5.4 Energy transfers in and between organisms (A-Level Only) – Nutrient Cycles – Mark schemes

Q1.

(a) Two suitable examples;
Examples
1. amino acid / protein / polypeptide / peptide;
2. nucleic acid / nucleotide / base;
3. DNA;
4. RNA;
5. ATP / ADP;
6. NAD / NADP (reduced or not);
7. Cyclic AMP / cAMP;
8. Chlorophyll;

List rule applies

Reject for either point nitrates / nitrites / ammonia / ammonium / urea

4. Accept pre-mRNA / mRNA / rRNA / tRNA

2 max

(b) Correct answer in the range 90 to 133.2 scores 2 marks;
1 mark for answers where yield calculated correctly for 1970 **OR** 2005;
(1970 in range) 170.8 to 176.4
OR
(2005 in range) 266.4 to 304.0;

Accept positive or negative values

2

(c) 1. Using more but getting less response over time;
2. The graph shows correlation but doesn't prove changes in yield due to fertiliser / but there could be other factors;
3. Becomes less cost effective with time;

Idea of over time is important

1. accept fertiliser becomes less effective over time

1. Accept use of figures from graph

1. Accept the idea of less grain / crop over time

2. Ignore whether correlation is positive or negative

2 max

[6]

Q2.

(a) 1. (Required to) make ATP / glucose phosphate, so less respiration / less energy for growth;

2. (Required to) make nucleotides, so less DNA / mRNA / tRNA for cell division / production of protein (for growth);

3. (Required to) make RuBP / NADP, so less CO_2 fixed / reduced into sugar;

4. (Required to) make phospholipids for membranes;

2 max

(b) 1. Hydrolyse;

Accept digest

2. murein / glycoprotein (in cell wall);

2

(c) 1. Bind to receptor (on target plant);

2. Acts as / leads to production of a transcription factor;

3. (Which) binds to promoter
OR
stimulates transcription of genes
OR
production of mRNA (for defensive enzymes);

3

(d) 1. Direct plant-to-plant transmission;

2. (So) localised response
OR
faster response
OR
no dilution of signal protein;

2

(e) 0.278;

Accept 1 mark for 1001.7 or

$$\frac{x - 450}{450} \times 100$$

= 122.6

2

(f) Should not use:

1. Fertilisers prevent development of mycorrhizae;

2. Mycorrhizae help plants to defend themselves (causing an increase in crop yield);

3. Mycorrhizae help plants to take up nitrates / phosphates (causing an increase in crop yield);

Should use:

4. Fertilisers containing phosphate and nitrate increase gross primary production so increase yield;

5. Most soil is poor in phosphate so without fertiliser (tomato) plant might not get enough phosphate;

4 max

[15]

Q3.

(a) 1. To kill any fungus / bacteria on surface of seeds or in soil;
2. So only the added fungus has any effect.

2

(b) So that only nitrate or ammonia / type of fertiliser affects growth.

1

(c) 1. So that effects of nitrate or ammonium alone could be seen;
2. So that effects of fungus can be seen.

2

(d) 1. Weigh samples at intervals during drying;
2. To see if weighings became constant (by 3 days).

2

(e) With live fungus – showing effects of the fungus:
1. Fungus increases growth of roots and shoots in both;
2. Produces greater growth with nitrate.

With heat-treated fungus – showing effects of fertiliser:

3. Similar dry masses for roots and shoots;
4. (Probably) no significant difference because SDs overlap.

4

(f) 1. Dry mass measures / determines increase in biological / organic material;
2. Water content varies.

2

(g) 1. Fungus with nitrate-containing fertiliser gave largest shoot: root ratio;
2. And largest dry mass of shoot;
3. 6.09:1 compared with ammonium-containing fertiliser 4.18:1

2 max

[15]

Q4.

(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]

Q5.

(a) 1. Excites electrons / electrons removed (from chlorophyll);

Accept: higher energy level as 'excites'.

2. Electrons move along carriers/electron transfer chain releasing energy;

Accept: movement of H^+/protons across membrane releases energy.

Reject: 'produces energy' for either mark but not for both.

