before second sampling. A significant minority also failed to refer to releasing the mosquitoes after first sampling. When provided, the equation for calculating the population size was often correct.

(c) Very few students gained the mark for this question, with many responses suggesting that sterile mosquitoes could still transmit the virus, or that the overall population size was too large for the method to have an effect. The most common acceptable suggestions involved the radiation shortening the life span of the mosquitoes, or female mosquitoes not being attracted to infertile males.

(d) Approximately a third of students gained this mark, usually by suggesting that releasing more transgenic males replaced those that had died. Unfortunately, most answers simply referred to mosquitoes dying without any reference to the need to maintain the number of transgenic mosquitoes in the population.

(e) The vast majority of students gained at least one mark for stating that the number of mosquitoes was lower in the treated area. Over 60% of students gained a further mark for specifying when this reduction in number became significant.

Q3.

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

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

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

(d) Almost a third of students obtained both marks, clearly expressing the idea that, due to the symptoms of AD developing late on, affected individuals would have already reproduced. Over 50% of students scored zero, often providing responses that suggested that the mutation was not harmful, or indeed that it was beneficial. An improvement in health care was also provided as an explanation for the frequency of

the mutation not being reduced. Students obtaining one mark often did not refer to the late onset of AD, but did understand that individuals with the mutation could still reproduce and pass on the allele.

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

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

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

Q4.

(a) Students had more success with this calculation than with the previous two in the paper; possibly this was because they had practised inserting numbers into this equation. It was pleasing to see that 58% of students knew what N and n represent, and could insert their values into the equation and get a correct answer. Another 20% obtained one mark for correctly calculating either the top or bottom number in the equation (but getting the wrong final answer). The commonest error was thinking that N = number of species.

(b) This question discriminated quite well, even though it involved a well-known method. The commonest error was to count the number (or percentage cover) of each species, when only the number of species is required. If a student wrote about counting the number of species and the number of individuals, they did not get the mark because the examiner had no way of knowing whether or not they understood the difference between the data required to calculate species richness and index of diversity.

(c) This question discriminated very well, even though 46% of students scored zero. Answers suggested that few students really understand P values, or the nature and purpose of statistical tests. They showed how many think statistical tests demonstrate whether or not results, i.e. the data collected, are significant, or accurate, or reliable. Quite a few followed statements, about the data being due to chance, with observations that this showed the method was incorrect, that the scientists made errors, or that not enough data were collected. The data in Table 2 came from a study published in a peer-reviewed scientific journal. Unless given specific information in a question that indicates otherwise, students should assume that data have been collected, processed and presented correctly. The results of the statistical test in this example indicate whether or not the **difference between** two means is significant or not. It was heartening to find a few students who noted that a t-test might have been used to obtain P; though this was not required to answer the question. Some students got the meanings of ≤ and ≥ the wrong way around. This might explain why quite a few thought that only the change in diversity for Islay was significant. Some students tried to compare 0.001 with 0.05. Many noted that there was a significant change in species richness on all three, but failed to note that there were increases on two islands and a reduction on the other.

Q8.

(a) Almost 95% of students gave community as the correct answer. Ecosystem was the most common incorrect response.

(b) The vast majority of students appreciated that competition would be reduced. However, only 60% referred to competition for a resource or named resource. A minority of students incorrectly referred to intraspecific competition.

(c) Surprisingly, almost 25% of students did not obtain a mark on this question and less than 10% obtained maximum marks. Many students gained one mark for stating that correlation does not mean causation. Students often realised that another factor was involved, but did not always specify a factor. When factors were identified, temperature, fish or food sources were frequent responses. A significant number of students referred to the wide spread of results at the same pH. Fewer students referred to the sample size and when they did, the sample size of 30 was often considered to be too small.

(d) Almost 60% of students provided a correct answer, most frequently in relation to fish feeding on the predators of water beetles. Beetles feeding on fish or on their faeces was also frequently awarded as was fish eating competitors of the water beetles. The most common misconception related to fish respiring and adding carbon dioxide to the water and benefiting water beetle species.

Q9.

(a) This was well answered with 80% of students obtaining both marks and less than 5% scoring zero. The most common error was to suggest that ‘energy is produced’.

(b) Over 80% of students obtained at least one mark, often by stating that standard deviation shows the spread of values around the mean. Many also realised it was less affected by anomalous results and that SDs can be used to determine if differences in results were significant. Some answers included the idea of calculating the standard error from the standard deviation. Unfortunately some students defined standard deviation as the range of results around the mean. The descriptions of range were less clear, often only stating that the range involved the highest and the lowest values.

(c) Approximately a third of the students obtained both marks often by explaining that rotating the containers provided aeration and distributed heat. The idea of distributing microorganisms within the waste and increasing the rate of decomposition were also frequently credited. There were fewer references to more enzyme-substrate complexes being formed. A common misconception was that rotation ensured that all the waste would be equally exposed to sunlight. However, where this was described as equal exposure to heat from the sun, the idea of preventing hot spots was credited.

(d) This question proved to be a very effective discriminator. Most students obtained at least one mark. This was usually awarded for either referring to less hostile conditions or to the decrease in the population of cocci and increase in the population of rods as succession occurred. Although most students referred to a 'change in the environment', few described how the environment changed or related the change to the action of microorganisms. A third of students obtained all three marks often providing very detailed and extensive answers which were continued on additional paper. These answers clearly described the role of cocci in changing the abiotic conditions, making the environment less hostile so that rods could then out-compete the pioneer cocci.

Q10.

(a) This question caused few difficulties for students with 95% obtaining one mark and 85% both marks. The process of generating random numbers either via a computer, calculator or out of a hat was well understood. The vast majority of students used these numbers as coordinators or to choose rocks which had been previously numbered. A minority of students referred to incorrect methods involving line transects or randomly thrown quadrats.

(b) 70% of students obtained this mark usually by suggesting that there would be too many algae to count, that algae are too small to identify or that they grow in clumps. Incorrect responses often suggested that using percentage cover was easier, more accurate or quicker without providing any explanation of these statements.

(c) Approximately, two thirds of students gained a mark on this question but only 20% obtained both marks. Students failing to gain any credit either gave unsuitable factors such as oxygen or carbon dioxide concentrations or named suitable factors but provided inadequate explanations. A significant minority named a biotic factor, most frequently predators. Explanations related to light, temperature and pH proved to be the most accessible marking points for students. Explanations related to salinity, wave action, wind and named nutrients were often too vague to gain credit.

(d) Approximately 75% of students obtained at least one mark, usually for relating the greater diversity of algae to a greater variety of food sources for consumers. One in four students obtained two marks as they also referred to an increase in number or variety of habitats at site B. Incorrect responses tended to focus on the abiotic conditions being different on the lower shore or the seawater providing more nutrients.

(e) (i) Over 80% of students obtained at least one of the two marks available. This mark was most often credited for stating that the consumers would be hungry or have an appetite. The idea of this allowing a comparison to be made was only appreciated by a minority of students. Consequently, only 11% of students obtained both marks. Most students suggested that the results would be more accurate, reliable or representative if both consumers were hungry.

(ii) This proved to be the most challenging question on this exam paper in terms

of achieving marks. Less than 1% of students obtained all three marks and less than 10% achieved two marks. Many students incorrectly suggested the use of a respirometer to determine the loss of mass due to respiration. Weighing the consumers before and after the experiment to find their gain in mass and subtracting this from the loss of mass of the alga was another method suggested by a number of students. Very few students appreciated that any chosen method would have to be conducted in the dark to prevent photosynthesis. Fortunately, students were able to gain a mark for conducting an experiment with only the algae present, even if the method was invalid. Similarly, conducting an experiment for the same time period of 50 hours was also credited. Despite these allowances on the mark scheme, more than 75% of students failed to obtain a mark.

