Q1.

2 (a) (i) (primary) producers / autotrophs; **1**

(ii) population; **1**

(iii) community; **1**

(iv) ecosystem; **1**

(v) primary consumers; **R** first consumers **1**

(b) place / area / space where an organism lives;
example of a habitat from passage (desert / woodland / coral reef);
example of a physical / biotic condition in habitat given; **2 max**

(c) small leaves / needles / needle-like leaves;
R 'spines' / thorns / narrow / fewer leaves
reduce / small surface area;
temporary / shed leaves;
leaves dry out and then rehydrate;
fleshy leaves / succulent leaves / leaves with hypodermis;
curled / rolled, leaves; **R** curved / folded / coiled
(very) thick / waxy / impermeable, cuticle;
stomata surrounded by hairs / hairy leaves / hairs trap moisture;
sunken stomata / stomata in pits / crypts / grooves;
R inverted / few stomata
stomata closed during the day / stomata open at night;

***max 2** for features given above*

(so) reduces / slows down (rate of) transpiration / water loss / evaporation / diffusion of water vapour;
R prevents / avoids water loss
N.B. link to one valid feature above **3 max**

[Total: 10]

Q2.

Question	Expected Answers	Marks
5 (a)	1 mark for working 86.5/809 x 100 (= 10.69); **A** 42 + 42 + 2.5/400 + 409 x 100 **R** 42/400 x 100 = 10.5 = 11 1 mark for correct answer 11%; **R** 10.7/other units if specified	**[2]**
(b)	Energy losses in respiration; **R** used up in/needed in respiration, energy lost in movement waste/urine/faeces/dead parts/excreta/excretion; primary consumers do not eat all the plant matter; **A** for secondary consumers not all parts of, plants/primary consumers, are digestible; energy losses as heat qualified e.g. in digestive system (of consumers)/to environment/atmosphere/surroundings; plants/primary consumers, migrate/swept away, by tide/waves AW; energy losses to decomposers;	**[max 4]**
(c)	proteins → amino acids; **A** proteins are decayed into amino acids deamination; ammonification/ammonia/ammonium ion; ammonia/ammonium ions, to nitrate; **A** nitrification oxidation;	**[max 2]**
		[Total: 8]

Q3.

5 (a) (bacterial urease converts) urea → ammonia;

ammonia → nitrite;
Nitrosomonas;
nitrite → to nitrate;
Nitrobacter;

nitrification;
oxidation / chemosynthesis; **[max 3]**

Q4.

6 (a) (i) *any **two** of the following for one mark*

amphipods
shrimps
Arctic cod
little auk ; [1]

(ii) some animals feed at different (trophic) levels / animals do not obtain all their food from one (trophic) level ; **A** correct reference to at least two consumer levels
animals may feed on different (trophic) levels at different, times / seasons ;
some food chains, do not start from primary producers / start from decomposing matter ;

named examples from food web ; [2]

(b) proportion of, phytoplankton / copepods, that is digested / some remains undigested ;
phytoplankton have cell walls ;
proportion that is absorbed after digestion ;
loss in, egestion / faeces ; } *in terms of energy loss or energy availability*
loss in, excretion ; }
loss in, respiration / heat (by copepods) ; }
energy losses in movement / AW ;
AVP ; e.g. denser phytoplankton means less energy loss in feeding [2 max]

[Total: 5]

Q5.

2 (a) habitat ;
all the organisms / plants and animals / populations / AW, in the ecosystem / forest / place / area / habitat ;
niche ;
population ; [4]

(b) (i) primary consumer / herbivore ; [1]

(ii) (sloth) cannot digest, cellulose / cell wall (in leaves), itself ;
R cannot digest leaves **R** allows sloth to digest cellulose
able to, absorb / use, products / sugars, from, cellulose / cell wall, digestion ;
provide, vitamins / minerals ;
ref to, protein / nitrogen, recycling ;
idea of protection from gut, pathogens / parasites ; [1 max]

(iii) predators are, secondary consumers / tertiary consumers / top carnivores ;
(population, size / number of) predators limited by numbers of prey / sloths / AW ;
energy loss, between trophic levels / along food chain / inefficient energy transfer ;
detail e.g. only 10% transfer / respiration / heat / movement / excretion / inedible parts / egestion / to decomposers;
(prey numbers small so) competition for, food / prey ;
predators hunted by humans ;
habitats / areas, of predators destroyed ; [3 max]

[Total: 9]

Q6.