3. Energy used to join ADP and Pi to form ATP;

Reject: 'produces energy' for either mark but not for both.

Accept: energy used for phosphorylation of ADP to ATP

Do not accept P as Pi but accept phosphate.

4. Photolysis of water produces protons, electrons and oxygen;
5. NADP reduced by electrons / electrons and protons / hydrogen;

Accept: NADP to NADPH (or equivalent) by addition of electrons/hydrogen.

Do not accept NADP reduced by protons on its own.

5

(b) 1. Protein/amino acids/DNA into ammonium compounds / ammonia;

Accept: any named nitrogen containing compound e.g. urea.

2. By saprobionts;

Accept: saprophytes.

3. Ammonium/ammonia into nitrite;
4. Nitrite into nitrate;
5. By nitrifying bacteria/microorganisms;

Reject: nitrifying bacteria in root nodules.

1, 3 and 4. Accept: marks for conversion even if incorrect type of bacteria named as being involved.

2 and 5. Reject: marks for type of bacteria if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts.

3 and 4. Accept: for one mark ammonia/ammonium into nitrate if neither mark point 3 or 4 awarded.

Note: there are no marks for the role of nitrogen-fixing bacteria as the question refers to producing a source of nitrates from the remains of crops.

5

[10]

Q6.

(a) R.

1

(b) 1. Protein / amino acids broken down (to ammonium ions / ammonia);

Accept: nucleic acids / RNA / DNA / urea / any named nitrogen containing compound as an alternative to protein / amino acids

Accept: saprophytes / saprotrophs

2. By saprobionts / saprobiotic (microorganisms).

Neutral: decomposers

Reject: answers where incorrect type of bacteria given as saprobionts e.g. Nitrogen fixing bacteria

2

(c) 1. (Fertility increased as) more nitrate formed / less nitrate removed / broken down;

Accept: Nitrate remains

2. Less / no denitrification / process P is decreased / fewer denitrifying bacteria.

Accept: more nitrification / more nitrifying bacteria / process R is increased

2

(d) 1. Grow crops / plants with nitrogen-fixing (bacteria);

Accept: grow legumes / named example e.g. peas, beans, clover

Accept: <u>fallow</u> year

Accept: use different amounts of ions / nutrients

2. (Different crops use) different minerals / salts / nutrients / ions (from the soil);
3. (Different crops have) different pests / pathogens / diseases.

2 max

[7]

Q7.

(a) (i) 1. Amino acid / protein / enzyme / urea / nucleic acid / chlorophyll / DNA / RNA / / ATP / ADP / AMP / NAD / NADP;

2. DNA / RNA / nucleic acid / ATP / ADP / AMP / NADP / TP / GP / RuBP / phospholipids;

1. and 2. Accept any named equivalent examples e.g. nucleotides.

Neutral: ammonia / nitrite / nitrate / phosphate.

2

(ii) 1. Saprobiotic (microorganisms / bacteria) break down remains / dead material / protein / DNA into ammonia / ammonium;

Accept: saprobionts / saprophytes / saprotrophs

Neutral: decomposer

2. Ammonia / ammonium ions into nitrite and then into nitrate;

Allow correct chemical symbols.

Accept: correct answers which use incorrect bacteria e.g. nitrogen-fixing but then reject m.p. 3.

3. (By) Nitrifying bacteria / nitrification;

3

(b) 1. Nitrate / phosphate / named ion / nutrients for growth of / absorbed / used by plants / algae / producers;

2. More producers / consumers / food **so** more fish / fish reproduce more / fish grow more / fish move to area;

Must have idea of more plants related to some increase in fish.

2

[7]

Q8.

1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

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

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

3. GP reduced to triose phosphate / TP;

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

4. Using reduced NADP;

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

5. Using energy from ATP;

Must be in context of GP to TP.

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

[6]

Q9.