(iii) This also proved to be a challenging question in terms of gaining maximum marks, with less than 4% of students gaining all of the three marks available. However, almost 50% of students obtained two marks almost invariably for explaining that the difference between the results (mass eaten by the two consumers) for *Laurencia pacifica* and for *Cystoseira osmondacea* were significant (or less than a 0.05 probability of being due to chance or reject the null hypothesis) and for stating that the difference between the results for *Egregia leavigata* and for *Microcystis pyrifera* were not significant. The mark point for understanding that the difference in results was most significant for *L. pacifica* was very rarely credited. Frequent errors included a complete misunderstanding of probability values, culminating in incorrect conclusions and no marks, confusion between accepting and rejecting the null hypothesis, and a misunderstanding of what the symbols < and > represent.

Q11.

(a) 56% obtained the marks for the calculation. Those who didn't, either didn't understand what was required and just subtracted one proportion from another, or read incorrectly from the graph.

(b) This part discriminated well but, again, few students obtained all four marks. A large number of students did not address the data as instructed. Instead they tried to introduce rote-learned answers relating to things such as 'correlation doesn't show causation', 'not enough data', or 'need repeats'. These answers did not receive any credit; the data are from a peer-reviewed scientific paper and there is no reason to suppose the methodology was suspect. At A level, we expect students to identify trends and relationships in data. Some students simply quoted a series of numbers from the graph. Many students did note that both species spend more time with heads up where there are many predators and obtained one mark. Some went on to note that the difference/increase was significant because the SDs do not overlap. The examiners did not accept references to the 'results' being significant; all results are significant, they are what happened. Quite a large number of students noted that wildebeest spend a similar time with heads up where there are many predators as impala do where there are few predators. Some students also noted that the scientists couldn't be sure that the animals were looking for predators when they put their heads up.

(c) This question proved accessible and 51% of students obtained both marks; usually relating time with heads up to less feeding and thus less energy for other activities.

Q12.

(a) (i) Approximately twenty five percent of students could suggest appropriate units for gross productivity, the majority of correct answers being kJ m^{-2} $year^{-1}$. There

were many different incorrect answers, including units of mass and energy per year, just energy, just mass and incorrect attempts at outlining areas; m^{-1}, cm^{-3} and arbitrary units.

(ii) Most students obtained one mark by linking reduced gross productivity to reduced photosynthesis. Only a third of students gained a second mark by relating the increased competition for light with reduced photosynthesis. Incorrect responses often referred to competition for a variety of other factors including carbon dioxide and food. A number of students confused net productivity with gross productivity and attempted to provide an explanation in terms of increased respiratory losses. An increase in losses of energy between trophic levels as food chains became longer was another incorrect explanation.

(b) The process of succession was well known with many students gaining full marks. The pioneer species dying, decaying and making the conditions less hostile by forming humus and enabling new species to colonise was the most common explanation. References to more habitats / niches or more animals were infrequent. Students who failed to gain maximum marks often omitted reference to pioneer species.

(c) There were many students who did not know what was required with many responses only explaining that the woodland had reached a stable climax community and no new organisms could grow so biomass did not increase. Unfortunately, other students discussed productivity without specifying whether it was net or gross. However, at least half the students gained one mark, often for recognising the decrease in gross productivity / photosynthesis. Fewer students described the relationship between gross productivity, net productivity and respiration.

(d) This caused few problems with almost ninety percent of students obtaining the mark. The most common correct responses referred to conserving species / habitats, maintaining biodiversity or reducing global warming. The importance of woodlands as a source of medicines and for tourism was also often credited.

Q13.

(a) This question proved to be a very effective discriminator despite similar questions on speciation occurring previously in this component. The vast majority of students obtained the mark for geographical isolation / separation. However, many students only referred to the lack of interbreeding after the new species had been formed rather than during the process of speciation. These responses did not obtain the equivalent mark point. Variation and mutation were not always linked or one of these was omitted. Mutations were occasionally caused by the environment or by variation. Different selection pressures were well known although sometimes there were vague references to ‘different conditions’ or ‘different climates’. Most students understood that differential reproductive success resulted in a change in allele frequency although weaker students referred to ‘alleles reproducing’. Less than five percent of students managed to miss every marking point, sometimes after writing a whole page in response. These answers often described succession or directional selection.

(b) As expected this question was very well answered with over seventy percent of students obtaining three out of the four marks available and just over a third obtaining maximum marks. Although there was some variation in which marking points were omitted, a significant number of students did not mention leaving time for lizards to distribute randomly in the population before obtaining a second sample.

Other common errors included omitting any reference to releasing the lizards after they were initially captured and / or providing an incorrect equation for calculating the final population. Most students appreciated that the method of marking the lizards should not cause harm or make them conspicuous to predators.

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

Q14.

(a) Many students appreciated that Hydrilla was a better competitor, although the factor being competed for was often not specified. Similarly, a number of students stated that Hydrilla would not be eaten to a great extent in its environment. Relatively few students provided both ideas in their responses. Often, students would give two examples where Hydrilla was the better competitor. The consumption of the plant was very frequently described as predation. A significant number of students thought there was competition for food, even though Hydrilla was identified as an aquatic plant. Weaker responses merely stated that it was better adapted or could grow / reproduce / photosynthesise faster. Some students clearly thought Hydrilla was an animal despite information to the contrary. It was also suggested that Hydrilla had introduced a disease that killed the native plants, hence removing any competition.

(b) This question proved to be relatively straightforward for most students who often gained at least one of the two marks. Most appreciated that controlling Hydrilla would have financial implications. References to loss of income from reduced tourism, fishing and recreational activities were also common but only two out of every five students gained both marks. It was also common for students to simply refer to reduced species diversity or more competition with crops.

(c) (i) The majority of students gained at least one mark, usually for explaining that the method would remove water. Fewer students mentioned that the water content could vary in different samples. Some students did link a constant mass to all the water being removed for two marks. Vague answers about repeats for reliable / accurate results or to identify anomalies were fairly common.

(ii) This question produced a good spread of marks with most students scoring at least two marks. These were often gained for identifying that the recommended concentration reduced growth and that higher concentrations of

fluridone could damage other organisms. The expense of using higher concentrations was also a very accessible mark. Over 25% of students gained all four marks, usually by also including a reference to the relative ineffectiveness of lower concentration of the chemical. Very few students highlighted that the highest concentrations of fluridone used did not produce a significant decrease in growth compared to the recommended concentration.

(d) (i) Less than two out of five students gained this mark by providing specific details on why the scientists carried out the control experiment. Most students simply stated that a comparison could be made without mentioning the chemical or fungus. Similarly, unqualified references to the effect of variables or treatments were not credited.

(ii) Most students obtained one mark by stating that the fungus would be specific or 'it is known' to work. Unfortunately, many students then described the general advantages of biological control rather than the advantages of using this particular fungus.

(iii) Correct answers usually included the fast action of fluridone, the fungus maintaining the Hydrilla at low numbers or that resistance does not develop against the fungus. However, many students only provided one of these and the majority simply referred to the general advantages of integrated pest control. These answers did not always link the specific effectiveness of each type of control agent and consequently did not always gain credit. Nevertheless, there were some excellent responses and over 50% of students gained at least one mark.

Q15.

(a) (i) Most students were able to provide a suitable definition of a species, incorporating both elements of the definition in their response. A limited number of students provided a response that was not related to either reproduction or offspring. These students made reference to the hierarchical system of classification.

(ii) Most students were able to explain correctly what was meant by uniform distribution. This was usually expressed in terms of being 'evenly or equally spread'.

(b) Most students were able to write a suitable equation to show how proportional sampling could be used to estimate the total size of a population. There were a number of occasions where perfectly correct expressions of the equation were not credited with any marks, despite the Marking Guidelines including all the possible correct expressions. When difficulty was experienced by some students, they at least were able to use **A** as the numerator in their equation. Some assessors failed to award two marks for a correct expression of the equation, incorrectly only awarding one mark.