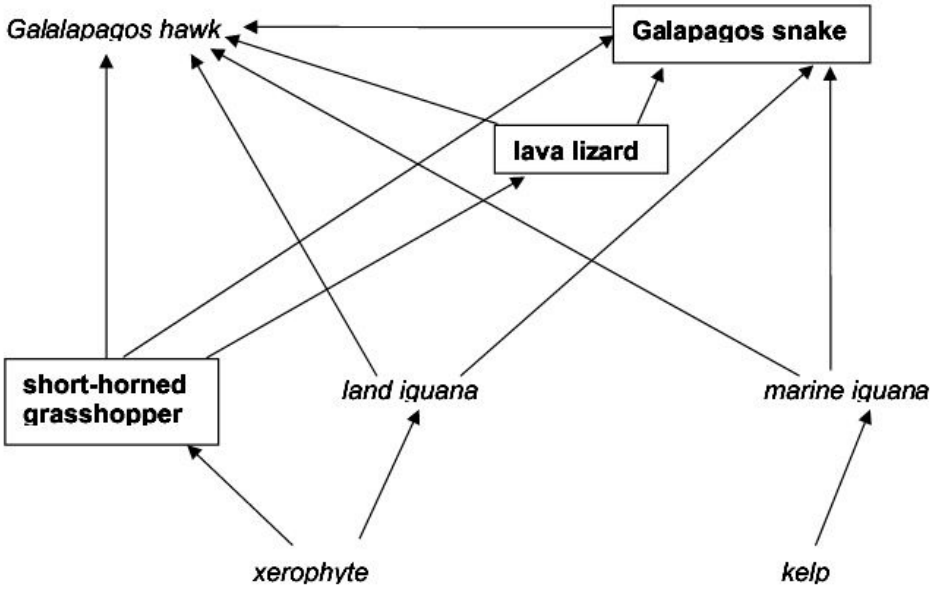
6 (a) **H** nitrogen fixation ;
J nitrification / oxidation ;
K denitrification / reduction ; [3]

(b) provide source of, fixed nitrogen / usable nitrogen / organic nitrogen / amino acids / ammonia / ammonium ions / AW ; **R** nitrate
ref. to protein production in legume ;
legume can, colonise / grow in, nitrogen / nitrate, deficient *or* poor soils ;
A not dependent on nitrate in soil
compete successfully with non-leguminous plants ; [2 max]

[Total: 5]

Q7.

6 (a)



animals in correct boxes ;
all five animals to hawk ;
all animals except hawk to snake ;

(only) short-horned grasshopper to lava lizard
xerophyte to short-horned grasshopper and land iguana } ;
kelp to marine iguana

max 3 if all correct but one arrow head missing
max 2 if arrow heads, mixed in incorrect direction/missing [4]

(b) kelp and xerophytes ; *allow ecf for next two mps if only one organism*
both, photosynthetic/autotrophic/fix carbon/AW ; **A** both have chlorophyll
both are, at the start of the food web/at the first trophic level/the source of energy to rest of food web/AW ; [3]

[Total: 7]

Q8.

5 **(a)** conversion of/AW, nitrogen (gas)/N_2 ; *in context of atmospheric nitrogen*
(to) ammonium (ions/compounds)/NH_4^+/amino acids ;

further detail ; e.g. nitrogenase (enzyme)/ref. conversion from unreactive (nitrogen) to reactive (compound)/reduction of nitrogen/ATP required/anaerobic conditions required for enzyme function [3]

(b) **(i)** ammonification/putrefaction/decomposition/decay ; [1]

(ii) supplies, ammonia/ammonium ions, for, nitrifying bacteria/nitrification ;
ammonia/ammonium ions, converted/oxidised/AW ;
to nitrite ;
to nitrate ;
Nitrosomonas/*Nitrobacter* ; *in correct context*
ref. nitrate useable form for plants ; [2 max]

Q9.

2 **(a)** **(i)** *habitat* = **B** } ;
ecosystem = **A**

abiotic component = **C** ;

ecological niche = **F** ;

population = **E** } ;
community = **D** [max 4]

(b) *seaweed* = (primary) producer ; **A** first (trophic level)

limpet / P. vulgata	*crab / C. maenas*
primary consumer	secondary consumer
A 1° consumer	**A** 2° consumer
A second (trophic level)	**A** third (trophic level)

;

max 3 for energy losses

energy losses in
respiration ;
heat loss, qualified ; e.g. heat loss, from digestion / movement / metabolism
heat loss in respiration = 1 mark
indigestible parts ; **A** named, e.g. cellulose
inedible parts ;
excretion ; **A** named excretory products
egestion ; **I** waste
death, not eaten ; [max 4]

[Total: 8]

Q10.