(a) (i) Nitrification / oxidation;

Accept 'nitrifying'

1

(ii) Denitrification;

Accept 'denitrifying'

1

(b) 1. (Nitrogen) to ammonia / NH_3 / ammonium;

1. Do not disqualify mark for any references to ammonia being converted to nitrite, nitrate etc

2. Produce protein / amino acids / named protein / DNA / RNA;

2. Do not disqualify mark for any references to protein being

formed from nitrogen, nitrite or nitrate

2

(c) 1. Soil has low(er) water potential / plant / roots have higher water potential;

1. Reference to water potential gradient is sufficient if correct direction of gradient or water movement is outlined

1. Accept WP or Ψ for water potential

2. Osmosis from plant / diffusion of water from plant;

2. Accept plant takes up less / not enough water by osmosis

2. Reference to movement of minerals by osmosis negates mark

2

[6]

Q10.

(a) 1. Fertilisers / minerals / named ion (added to soil);

Accept any named examples of natural fertilisers for mark point 1 e.g. manure, bone meal etc. Ignore named elements

2. Role of named nutrient or element e.g. nitrate / nitrogen for proteins / phosphate / phosphorus for ATP / DNA;

Accept fertilisers / minerals / named nutrient / element removes limiting factor for mark point 2

3. Selective breeding / genetic modification (of crops);

Accept idea of choosing particular variety of crop for mark point 5

4. Ploughing / aeration allows nitrification / decreases denitrification;

5. Benefit of crop rotation in terms of soil nutrients / fertility / pest reduction;

5

(b) 1. Protein / amino acids / DNA into ammonium compounds / ammonia;

Accept any named nitrogen containing compound e.g. urea for mark point 1

2. By saprobionts;

Accept saprophytes for mark point 2

3. Ammonium / ammonia into nitrite;

Accept marks for conversion i.e. mark points 1, 3, 4 and 6 even if incorrect type of bacteria named as being involved

4. Nitrite into nitrate;

However, reject marks for type of bacteria i.e. mark points 2, 5 and 7 if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts

5. By nitrifying bacteria / microorganisms;

6. Nitrogen to ammonia / ammonium;

Award one mark for ammonia / ammonium into nitrate if neither mark point 3 or 4 awarded

7. By nitrogen-fixing bacteria / microorganisms in soil;

Ignore reference to nitrogen-fixing bacteria in root nodules. If not specified, assume nitrogen-fixing bacteria are in the soil

5 max

[10]

Q11.

(a) Nitrification;

Accept nitrifying.

Do not accept nitrogen fixing.

1

(b) 1. Uptake (by roots) involves active transport;

Reject all references to bacteria

2. Requires ATP / aerobic respiration;

2

(c) (i) 1. Not enough time / fast flow washes bacteria away;

"Not enough time for bacteria to convert all the ammonia to nitrate" gains 2 marks

2. (Not all / less) ammonia converted to nitrate / less nitrification;

2

(ii) 1. Algal bloom / increase in algae blocks light / plants / algae die;

2. Decomposers / saprobionts / bacteria break down dead plant materials;

3. Bacteria / decomposers / saprobionts use up oxygen in respiration / increase BOD causing fish to die;

3. Accept alternatives such as microbes / saprophytes.

3

[8]

Q12.

(a) (i) 1. Gases / correct named gas not released;

2. Conditions (in digester) can be controlled;

3. Products / named product can be collected;

4. Open ponds associated with health risk / environmental damage / eutrophication;

Correct named gases include: methane, carbon dioxide, hydrogen sulphide, nitrogen oxides

1. Allow substance = product

4. Accept 'pond' in any context

2 max

(ii) 1. <u>Respiration</u> causes temperature increase / release of heat;

2. Enzymes would be denatured / microorganisms killed;

2

(b) (i) 1. Increase algae / algal bloom causes light to be blocked out;

2. Plants can't photosynthesise / plants and / or algae die;

3. Bacteria / saprobionts / EW feed off / breakdown dead organisms using up oxygen / bacteria respire / BOD rises;

3

(ii) 1. Acts as soil conditioner / improves drainage / aerates soil / increases organic content of soil;

2. Contains other elements / named element / wider range of elements;

3. Production of artificial fertiliser energy-consuming;

4. Less leaching / slow release (of nutrient);

Unspecified answers relate to natural fertiliser. Ignore references to cost / eutrophication

2. i.e. elements other than nitrogen, phosphorus and potassium

1 max

[8]

Q13.