(c) (i) Many students were able to provide at least one correct assumption when using either of the two techniques. It was not necessary to include comparisons of the two methods. Credit could be awarded for difference by implication. Many students experienced difficulty expressing the second of the two marking points, when employing mark-release-recapture. These students suggested that the size of the sample was not required, rather than the size of the area or the size of the sampled region was not required.

(ii) Some students experienced difficulty when explaining one assumption about

the animals caught when either method was used. The correct assumption was that the animals caught were from the same population. This was incorrectly expressed as 'the sample that was caught was in proportion to the size of the total population'.

Q16.

(a) The vast majority of students correctly named the pioneer species as *Ulva lactuca.*

(b) (i) Fewer than half the students obtained this mark. Those who did frequently referred to the difficulty in counting or identifying individual organisms because of their small size. Many students simply stated it would be 'easier' or 'more accurate' without providing any explanation.

(ii) Most students did not obtain this mark, as they simply stated that the concrete blocks were 'not natural' or were 'man-made'. Correct responses usually referred to factors such as nutrients, minerals or texture being different and affecting the growth of algae.

(c) Most students obtained at least one mark, usually for the principle of a species making the conditions less hostile. However only ten percent of students gained all four marks by using the results provided to describe and explain the process of succession. These students referred directly to the species involved and related the changes in percentage cover to interspecific competition as the environment changed. Many students simply provided a generic description of succession, often only referring to the pioneer species. This rote learning was clearly demonstrated by the number of students who included mosses, shrubs and trees in their responses.

Q17.

Large numbers of good and excellent essays were seen.

The vast majority of students appeared to understand that this is a synoptic exercise, where they have to draw on a wide range of examples to obtain a high mark. Some students only dealt with one or two topics but in great detail and depth. Unfortunately, this severely limited the mark they could obtain.

Essays with a narrow scope were more common with this question about relationships and interactions. Many of these just went on endlessly about food chains and webs. Attempts at extension material were common. However, the use of examples that any member of the public might use did not gain any extra credit; for example, vague accounts of the plight of polar bears as ice caps melt. Extension material has to be at least of A-level standard and accurately described using appropriate scientific terminology.

There are many different types of relationships and interactions between organisms.

There were some good accounts of the interactions between pathogen and host. These usually focused on the reaction of the immune system to a pathogen. Some looked more at how a pathogen may harm the host. This was a topic area where extension material was quite often included, usually relating to detailed accounts of the effects of a pathogen not named in the specification. Cholera was used as a specific example by many, together with varying amounts of detail on how it interacts with the host. Tuberculosis was quite often cited but relevant detail appeared to be rare.

Only the best essays tended to contain detailed and relevant accounts of taxonomy, classification and evolution. These included accounts of principles of phylogenetic classification, DNA hybridisation and immunological comparisons of proteins. These

essays often contained good accounts of evolution of populations and speciation. Weaker essays often contained rambling accounts of competition and evolution of new species but used little or no correct terminology and often confused populations and species.

Behaviour was a very popular topic. There were good accounts of its importance during reproduction to identify individuals of the same species, in order to produce fertile offspring. Some accounts went on to explain its role in identifying individuals in breeding state, or even its role in promoting gamete production or release. There were a lot of vague descriptions of behaviour showing who was ready to mate, with no A-level content.

Many essays had very long and rambling accounts of relationships within ecosystems. Some consisted of little else. There were some very good accounts of the concepts of food chains and food webs and the inter-dependence of populations of different species within a community. These often went on to consider energy transfers within ecosystems, between different trophic levels. Weak accounts were at GCSE level or below, with references to plants making their own food, or energy, and this being passed on to all the animals. The predator-prey relationship was often described but infrequently with references to populations, inter and intra-specific competition or time lags.

Succession was another frequently seen topic. The best accounts wrote about pioneer species and communities, resultant changes in abiotic and biotic factors and the ensuing competition from other species that (may) out-compete the pioneers. They also wrote about communities and biodiversity changing over time until a climax community was established. Many accounts contained little or no scientific terminology or concepts.

Human impacts on the environment were as commonly written about as relationships within ecosystems. Unfortunately, many accounts were at or below GCSE standard and were often at the level of humans causing global warming which was bad for polar bears. There were good accounts that used, for example, deforestation as an example and contained references to habitat destruction, loss of niches, loss of diversity and the reasons for this. Others wrote about farming and the simplification of food webs, loss of diversity, use of pesticides and selective breeding. Nutrient cycles were written about by most students. The specification rather limits what they can be expected to know about the carbon cycle but some failed to include any relevant detail. The nitrogen cycle was well done by some but there were common misconceptions about what happens in the root nodules of leguminous plants. Many thought that *Rhizobium* converts nitrogen to nitrates for the plants. There was also considerable confusion between nitrifying and denitrifying bacteria. Many students went on to write about eutrophication and it was pleasing to see many correct accounts of the process.

Gene technology in various forms was a popular topic. Most wrote about genetically engineering microorganisms to produce useful substances such as insulin. Others wrote about genetically engineered crop plants with herbicide resistance, or that produced an insecticidal protein. The quality of the accounts varied a great deal. Many who wrote about this also wrote about evolution of antibiotic resistance in bacteria. Good accounts included horizontal transmission of genes for resistance between species of bacteria, involving plasmids. Relatively few students made any mention of antibiotics as a selection pressure, or random mutations as the source of resistance.

Q18.

(a) (i) A large number of students had difficulty translating the relevant Figure into a description of results. There was a tendency to quote figures without identifying what was shown such as the lack of an overall pattern, or that there was little difference between certain islands.

(ii) Only the higher scoring students were able to gain more than one mark. The

nature of the question was “Suggest” but few could use prior knowledge or understanding in the context of island populations beyond the idea of less, or no, immigration or emigration.

(b) This question, testing the ability to interpret given evidence, proved to be challenging for students. Few achieved better than a single mark and this was often the result of a lenient interpretation of the Marking Guidelines by the assessor.

(c) The majority of students could suggest the evidence that would support the conclusion, which was a complete contrast to the limited ability to interpret evidence shown in the previous question.

Q19.

(a) Very few students gained all three marks as most students failed to use all the relevant data to show that succession had occurred. The vast majority of students gained one mark for linking the change in species to a change in abiotic conditions, more soil or a less hostile environment. Approximately a third of students gained a second mark for explaining that the increase in depth of soil was caused by the death / decay of plants. Only the better answers then linked the decrease in bare ground / surface water to the presence of more plant species.

(b) Approximately forty percent of students scored zero on this question, as they simply described how succession provided a less hostile environment for all species of organisms. Most students obtaining a single mark explained that the increase in plant species would provide more niches / habitats. However, less than a third of students then explained that the increase in plant diversity would provide more food sources.

(c) (i) The vast majority of students gained at least one mark for this question and almost thirty percent gained both marks. Common correct responses referred to the method of marking organisms not affecting their survival, no immigration / emigration and the need to allow time for marked organisms to reintegrate into the population. Random sampling on its own was not credited, neither were references to the population not increasing or decreasing unless there was further qualification.

(ii) The vast majority of students correctly calculated the number of sand lizards to gain both marks. A minority of students obtained an answer of 51, having interpreted the second sample size as being 30 rather than 20, and were awarded one mark.

Q20.

(a) Approximately half the students correctly calculated the rate of oxygen uptake as 0.8 arbitrary units.

(b) (i) Most students gained two marks for this question. They linked the uptake in oxygen to aerobic respiration and then provided one of a range of correct responses to explain the decrease in uptake including: oxygen / glucose becoming limiting, ethanol causing death of cells and, most commonly, anaerobic respiration occurring. Very few students gained a third mark by linking the increase in uptake of oxygen to the growth / reproduction of the yeast cells. Weaker answers linked ethanol production to oxygen uptake, or suggested that the yeast would carry out photosynthesis.