6 **(a)** **(i)** denitrification ; [1]

(ii) nitrate required for, amino acid / protein / nucleic acid, production in plants ;
A other relevant named N-containing biochemicals
nitrogen (gas) not useable form for (most) plants ;

removal of nitrate
slows / AW, growth of plants ; **A** reduces crop yield **A** plants need nitrates for growth
decreases fertility of soil / fertilisers need to be added to soil ; [2]

(b) **(i)** nitrification ; [1]

(ii) *P. stutzeri* / bacteria, can be (added to the water and) used to, remove nitrate / carry out denitrification ;
detail ; e.g. use of filter bed
ref. to leave for sufficient time to remove nitrates
nitrogen escapes to air [2]

(c) 1 air / oxygen, will not get into soil ;
2 lack of oxygen reduces uptake of ions by plants / AW ;
3 ref. saprobiotic bacteria and fungi / nitrifying bacteria / (some) nitrogen fixing bacteria, are aerobic ;
4 ref. reduced populations (of bacteria in mp 2) ;
5 example of effect on nitrogen cycle ;;
6 e.g. slower rate / AW, of decomposition / decay
nitrogen fixation cannot occur (as rapidly)
nitrification cannot occur / nitrate will not be produced / less nitrate produced
(more) denitrification will occur
7 crops / plants, will use up remaining nitrate ;
8 ref. leaching of, nitrates / other nutrients, for growth or (only) low levels of nitrates / other nutrients, for growth remain in soil ; **A** ref. leaching reducing soil fertility
9 AVP ; e.g. named example of another nutrient, with role
will take time to, recover nitrate levels / resume nitrogen fixation ;
fertilisers (previously) applied washed away ; [max 4]

[Total: 10]

Q11.

5 **(a)** *ignore **Y***
X = mitosis ;
Y = meiosis / mitosis [1]

(b) 1 chromosome number is halved / 2n → n / diploid → haploid ;
A 2 sets of chromosomes → 1 set of chromosomes

explanation to max 1
2 restore diploid number on fusion ; **R** restore full set if not qualified
3 avoids number doubling with each generation ;
4 allows expression of (recessive) alleles / AW ;
5 allows variation / new combinations of chromosomes ; [2]

(c) *if only use formulae, these must be correct – otherwise ignore*

1 nitrification / nitrifying / oxidation ;
2 ammonium ions to nitrite ions ;
3 nitrite ions to nitrate ions ; **A** one mark for ammonium to nitrate
4 *one named microorganism in correct context*
Nitrosomonas / Nitrobacter ; **R** *Rhizobium*
5 ammonium / nitrate / AW, absorbed by plants / leached / AW ;
R used by plant [max 3]

(d) **1** ammonium ions are (positively) charged ; **A** hydrophilic / polar / water-soluble
2 cannot pass through, phospholipid bilayer / membrane ;

either
3 active transport ;
4 moved against concentration gradient ;
or
3 facilitated diffusion ;
4 moves down its concentration gradient ; [max 2]

[Total: 8]

Q12.

6 **(a)** **G** ;
A ;
B ;
F ; [4]

(b) *do not accept list ATP, DNA, RNA, phospholipid as these must be qualified*

1 idea of, increase in cell numbers / more cells ; **A** ref. to mitosis / cell division
2 ATP, qualified ; e.g. for, cell growth / anabolic reactions
3 (activated) nucleotides for, DNA / RNA, synthesis ;
4 phospholipid for membranes ;
5 DNA replication (for cell division) ;
6 RNA for, protein synthesis / AW ;
7 AVP ; e.g. activate glucose for glycolysis
ref. NADP, light-dependent reaction [max 3]

[Total: 7]

Q13.

6 (a) (i) *max 3 if no reference to examples in passage*

habitat
location / place / area *or* (type of) local / AW, environment ;
characterised by, its physical features / the freshwater environment / its dominant producers;
where, an organism / a population, lives ;

commmunity
all populations of all species / AW ;
within a specified area / AW, at a particular time ; [max 4]

(ii) phytoplankton ; [1]

(iii) *accept plants for phytoplankton*

1 photosynthetic / carry out, photosynthesis / carbon fixation ; **A** autotrophic
2 conversion of light energy to chemical energy ;
3 equation ;
4 have light-absorbing pigments ; **A** chlorophyll
5 ref. to independence *or* dependence of other organisms ; *in context of energy*
6 ref. to input of energy to ecosystem ;
7 base of the food chain(s) / first trophic level / AW ; **A** consumed by, herbivores / primary consumers [max 3]

(b) (i) *energy losses*
in, egestion / faeces / undigested material ;
in excretion ; **A** urine / urea
heat from respiration ;

energy other uses
ref. maintenance ;; e.g active transport / metabolic reactions / digestion
for, muscle contraction / movement ; [max 3]

(ii) *any one valid suggestion e.g.*
more confined space so less movement ;
move more so greater energy loss (through respiration / as heat) ;
more predators so use more energy escaping from them ; [max 1]

[Total: 12]

Q14.