(a) Complementary to / fits / binds to <u>active site</u>;

Competitive / competes / 'prevents' enzyme-substrate complexes / 'prevents' urea attaching;

Max one mark if candidate suggests that active site / enzyme is damaged destroyed or useless.

Allow inhibitor 'prevents' or 'stops' urea / substrate attaching unless candidate clearly indicates this is permanent.

Ignore reference to inhibitor forming an enzyme / substrate complex.

2

(b) (i) Reduces loss of ammonia up to <u>day8 / 9</u>;

1

(ii) Increase in urease / temperature;

More enzyme-substrate complexes;

More bacteria;

2 max

(c) Less urea / ammonia lost (from soil) / less urea broken down;

Urea / ammonia converted to nitrite / nitrate;

Used to produce protein / amino acids / DNA / bases / nucleotides;

Reference to incorrect bacteria (e.g. denitrifying) producing nitrite / nitrate negates second marking point.

3

[8]

Q14.

(a) Ammonia / ammonium / NH_3 / NH_4^+;

1

(b) Will have similar shape / tertiary structure (as substrate) / complementary shape (to active site);

Neutral: same shape as substrate

Fit / bind with active site / forms enzyme-substrate complex;

Reject: same shape as active site

2

(c) (i) Provides ATP for the reaction / nitrogen fixation / reduction of nitrogen / formation of ammonia;

Accept: ATP or energy

Enzyme / nitrogenase produced quicker / <u>more</u> enzyme produced;

Ignore references to temperature

Uses / removes oxygen (so nitrogenase works);

Use of oxygen must be in the correct context

2 max

(ii) ATP used for / needed for nitrogen fixation / reduction of nitrogen / formation of ammonia / production of enzyme / nitrogenase;

Accept: ATP or energy

(So less ATP) available for growth / protein synthesis / production of new cells / production of biomass;

Accept: converse for those without fertiliser

2

[7]

Q15.

(a) 1. Saprobionts / saprophytes;

2. Digest / break down proteins / DNA / nitrogen-containing substances;

3. Extracellular digestion / release of enzymes;

4. Ammonia / ammonium produced;

5. Ammonia converted to nitrite to nitrate / ammonia to nitrate;

6. Nitrifying (bacteria) / nitrification;

7. Oxidation;

Ignore all references to other parts of the nitrogen cycle

1. Accept saprotrophs. Allow this mark if saprobionts linked to fungi.

2. Ignore"nitrogen in plants"

Ignore enzymes excreted

6. Accept Nitrosomonas / Nitrobacter

5 max

(b) 1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

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

3. Reduced to triose phosphate / TP;

4. Using reduced NADP;

5. Using energy from ATP;

6. Triose phosphate converted to other organic substances / named organic substances / ribulose bisphosphate;

7. In light independent reaction / Calvin cycle;

3. Accept add hydrogen for reduced

4. Accept alternatives such as NADPH for reduced NADP / GALP for TP / ribulose biphosphate

6 max

[11]

Q16.

(a) 1. High concentration of carbon dioxide linked with night / darkness;

Accept: converse of low in day

2. No photosynthesis in dark / night / light required for photosynthesis / light-dependent reaction;

Ignore references to rate of photosynthesis in day / night
Accept day = light

3. (In dark) <u>plants</u> (and other organisms) respire;

Must be a reference to plants or <u>all</u> organisms

4. In light net uptake of carbon dioxide by plants / plants use more carbon dioxide than they produce / rate of photosynthesis greater than rate of respiration;

Do not allow converse for this point
Accept description of compensation point

5. Decrease in carbon dioxide concentration with height;

Accept: converse of increase closer to ground

6. At ground level fewer leaves / less photosynthesising tissue / more animals / less light;

5 max

(b) 1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. To produce two molecules of glycerate 3-phosphate / GP;

3. Reduced to triose phosphate / TP;

4. Requires reduced NADP;

5. Energy from ATP;

This mark scheme is based on specification content. Accept alternate names such as NADPH

Credit relevant diagrams

Accept: description of 'reduced'

5

[10]

Q17.