(ii) The vast majority of students appreciated that the ethanol was produced

during anaerobic respiration. However, only half these students linked the increase in ethanol production to the fall in oxygen uptake. Relatively few students referred to the decrease in ethanol production as the glucose was used up.

(c) Overall this question was well answered by students. The role of oxygen in the ETC was well known and there were some very clear answers that gained all three marks. The decreased uptake of oxygen and the earlier and greater production of ethanol were often described. Occasionally, the sodium azide was believed to have no effect on ethanol production. NADP was sometimes included rather than NAD in descriptions of the ETC and there were disappointing references to energy being produced. Some confused responses suggested that oxygen was needed for ethanol production and without oxygen being used, no ethanol would be produced. Weaker answers described yeast as a plant and referred to the Calvin cycle.

Q21.

(a) The vast majority of students correctly identified the pioneer species as being crabgrass. A small minority provided the incorrect response ‘bare field’ or ‘grassland’.

(b) Almost ninety percent of students obtained at least one mark, often for indicating that the species present changed the environment. Many of these students also gained a second mark by referring to the habitat becoming less hostile or by describing how new species outcompeted species already present. A misconception by weaker students was that succession involved new species developing from existing species.

(c) Most students did not gain this mark as they suggested that no light would pass through to the forest floor. Very few students appreciated that only those plants which could photosynthesise at low light intensities would be present.

Q22.

(a) Four out of five students were able to provide a suitable definition of the ecological term community. Incorrect responses were often definitions relating to a population or ecosystem.

(b) (i) Almost two thirds of students correctly provided the range of depths, 7.2 to 8.4, at which all three species of fish may be found living together. The most common incorrect response was 6.8 to 8.4.

(ii) The vast majority of students obtained both marks for this question often by referring to competition for food. Students gaining one mark usually described competition for an unspecified ‘resource’.

(c) Most students gained one mark for a description of the decreasing temperature with increasing depth of water. Approximately half of these students then gained another mark for describing either the overlap of the ranges of the fish or the idea that another named factor could be involved. Very few students mentioned both of these ideas to obtain 3 marks. Some students merely described the depth ranges and temperatures at which each of the three species of fish were found or referred to the unknown sample size or lack of statistical tests. Although a significant number of students referred to correlation not indicating causation, this was more often than not described in an incorrect context.

Q23.

(a) Most students gained the first mark for the idea of placing quadrats at intervals along the transect, although some wrote about grids and random coordinates. Few scored the second mark, failing to recognise the units on the graph so not mentioning the size of the quadrat in order to give the number of seeds per m^2.

(b) (i) Most students could identify the wind direction but not all linked the distribution with the seeds blowing further, referring instead to more seeds.

(ii) This question was generally very well answered. Only a very small number of students referred to their own investigation for mark point 3 but the other two mark points were accessible.

(c) (i) Many failed to pick out the information about the 'large number of seeds' from the stem of Resource A. Few students gained the second mark; demonstrating a poor understanding of this aspect of succession.

(ii) Again, many failed to pick out 'small seeds' from the stem of the resource or the stem of the question. Those who did frequently failed to link growth to light and photosynthesis, or to a lack of nutrients within the seed. Many wrote generalised answers about unsuccessful competition that did not gain credit.

Q24.

(a) (i) Generally well done although some students wrote 'random' distribution or that 'each plot was in a different row or column', failing to point out that there was one of the seed densities concerned in each row and column.

(ii) Only the better students could appreciate the reason for arranging the plots this way. Many incorrect answers were seen relating to 'reducing competition' or 'the same conditions' or 'fair test'.

(b) Some students wrote about inappropriate factors that cannot easily be controlled in the field, for example light, temperature and carbon dioxide concentration.

(c) (i) Better students gave good fluent answers here with the two main trends supported by some figures. Schools and colleges must encourage their students to look for trends – many answers were seen here describing the individual figures at great length without identifying overall patterns in the data.

(ii) Many students failed to refer to intraspecific competition. Some only wrote about competition for space. This was insufficient to gain mark point 2.

Q25.

(a) This question was extremely well answered by the vast majority.

(b) Most students gained the first mark for referring to a small number of seeds but not all went on to give a further reason why not all those seeds would survive.

Q26.

(a) Students should have been able to draw on their experience of ecological investigations to suggest a suitable technique. The better responses made appropriate reference to a transect and the placing of quadrats at regular intervals. Less able students were often inaccurate in their descriptions of placing the transect. References to both across and along the shore figured frequently in their

answers. Another common error was to suggest randomly placing quadrats, an approach that would not have generated the required data.

(b) Most students were able to point out that *U. pertusa* would be uncovered by water for most of the day, although they did not always express this idea with sufficient clarity to gain credit. They were usually able to progress to link this to the ability to withstand desiccation.

Q27.

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

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

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

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

Q28.

(a) Many students knew exactly how to investigate the distribution of marram grass across a sand dune and gained three marks. If one point was missing, it tended to be marking point 2, because the quadrats were not placed regularly. Many answers referred to random sampling and using two tapes at right angles and co-ordinates generated from a calculator’s random number generator. These answers were not appropriate.

(b) Some excellent answers were seen which explained both points and gave several of the options for the second marking point. Many students gained the second marking point only, often giving two aspects of that point, usually less hostile and adding nutrients. Improved water retention was less commonly stated. Uncredited responses often described succession and the entry of new species to reach a climax community without explaining the role of marram grass in this process. A few students merely described what a pioneer species is or described the way the features of marram grass enable it to survive in harsh conditions.

Q29.

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

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

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

Q30.

(a) Candidates frequently failed to gain credit because they wrote that the mites affected breeding (as stated in the question) rather than reduced breeding success, before they went on to explain why.

(b) The response 'to eliminate bias' gained most candidates one mark for their answer to part (i), but fewer appreciated the importance of being able to apply a statistical test to the data collected. In part (ii), many candidates showed that they understood the significance of variation in breeding success but did not look critically at the independent variable so did not comment on the lack of data between 15 and 170 mites per pair of parent birds. Weaker candidates tried to answer the whole question in a single sentence rather than breaking their answers into separate parts.

(c) In part (i), candidates seemed to find it difficult to go beyond the general answer of 'there is no difference' and relate their null hypothesis to the investigation in question. A common error was to state that, 'There is no difference between the mites and the breeding success of the birds'. Most incorrect responses to part (ii) simply restated that the correlation was negative, or that one value went up as the other went down. Marks were only gained by answers that related to the data in the question, stating clearly that breeding success went down as the number of mites went up.

(d) Many candidates made reference in part (i) to anomalous data, rather than describing the wide scatter or points. Others failed to gain marks because they did not refer to the number of mites and the size of the oil gland in their answers. In part (ii), some candidates only considered the practical details here, rather than using the information in the stem. They were required to explain that preening only took place at certain times of day and that after preening the gland was significantly smaller, causing the measurement to be lower than it would have been earlier in the day.

(e) Most candidates realised that pathogenic organisms were harmful, but few made the second step and explained that a reduction in pathogens would allow the parent birds to have greater breeding success because, for example, they had not passed

disease to their offspring.

Q31.

(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.

Q32.

(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.

Q33.

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

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

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

Q34.

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

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

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

Q35.

(a) (i) The vast majority of candidates had little difficulty obtaining at least one mark by referring to the decrease in spadefoot toads as the number of newts increased. The more observant candidates, approximately forty percent, also noted that although southern toads were similarly affected, this trend was only evident up to 4 newts per pond after which the number of southern toads increased.

(ii) Most candidates appreciated that an increase in newts resulted in less competition for the spring peeper frogs leading to an increase in their percentage survival. However, many candidates did not link this to the newts feeding on the toads or they did not always clearly distinguish between toads and frogs in terms of prey.