(a) (i) dissolve (in soil water) / run-off / leaching; *reject nitrogen dissolving.*

1

(ii) insoluble / less soluble;
(molecules) require breaking down / slow release;

2

(b) increased growth / algal bloom;
blocks light; less photosynthesis;
plants die;
increase in decomposers / bacteria; *ignore growth of bacteria*
bacteria respire;
less oxygen;

4 max

[7]

Q18.

(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]

Q19.

(a) (i) **P** = 3;
Q = acetylcoenzyme A;

2

(ii) 36 ATP, however derived = 2 marks
30 ATP, however derived = 1 mark

2

(iii) *Correct statement in the context of aerobic respiration or anaerobic respiration concerning*:
Oxygen as terminal hydrogen / electron acceptor allowing operation of electron transport chain / oxidative phosphorylation;
Fate of pyruvate;
Significance of ATP formed in glycolysis;

3

(b) (i) Thick walls exclude oxygen;
Produced by photosynthetic cells (of fern and *Anabaena*);
Contain no chlorophyll so do not photosynthesise;
Do not produce oxygen;
Oxygen would inhibit nitrogen fixation process;

max. 3

(ii) Decomposers / bacteria / fungi / saprobionts (in fields);

Convert protein / organic nitrogen (in cells of fern) into ammonium ions (*allow ammonia*);
Ammonium ions (ammonia) converted to nitrite, then converted to nitrate;

Allow 1 mark for NH_3 / $NH_4^+ \rightarrow NO_3^-$
By nitrifying bacteria / correctly named;
Nitrate used to form protein / amino acids in rice;

5

[15]

Q20.

(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]

Q21.

(a) **P** – denitrification;
Q – Nitrogen fixation;

2

(b) Ammonia formed by decay / decomposition / putrefying / ammonifying / by action of decomposers / saprobionts;

On nitrogenous waste / urea *or* nitrogenous compounds (e.g. proteins, amino acids, DNA, ATP);

2

(c) Oxygen added / hydrogen removed;
Ignore references to electron loss

1

[5]

Q22.

(a) No - very little increase / no increase in yield of grass when *Rhizobium* added / no difference between C and D;

1

(b) Yes: increased yield with nitrates;

Correct reference to result in graph **C** c.f. graph **A /** use of correct numbers (from C + A)
e.g. greater yield of soyabean in C than in A /
greater yield of soyabean with nitrate than without <u>if no *Rhizobium;*</u>

2

(c) Forms mutualistic / symbiotic union with soyabean / forms root nodules / mutual benefits (/ described);
makes ammonia / ammonium; (Nitrates – CANCEL)
Helps produce organic-N / amino acids / protein;

max 3

[6]

Q23.

(a) (i) nitrogen-fixing;

(ii) nitrifying;
(names neutral, name only no mark)

2

(b) (i) growing legumes / named legume;
ploughed in / allowed to decompose / nitrogen-fixing (bacteria in nodules);

OR

allow cattle / named species / (farm) animals (to graze);
add dung / urine;

OR

spread / add manure / slurry;
decomposed to release nitrates / ammonia / nitrites;

2

(ii) bare soil / fallow in winter / hedge removal; leaching (of nitrates) / soil erosion;

OR

uptake of nitrates / ammonium compounds by crop;
harvesting crop / named crop which would be harvested;

OR

(farm) animals eat plants
(in field); (then) animals removed;

2

[6]

Q24.

(a) breakdown of organic matter / sewage by enzymes from bacteria;
nitrates / ammonia used by algae to make amino acids / proteins;
algae photosynthesise;
bacterial respiration uses O_2 / produces CO_2 for algae;
(respiration) allows for reproduction / growth of bacteria;

4

(b) sufficient light penetration for photosynthesis (of algae);
warm leads to faster enzyme activity;
faster bacterial respiration / decomposition;
faster photosynthesis;
increased growth / reproduction of bacteria / algae;

4

[8]

Q25.

(a) more proteins / amino acids / more DNA / nucleotides / nucleotide derivative;
increased cell division / number of cells formed;

2

(b) reduced light / shading;
less photosynthesis;

2

(c) 1 bacteria / fungi feed on dead matter saprobiotically;
2 respiration uses up oxygen;
3 converts proteins to amino acids;
4 then to ammonium compounds;
5 nitrifying bacteria convert ammonium compounds;
6 via nitrates;

6

(d) lower species diversity / number of species;
species tolerant to low oxygen thrive / species requiring high oxygen die out;

2

[12]

Q26.