(b) This proved more demanding with approximately half the candidates gaining one mark for explaining that an increase in newts/predators caused a decrease in the number of toads. However, fewer candidates linked the increase in available food to an increase in the growth or mass of the remaining tadpoles. There was a significant number of candidates who answered this question in terms of an increase in the rates of reproduction of frogs and toads.

Q36.

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

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

years in the stem of the question, only better candidates conveyed the idea that speciation had occurred over a long time period.

Q37.

(a) The majority of candidates completed the calculation successfully. A few failed to recognise that 18 marked and 20 unmarked birds produced a total of 38 birds trapped in the second sample. Collectively, there were various permutations of the three numbers with some candidates arriving at a population size that, on careful thought, could not have been right.

(b) In the remaining parts of the question, better responses were seen from candidates who could apply their understanding of the limitations of mark-release-recapture with specific information.

(i) In June, there is an increase in population size when young birds leave their nests to join the adult population. It was not appropriate to describe this as migration.

(ii) In March, birds in territories would not mix within the population and sampling would result in capturing the same birds.

(c) Recording the DNA base sequence of whales would be similar to marking the animals. If the base sequence were identified again, then it would be known that the same ‘marked’ animal had been recaptured.

Although many candidates clearly understood the technique of mark-release-recapture, a large number could not apply what they knew when presented with an unfamiliar context.

Q38.

(a) A large number of candidates did not associate an increase in soil nitrate concentration with the process of nitrification or with the activity of nitrifying bacteria. This was despite identification of dead organisms and the process of decomposition as the starting point for formation of nitrates.

(b) (i) The graph showed that when pioneer plants first colonised abandoned crop fields there was a high percentage cover of bare soil. Few made use of the data and used the graph to help answer this question. Discussions of fluctuations in air temperature gained little credit.

(ii) Similarly candidates also failed to recognise from the graph that, after 50 years, there was greater cover of woody plants. Those that appreciated this were able to explain the advantage for new colonisers of an ability to survive in the shade of taller woody plants.

(c) In the final part of the question, candidates were reminded to use the graph and many did appropriately. They were able to explain that small annual plants would be outcompeted by woody plants unless these were removed or had their growth managed.

Q39.

(a) (i) It could be concluded from the evidence in Figure 1 that fewer people visited site R because the mean value was lower than that for the other two sites. Although most candidates made reference to this, relatively few commented

on the values of the standard deviations. All that was expected from the question about probability values was recognition that there was a probability of less than 5% that the difference was due to chance. It was clear in the answers to this part of the question that many candidates lack an understanding of the principles underlying statistical tests.

(b) (i) Candidates were more successful with part (b). Most appreciated that using only 10 quadrats was inappropriate because the number of species was still increasing.

(ii) Similarly, using 25 was inappropriate since the curve on the graph had levelled out and the same result could be obtained using fewer quadrats.

(c) Incubation at a high temperature would result in combustion and the loss of dry mass. Weaker candidates responded inappropriately to the reference to temperature and offered explanations based on enzyme denaturation.

(d) Candidates who were successful with subsequent questions appeared to have spent some time interpreting the data first. Weaker candidates tended to plunge straight into questions, a strategy that resulted in limited credit. The ratio of dry biomass of animals to dry biomass of seaweeds is less than one because the animals feed on seaweeds. It is the loss of energy between trophic levels, due to respiration or as heat for example, that results in a ratio of less than one. Relatively few candidates were able to explain this.

(e) The better candidates could show how the data in Figure 3 supported the view that a smaller number of larger seaweeds were found on frequently visited beaches. They appreciated that the site with most people (U) had the largest ratio for dry biomass of seaweeds to abundance of seaweeds, although they could not always justify this. The difficulty for many continued into the final part of this question, but better candidates could draw some conclusions. Rows one and four revealed that fewer larger animals were found where there was more human disturbance and credit was given where the data were used to support this idea. Row two showed that the number of plant species also fell where there was more disturbance.

Q40.

More sophisticated answers were required to gain credit here. Those students who wrote ‘food source’ rarely went on to state ‘food source for the plant-eating fish’. Similarly, those who wrote ‘shelter’ rarely went on to describe why this would be important for reducing stress or avoiding predators. Some gave acceptable alternative answers relating to plants providing a place for fish to lay eggs.

Q41.

(a) Most candidates picked up on the idea that three paper birch trees was too small a sample, although the idea was often poorly expressed. Surprisingly, very few commented on the subjective nature of the descriptions. Many misunderstood the data, confusing the ion concentration inside the tissues with the ion concentration in the outside soil, even though they were told that the trees were all in similar soil conditions. Many did not realise that the high salt concentration in paper birch could indicate that it could tolerate salt or that the low concentration in red oak meant it may be able to prevent ions entering. Many stated that the “experiment” was invalid as different numbers of trees had been used or because they were not all healthy, failing to realise it was salt making them unhealthy. Very few candidates commented on the other trees and the conclusions that they were salt intolerant.

(b) Most candidates could link the data in resource B with that in D but weaker candidates became sidetracked over the effects of temperature in resource A. Resource C was used by most candidates but weaker ones failed to gain credit because they either did not read the graph carefully enough or gave a vague response. No candidates referred to the ability of some species to prevent salt entering the tissues.

Q42.

(a) Considerable confusion was evident between light duration and light intensity in candidate responses. There seemed to be little appreciation that light intensity would affect the rate of photosynthesis and light duration would only affect the time available for photosynthesis. It was not possible to credit references to light intensity although many centres did so.

Many candidates correctly recognised that it was essential to monitor the number of hours of sunshine to check that both crops were experiencing similar levels.

(b) All factors were seen in responses. The explanations were often weak and were not sufficiently precise to award the mark correctly. Light intensity, light and carbon dioxide were regularly seen but were ~~these~~ often incorrectly awarded marks by the centre.

Q43.

(a) Candidates recognised that temperatures were generally higher and also suggested that the temperature fluctuated. This question was usually marked at the correct level. It was less common for candidates to identify that the trend in the data may have been due to chance.

(b) This was well understood with the vast majority scoring two or more marks. It was marked at the correct level by most centres. Most commonly the null hypothesis was absent in responses. Many accounts provided extensive unnecessary detail about calculating the test statistic. This was often incorrectly given credit.

(c) (i) Only a very small number of candidates established valid links between egg-laying and daylength. Very few candidates realised that daylength was related to a particular time of year. Too many answers which did not correspond to points on the marking guidelines were credited by centres. Credit was also often incorrectly given for synchronising egg-laying rather than breeding behaviour.

(ii) Candidates had more success with the relationship of egg-laying and temperature. They established links with availability of food and an increase in insect numbers. Many candidates, however, discussed body temperature and survival of young and this was incorrectly credited by some centres. Others answered in terms of temperature affecting egg hatching.

(d) This was well answered by the vast majority and marked at the correct level.

(e) Many candidates were able to use the data supplied to suggest that the date of egg-laying would be imprecise. Many answers were linked to the collection of data by volunteers, candidates considering that as a consequence the data were unreliable and the conclusions that could be drawn were debatable. Again answers not meeting the requirements of those in the marking guidelines, such as ‘don’t know when the eggs were laid’, were credited.

Q44.

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

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

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

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

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

Q45.

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.

Q46.

This question was directly related to the section on succession and required candidates to interpret data relating to a specific situation. Many responses reflected poor examination technique with candidates persistently failing to follow the instructions given and make use of the graph.

(a) Candidates should be encouraged to take time to understand data given in the form of graphs or tables before attempting the questions. It appeared to the examiners that many considered the figure to represent data that they had previously encountered, and interpreted it as representing changes in population with time. Better candidates were, however, able to recognise that Species **X** had a higher rate of photosynthesis at higher light intensities and some were able to link this to competition and establishment at an early stage in succession.

(b) Those candidates who had interpreted the graph successfully were usually able to point out that species **X** would produce shade and under these conditions species **Z**, with its higher rate of photosynthesis at lower light intensities, would be able to grow. There were many answers, however, based on Species **X** growing, dying and adding nutrients to the soil. Such an answer may have been partly correct but it made no use of the data provided, an essential prerequisite to gaining credit.

Q47.

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.

Q48.

(a) There was a lack of precision to many answers to part (i) of this question. Disappointingly few made clear that an ecosystem comprises the community or all the populations (not communities) together with all the abiotic factors in an area. Nearly everyone answered section (ii) correctly.

(b) Most candidates began their answers promisingly by suggesting that the pygmy weed would compete for a named resource. Many also explained that this could result in the reduction in numbers of the naturally occurring plants. Good candidates than went on to explain that this would reduce habitats for consumers, whose numbers would also decrease, reducing the diversity of the pond community. However, a sizeable minority erroneously suggested that the success of the pygmy weed would lead to eutrophication and that animals would die as a result of a lack of oxygen.

Q49.

(a) In this question, it was a relatively common failing for candidates to be unable to write about the relevant part of the nitrogen cycle without also trying to include other aspects. In (i), some candidates failed to distinguish between the roles of decomposers and nitrifying bacteria in their answers, phrasing their responses along the lines of “the decomposers and nitrifying bacteria convert the organic substances into ammonia and then to nitrates”. It was also disappointing to read the number of answers that included references to lightning and the Haber process. However, candidates who understood the nitrogen cycle well usually had little problem with this question. There was a general understanding in (ii) that nitrogen-fixing bacteria convert nitrogen gas into a form that is more readily available; however, there was also a widespread misconception that they convert the gas directly into nitrate ions.

(b) In (i), a disappointing number of candidates did not read the question carefully and described changes in the populations of both types of bacteria and both types of protoctistans, usually without really explaining the reasons for any of the changes. Good candidates recognised the predator-prey relationship between the dispersed

bacteria and the free-swimming protoctistans in the way the numbers increased and then declined slightly out of phase with each other. In (ii), candidates who understood the process of succession were generally able to recognise the changes in the environment in the treatment tank that resulted in changes in the community inhabiting that environment. A common failing was not to make clear that it is the activities of the organisms that inhabit an area that change the environment and so make it suitable for colonisation by other species.

Q50.

(i) Most candidates knew the meaning of the term "population". However, imprecise language, as ever, cost marks. A population is *all* the organisms of one species in a particular area (at a particular time). It is *not* all the organisms of a species, or a group of organisms of one species in a particular area.

(ii) Most candidates explained that deforestation destroys habitats and this reduces the prey numbers/biomass. However, few used the graph to say that only if the prey biomass fell below 600 tonnes per 100 km^2 would the tiger population decrease.

Q51.

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.

Q52.

Several parts of this question elicited responses that displayed a basic understanding of principles, but which lacked real detail and depth of understanding

(a) In (i) many candidates understood that the importance of removing bias in sampling, but most only referred specifically to the random placing of quadrats and made no mention of the systematic sampling of the nettle plants within the quadrats. In (ii) Too many candidates did not get beyond saying “to make it a fair test“. Good candidates, however, wrote about the need to control as many variables as possible and that plants at different heights could be different sizes simply because of age or could be subject to different shading effects.

(b) Part (b) was another instance of candidates failing to take note of the requirements of the question and producing a response to similar, but more general, questions that have been asked in the past. This question required candidates to use the data to explain the preference for standard deviation over range when comparing

variation in two populations. Those candidates who did take note of the requirement had no problem in pointing out that, although the ranges were similar, suggesting similar populations, the standard deviations were different, suggesting a different degree of variation about the mean.

(c) Most candidates could calculate the actual areas, using the formula supplied, producing the answers of 3404 mm^2 (low light intensity) and 2924 mm^2 (high light intensity). Too many, however, simply wrote the ratio as 3404 : 2924 or just reduced it to 851 : 731 by dividing by 4. They should appreciate that the actual ratio of 1.16 : 1 immediately conveys the information of a 16% larger leaf area in the site with low light intensity, whereas the unresolved ratios do not do this.

Q53.

(a) Most candidates knew the mark-release-recapture technique, and were able to describe the various steps. However, they did not always explain the reasons behind the steps. For example, they did not always explain that the released insects should be left for a suitable period of time to allow them to re-integrate with the rest of the population.

(b) (i) Nearly all candidates knew that there would be only one degree of freedom.

(ii) Most candidates knew that the 0.05 level of probability is that most commonly used in biological analysis to judge statistical significance.

(iii) Responses to this section were generally disappointing. Most candidates were unable to reason that, because the value for χ^2 is greater than the critical value, then there is a probability of less than one in one thousand that the results are due to chance. They were uncertain as to whether the difference in values of χ^2 implied that the differences in results are due to chance or due to some biological cause. They wrote about rejecting a null hypothesis which had not been stated and also merely that 'the results are statistically significant'. Candidates should be aware of the logic that, if χ^2 is greater than the critical value, there is only a probability of (usually one in twenty) that the results are due to chance as the basis for rejecting any null hypothesis and accepting the experimental hypothesis.

(c) (i) A number of candidates realised that some of the biomass produced in photosynthesis would be respired by the plant, but very few actually explained that biomass is lost in the form of carbon dioxide. Most of those who involved respiration in their answers suggested that energy is lost, which is true, but loss of energy does not account for the difference in biomass between gross primary production and net primary production.

(ii) Nearly all knew that a higher net primary production would lead to more dead plants and so more food for the detritivorous insects.

Q54.

(a) Fertiliser was the most frequently seen answer but many attributed dying plants with the ability to release significant volumes of phosphate.

(b) The calculation was well done by many and some credit was given even to those who chose the wrong denominator or misread the graph. Some used the wrong graph or calculated the 1995 level as the difference.

(c) It was good to see most candidates attempting this question, many appreciating that other factors might be involved. The second mark was only rarely given, usually for a comment on the validity of the information or for an explanation of the effect of the factor.

(d) Whilst many candidates were easily able to gain maximum credit here, a number performed badly and failed to recognise the idea of the question. References to phosphate killing fish directly or to plants giving out lethal levels of carbon dioxide were often seen. The main points missed were reference to *increased* phosphate and development of the lack of light aspect in reducing photosynthesis and thus oxygen output.

Q55.

(a) Most candidates were able to explain the meanings of the two terms correctly, but again, a lack of precision cost marks for some candidates. It is insufficient to describe a population as 'a group of organisms of the same species' or 'all the organisms of a species'. It is, similarly, insufficient to describe a community as ' a group of populations'.

(b) (i) Most candidates were able to quote suitable conditions necessary to ensure the validity of the mark-release-recapture technique. They were also usually able to calculate the size of the woodlice population.

(ii) Most candidates were able to quote suitable conditions necessary to ensure the validity of the mark-release-recapture technique. They were also usually able to calculate the size of the woodlice population.

(c) Most candidates knew that the quadrats must be placed randomly and many were able to describe a method of achieving this. They usually realised that the number of dandelion plants per quadrat must be counted (although some suggested estimating percentage cover, which is *not* suitable in this instance) and the count repeated. However, rather fewer went on to say that one could then calculate the mean number per quadrat and, from this, estimate the number in the field by multiplying by the ratio of area of field to area of quadrat.

(d) (i) A majority of candidates was able to interpret the unfamiliar diagram to establish both the niches of the two species and the areas from which they were excluded. Some established the 'exclusion areas' correctly but not the basic niches.

(ii) Some candidates confused sympatric and allopatric speciation, but the majority answered along the right lines. Most were able to establish the principle of reproductive isolation and could usually suggest a suitable mechanism that would bring this about. However, candidates frequently confused species and populations in their answers, which led to confusion about when the processes they were describing had occurred. For instance, many wrote about 'gene pools of the two *species* becoming more and more different until they could no longer interbreed' when what they should have been describing was gene pools of the *populations*. However, a good number established the principle that the two would be distinct species when they could no longer interbreed to produce fertile (rather than viable) offspring.