(a) (i) ammonia / ammonium ions / compound;

1

(ii) glucose;

1

(b) <u>final</u> acceptor for hydrogen:
to form water;

2

(c) glycolysis can continue;

NAD can accept more hydrogen;

2

(d) secondary / tertiary structure;
produces particular shape of active site;
or
(shape of) active site;
complementary to shape of substrate;

2

(e) sodium ions / non-competitive inhibitor binds to enzyme
at a site other than active site;
resulting in change of shape of active site / no longer complementary;
substrate can no longer bind with the enzyme / enzyme-substrate
complexes no longer formed;

3

[11]

Q27.

(i) excessive use of fertilisers;
run-off / leaching;

2 max

(ii) 1. growth of algae / plants stimulated / increased;
2. death of algae / plants;
3. more bacteria / decomposers / decomposition;
4. respiration;
5. decomposers / bacteria remove oxygen;
6. animals die (because of lack of oxygen);

5 max

[7]

Q28.

(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]

Q29.

run off / leaching of nutrients / nitrates;
leads to increased growth of algae / plants;
competition for light / effect of competition;
death of algae / plants;
increases food supply / increases microorganisms / decomposers;
respiration (of microorganisms) uses up oxygen / increases BOD;
fish / animals die due to lack of oxygen;

[5]

Q30.

(a) proteins / amino acids broken down;
deamination / ammonification / release of ammonium compounds;
conversion to nitrates;
by nitrifying bacteria / named bacterium;
nitrates absorbed into roots;

5

(b) fewer nitrates in the soil for the next crop / plants grow less well
because of lack of nitrates;
requiring application of more fertiliser / economic reason for using less fertiliser
/ valid environmental reason explained e.g. nitrates leaching into water /
eutrophication / explanation / health related e.g drinking water;

2

(c) production of phospholipids;
in cell membranes;
synthesis of ATP;
production of DNA;
production of RNA;
production of NADP;

4 max

[11]

Q31.

(a) contain nitrogen-fixing bacteria in roots / nodules (so don't need fertiliser);
nitrogen containing compounds added to the soil
when plant dies / after harvest of crop;

2

(b) low(er) / more negative water potential in soil (than in the plant);
prevents roots from taking up water (from the soil) / plants still lose water
by transpiration; plants lose water to soil by osmosis;

2

Q32.

(a) (i) mass produced increases then levels off at 17.1 kg m^{-2} /
concentrations above 40 kg ha^{-1};

1

(ii) replaces nutrients removed;
fertiliser provides nitrate needed for protein / amino acid
production; as more fertiliser added, there is more growth /
protein / amino acid / yield;

2

(iii) plants already have enough nitrate / nitrate no longer limiting;
another named factor / element is limiting growth;

2

(b) because cattle excreted / produced faeces / droppings / cowpats / manure; in field B crop used elements / minerals / nitrates / nutrients last year;

2

[7]

Q33.

(a) Push – legume

Pull – grass;

Both needed for mark

1

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

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

2. Use random number table / calculator / generator;

Allow 'Select from a hat' idea.

3. To generate coordinates;

3

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

2. For light / nutrients / water;

OR

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

4. Only eating / damaging grass;

2 max

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

Accept 'ammonia' for 'ammonium compounds'.

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

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

2

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

2. Calculation to justify mp 1;

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

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

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

Accept '$350 extra income compared to $28 extra spend'.

Mp5 gains credit for both mp4 and 5

3 max

[11]

Q34.

1. Growth of algae / surface plants / algal bloom blocks light;

2. Reduced / no photosynthesis so (submerged) plants die;

3. Saprobiotic (microorganisms / bacteria);
   3. Accept: Saprobiont / saprophyte / saprotroph
   3. Neutral: decomposer

4. Aerobically respire / use oxygen in respiration;

5. Less oxygen for fish to respire / aerobic organisms die;

[5]