Q56.

Much of the material in this question was unfamiliar and required careful analysis to score highly. Even so, candidates across the ability range scored highly on the question,

although it was mainly able candidates who did so.

(a) Many answers to this question, which demanded only straight recall, were disappointing. Most candidates did not get beyond saying that stabilising selection acts against the extremes and results in a smaller range or standard deviation. They often cited the example of human birth mass. Better candidates were able to explain that this occurred because those individuals showing the mean value were best adapted to the environment and that, as a consequence, the mean would not change as the process repeated itself generation after generation. However, only a few of those took notice of the question and explained that stabilising selection occurs in an unchanging or stable environment.

(b) Candidates who made the link between temperature, the activity of slugs and the proportions of cyanogenic and acyanogenic clover plants usually went on to score well by explaining the selective advantage of producing cyanide when slugs are active and not producing cyanide when temperatures are so low that the cyanide would be released into the plant's own tissues.
Those who did not make this link often pursued an inappropriate line of reasoning concerning the effect of temperature on enzyme kinetics and developed highly teleological answers.

Q57.

(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.

Q58.

Whilst it was pleasing to see a few excellent candidates achieving full marks with this question, it was more common to see low-scoring answers. Most candidates still struggle with numerical and statistical treatment of data and its application to biological situations.

(a) Most candidates gave an appropriate genotype and recognised the approximate 3:1 ratio in the offspring as the evidence for such. A number incorrectly used different letters for the dominant and recessive alleles or assumed the characteristic to be sex-linked.

(b) Statistical tests are used to test the *probability* of results being due to *chance*. Whilst the concept of chance was well demonstrated, the probability of this being the case was seldom identified.

(c) Well-prepared candidates were familiar with a definition of *codominant*. Answers were then clear and concise − both alleles would be expressed in the phenotype of a heterozygote. Where this was not the case, weak explanations, such as 'neither is dominant', often failed to make the point.

The clue to the calculations was in the wording of the questions. Part (iii) required use of the Hardy-Weinberg equation. This was not requested in part (ii) and attempting to do so was an inappropriate strategy. All that was required was an addition of all alleles present (1000) against which the *actual* frequency of the particular allele could then be established (0.25 or 25%). Many candidates failed to recognise the significance of calculating the *actual* frequency (250 in 1000).

For most candidates, their remaining credit was restricted to identification of the Hardy- Weinberg equation. Those that were able recognised that their actual frequency would be q, (but would work equally as p) from which q^2 could be determined and applied to determine the expected number with the genotype in the population (500). It was interesting to note that candidates who performed well with the mathematical nature of this question were not always successful with questions testing biological understanding.

Q59.

Failure to use the correct ecological terms was a major problem in this question.

(a) Succession was only explained well by a minority of candidates. The term 'community' was seldom used – instead candidates referred to one species replacing another, or just stated that the 'plants' or 'organisms' would change. Many candidates described succession purely in terms of an increase in the number of species. Specific changes in environmental factors or the role of species in changing these factors were seldom mentioned. Climax community was described more accurately with most candidates stating that it was the end point of succession.

(b) Most candidates correctly explained the changes in the number of other species in terms of interspecific competition for light or nutrients. There were many vague references to 'resources' or 'space' which could not be given credit.

(c) Only a minority of candidates answered in terms of biomass production, i.e., the balance between photosynthesis and respiration. Most did not use the information given in the table about the appearance of the heather, and just discussed the changes in terms of competition.

Q60.

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

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

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

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

Q61.

(a) Many candidates described examples they had learned rather than applying their understanding to answer the question set.

(b) Most candidates were only able to score two marks, as they did not realise the importance of competition in the process. There were many vague references to different ‘plants’ rather than ‘species’.

(c) Few candidates understood what makes an ecosystem stable, most just referring to the features of a climax community.

(d) There were some very good answers, with many candidates scoring full marks.

Q62.

(a) A large number of candidates just described what random sampling involves and so failed to answer the question set. Many used transects instead of quadrats, and many determined percentage cover rather than the density. Only a minority scored

the mark for how to distinguish between the two types of distribution. There were many vague and incomplete answers which did not state what they would measure or how the data would show the type a particular type of distribution.

(b) Most candidates were able to score both marks.

Q63.

(a) Most candidates scored two or three marks for mentioning the lack of predators, the impact on prey populations or the effect of competition. Only a minority discussed niche overlap, the effect of other species in the food web or ecosystem stability. A significant number stated there would be no competition or that the niche of the crab would not be occupied.

(b) Most candidates either failed to see or describe the plateau in the curve.

(c) Most candidates correctly explained the isotonic equilibrium.

(d) This was intended as a grade A discriminator, but it was only correctly answered by a very few candidates. In part (i), most candidates tried to explain the uptake of salts in terms of preventing water loss from the crab, not realizing that water would actually be entering the crab, and that the salts were required to prevent internal changes in water potential from occurring. In part (ii), most candidates answered the question in terms of the crab needing to keep warm, either by using the warmer sea or by producing heat internally. Only a very few realised that the reduction in temperature would limit the ATP production by respiration, and that there would insufficient to maintain the active uptake.

Q64.

(a) (i) Most candidates realised that dry mass would contain no water but did not give the advantage that this measurement would have. Only the better candidates gave some indication that water content would be a variable.

(ii) This was generally well answered with most candidates being able to recognise that the competition was intraspecific.

(iii) Most candidates were able to gain the first mark for stating that the dry mass increased with population density while that density was low. However too many referred incorrectly to exponential growth or lag phases; others gave only vague references to competition or limiting factors without giving specific examples.

(b) This was generally well answered, although some candidates were imprecise in stating that the environmental variables should be ‘similar’ rather than ‘exactly the same’. Several candidates incorrectly made it clear that they thought that seeds were clones of the parent plant.

Q65.

(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.

Q66.

(a) The answers to this question were often poorly worded and along the lines of, 'all the organisms living in the same place.' Such responses failed to obtain any marks, because 'all organisms' could be those of one species. Candidates were awarded one mark for understanding that 'community' refers to all the species living in a particular place. Only a minority of candidates used terms such as 'population', 'environment' or 'habitat'.

(b) A significant number of candidates wrongly interpreted the graph as a growth curve for a population of one species. Others launched into a description of succession, with little or no reference to the question. Many candidates obtained one mark for the idea of an increase in biodiversity in the field with time. Fewer went on to obtain a second mark by linking this to more feeding opportunities for (more species of) Hemiptera. Only a small minority also made reference to the increase in diversity of habitats or niches during the succession.

(c) Most candidates opted for the 'capture, mark, release and re-capture' method. Quite a few failed to obtain the mark because they failed either to 'mark' the insect, or failed to 're-capture' it. Other valid methods were given credit.

Q67.

(i) There were very few correct answers. Most candidates worked out the percentage differences between the control and the normal virus and between the control and the genetically engineered virus. They then subtracted one from the other. This approach was awarded one mark. Others ignored the control data completely and worked out the percentage difference between the effects of the two viruses. This approach was not credited. A small number of candidates did not attempt the calculation at all.

(ii) Many candidates obtained one mark for the idea that the genetically engineered virus reduced the (total) time that caterpillars could eat the leaves. Fewer linked this specifically to the effect of the toxin from the scorpion.

Q68.

It was pleasing to see so many good answers to a statistics question with many clearly understanding the basic principles.

(a) Most could give a good working null hypothesis. Those that did not usually stated a hypothesis instead.

(b) Most could give the expected values.

(c) Most candidates gave the correct number of degrees of freedom as 2.

(d) The chi-squared value was well explained. Many candidates were able to relate the information to the difference not being due to chance and being significant, so that the null hypothesis could be rejected.

(e) Many realised that the algae photosynthesised and would therefore supply the fungus with carbohydrates. Few could give the role of the fungus in this relationship; for example, supplying water, minerals or giving anchorage.

Q69.

(a) This question was answered well by many candidates, with many relating their answers to the diagram and giving a good explanation of succession. Explanations were often rambling, using very superficial language, but managed to include enough to gain the marks.

(b) Few could explain how deforestation would affect the process of succession by soil erosion, run off or leaching. Various explanations were offered for high and low levels of nutrients entering the lake, which included bits of dead trees ending up in the lake. Most suggested that as more water would enter the lake this would speed up or slow down succession.

(c) This was poorly answered with very few knowing factors that limit the size of a population. The explanations that were given were often vague, with poor use of technical terms. Most candidates simply listed factors, e.g. competition, predation, disease, but offered no explanation.

Q70.

(a) Almost all of the candidates cited the long roots of the plant.

(b) Almost every candidate correctly identified inter-specific competition.

(c) Most candidates thought that the nitrogen-fixing bacteria in the root nodules of the mesquite would remain active somehow after the plant was dead. There were few attempts to relate the increase in fertility to the decomposition of the plants.

Q71.

Most obtained one mark for noting that cadmium reduced the amount of enzyme produced with the hormone present. Few made any reference to the data without the hormone, showing that cadmium has an effect on the action of the hormone.

Q72.

This proved to be the most demanding of the three structured questions, probably

reflecting the fact that ecological principles tend to be poorly understood by the majority of candidates. Many candidates failed to absorb the significance of the information about the context and, as a result, did not apply their knowledge sensibly to the situation described.

(a) (i) There were some good answers to this part, but a surprisingly large number of candidates apparently did not know what was meant by dry biomass. Many simply churned out the standard answer about the use of quadrats without any reference to measuring the biomass. Many of those who did refer to drying the plant material merely described placing it in an oven, or even a kiln, without any indication of an appropriate temperature setting. A surprising number suggested burning the plants and collecting the ash, or using a bomb calorimeter. Few mentioned reweighing the dried material until a constant mass was achieved. Some candidates unrealistically tackled the problem in a different way by collecting one plant, or one of each species, and then, after drying, multiplying by the number of plants in the sample area. Others did not notice that the question referred to the parts above ground and dug up the whole area.

(ii) Many candidates answered this part well and gave good explanations of how to select random positions for the quadrats in a large number of sample areas. Frequently this was the only section of the question in which weaker candidates scored marks. Often, though, the number of samples was unreasonably small, in view of the information that a large area of forest was involved.

(iii) As in coursework, candidates were often unclear as to what is meant by 'limitations'. Many simply described basic precautions, such as keeping all variables the same, or errors to be avoided, such as inaccurate weighing. Others offered vague statements about climate, weather, the time of day or year chosen for taking measurements, or differing rates of photosynthesis. Few recognised the limitations imposed by dealing with a large area of forest, such as variable growing conditions or abiotic factors in different parts. Some did gain credit for realising that measurement of biomass would destroy the plants so different samples would be needed each time, or for recognising the difficulty in measuring the rate of increase for a large tree.

(b) (i) In view of the regular use of graphs with different scales on the *y-axes*, it was surprising that only a very small proportion of candidates, probably less than one in ten, read the graph correctly. The vast majority gave an answer of 1:1.

(ii) This part was targeted at the grade A candidates, so it was perhaps unsurprising that very few could explain the change in ratio. Many simply gave a brief description of succession. Those who referred to the graph most often incorrectly suggested that biomass had stopped increasing by 100 years, thus explaining the supposed 1:1 ratio. Frequently it was stated that a climax community was established after 70 years so there was no more growth. A very small number suggested that trees would grow more slowly than herbaceous plants, but virtually none realised that the ratio would change because a large proportion of a tree is non-photosynthesising biomass.

Q73.

(a) Most candidates gained good marks on this question, although there was a tendency for candidates to produce well-rehearsed descriptions of succession without always applying their ideas to the particular example given in the question. As a result, marks were sometimes missed by the use of inappropriate references, such as incorrect examples of colonising plants. The point that further changes in

conditions were needed to enable forest to develop was a common omission by candidates not gaining full marks. A number of candidates expressed themselves poorly, referring to shrubs turning into trees or smaller plants being replaced by bigger ones.

(b) This question was generally well answered with very few candidates failing to gain the mark. Those who did not answer well often described the tolerance of Sphagnum without explaining the relevance of the term climax community.

(c) This question was poorly answered with a number of very disappointing ideas being presented. Many candidates made the link between the lack of oxygen and inability of the tree to respire but failed to refer to roots; the mark for active transport was often gained. A significant number of candidates, however, incorrectly referred to the role of bacteria, attributing the lack of survival of trees to the inability of bacteria to produce nitrates in the absence of oxygen or the action of denitrifying bacteria. The weakest answers suggested oxygen was needed for photosynthesis, in some cases by the roots.

(d) Most candidates gained at least one mark for appreciating the effect of acid conditions on decomposers and many correctly described the effect of pH on enzymes. Few candidates gained the third mark, with only a small minority referring to the anaerobic conditions.

Q74.

(a) (i) The definition of an abiotic factor is well known. Most candidates achieved this mark and they usually went further than required by supporting their definition with suitable examples.

(ii) This proved to be a good discriminating question. Relatively few candidates achieved the mark because most failed to give an example of an abiotic factor or, if one was quoted, the candidate often described how it is affected by the size of the population; this was a common misconception.

(b) Most candidates achieved at least two marks for this question, often for providing a valid description of the formula used because this clearly indicated the type of counting taken at two time points. Many candidates did not gain a mark by failing to state that the organisms captured in the first sample are counted before they are released. Some lengthy answers achieved no marks by effectively only repeating the detail given in the stem of the question. It appeared that in some centres candidates had not studied this technique.

Q75.

This question produced a range of answers with most candidates interpreting the graph correctly. The synoptic questions were less well answered, although most candidates gained some marks.

(i) Most gained one mark for correctly stating there would be a rise and fall; fewer gained the second mark for appreciating there would be a time lag in the pattern.

(ii) Few scored well on this question with a significant number gaining no marks. Most that achieved marks, appreciated that there would be less food or energy reserves. A number suggested that there would be fewer leaves decomposing and therefore less nutrients available, which was not credited. There was a disappointing number of references to evolution (occurring in one year) or suggestions of responses by the plant to the larvae, such as reducing leaf growth to avoid damage.

Q76.

Candidates gave variable answers. Most students recognised the question was concerned with succession but often failed to achieve good marks by not clearly interpreting the data or by simply giving an account of succession not linked to the information given.

(a) (i) Usually students gained marks by appreciating that the short-lived plants were the colonisers and that competition with the long-lived plants resulted in the changes observed. Fewer gave good explanations of how or why these changes occurred.

(ii) This was answered less well with students often failing correctly to link the time period with the data in the graph and many referring to competition between the short and long-lived plants. Few appreciated that the death of long-lived plants enabled recolonisation by short-lived plants.

(b) Most gained one or two marks but the expression of ideas was generally poor and few gave a good account of a controlled experiment which generated valid data. There were vague references to ‘adding varying amounts of zinc’ or ‘seeing when the plants died.‘

Q77.

(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.

Q78.

(a) A surprisingly high proportion of candidates failed to calculate the percentage correctly, and those who did often did not round off their answer, thus suggesting that a fraction of a species existed.

(b) Few candidates showed appreciation of the role of isolation in the production of new species that would be unique to the Solomon Islands. Most focused on one aspect only. For example, some described adaptation to the range of habitats without discussing speciation. Others pointed out the problems of interbreeding without considering how the endemic species might have arisen in the first place.