3 (a) (i) **A =** denitrification / reduction ;
B = nitrogen fixation / lightning ;
C = nitrification / oxidation [3]

(ii) decomposition / decay ;
A reference to decomposers
saprotrophs / bacteria / fungi ;
A detritivores
digest / breakdown / hydrolyse, organic nitrogen / protein / amino acids / urea ;
protease / urease ;
deamination ;
production of ammonium (ions) / ammonification ;
nitrification / ammonium (ions) to nitrate (ions) ;

accept correct formulae for ammonium ions, nitrite ions and nitrate ions [max 3]

(b) (i) *phosphate*
any one relevant ;
e.g. part of structure of
AMP / ADP / ATP
nucleotide
nucleic acid / DNA / RNA / polynucleotide
phospholipid
A phospholipid bilayer
phosphorylation / enzyme activation
bone tissue

nitrate
any one relevant ;
e.g. (nitrogen for) amino acids / proteins / enzymes / named (e.g. haemoglobin)
AMP / ADP / ATP
nucleotide
nucleic acid / DNA / RNA / polynucleotide named nitrogen base (adenine / cytosine / thymine / uracil / guanine)
(some) phospholipids [2]

(ii) **1** growth linked to, increase in cell size / cell number ;
2 growth linked to, increase in biomass / reproduction ;
3 increases energy available as food for next trophic level ;
4 nitrogen is in, amino acids / proteins, for growth ;
5 ATP (containing phosphate) required for, transcription / protein synthesis / enzyme synthesis / anabolic reactions / growth ;
6 *idea that*, growth of cells / cell division, requires membrane synthesis ;
7 nitrogen in membrane proteins / phosphate in membrane phospholipids ;
8 (cell division and), DNA, synthesis / replication ;
9 *idea that* more biomass (per unit time) returned to soil ;
10 AVP ; e.g. ref. to phosphate taken up by plants and passed into food chain ; [max 3]

[Total: 11]

Q15.

2 (a) 14 147; **1**

(b) 3.74%; **1**

(c) more energy available at lower trophic levels / less energy available at higher levels / energy lost between trophic levels;
any two figs from fig. 3.1 to qualify above statement (comparison req, no units needed);
therefore can sustain a larger population;
greater variety of food / not have to rely on one food source;
less chance of starvation / more chance of survival / less competition for food;
may feed on detritus / dead organisms / waste materials (dead leaves, faeces, urine); **max 2**

(d) breakdown / decay / feed on / digest / secrete hydrolytic enzymes onto, organic molecules / dead plant / animal / excreted / egested, material; R. decomposing
starch / cellulose, to sugars;
respire;
release carbon dioxide;
protein to amino acids;
deamination (of amino acids);
(release) ammonia (NH_3) / ammonium ions (NH_4^+) / ammonium compounds / ammonification;
(becomes available for) nitrification / ammonia -> nitrite -> nitrate / ammonia -> nitrates / ammonium -> nitrates;
R. nitrifying / named bacteria unqualified / ammonia -> nitrite
max 4

[Total 8]

Q16.

3 (a) ***calcium***

bone/teeth, formation/strengthening; **R** calcium in bone

R calcium for healthy bones and teeth

enamel/shell, formation/strengthening;

reference to muscle/nerve/synapse, function e.g. muscle contraction, generation of nerve impulse;

blood clotting;

calcium pectate, in cell wall/middle lamella;

spindle formation;

for fertilisation/fusion of egg and sperm;

iron

forms part of, haem/haemoglobin/myoglobin; **A** transport of oxygen in haemoglobin
A forms prosthetic group of haemoglobin

reference cytochrome(s)/electron carrier(s);

important in chlorophyll synthesis;

prosthetic group of some/named, enzymes/catalase;

potassium

activates enzymes;

cofactor in, photosynthesis/glycolysis;

reference to nerve/muscle, function e.g. conduction of nerve impulse, muscle contraction;

maintains osmotic balance/water potential of cells;

stomatal, opening/closure/turgidity of guard cells;

reference to Na^+/K^+ pump mechanism - qualified; **3**

(b) (i) L - urea; **A** ammonia/creatinine/uric acid/NH_3 **R** NH_4

M - nitrite (ions); **A** NO_2^- **R** NO_2 **2**

(ii) nitrification; **A** oxidation/chemosynthesis **1**

(c) (i) 15 mg/20 hours; **A** 55-40/60-40, 55-40/20, 15/60-40

0.75 (mg h^{-1}); **2**

(ii) ions/minerals/nitrates in batch P are absorbed (only) by diffusion; } **A** converse for batch N

no/limited/less, energy for active absorption/transport; } **A** converse for batch N

because (cyanide) inhibits, respiration (must be linked to explanation)/ATP synthesis; } **A** converse for batch N

ions in batch N are absorbed by active transport (and diffusion);

(idea of) after 10 hours no concentration gradient in P;

as rate of assimilation/use = rate of absorption (so concentration in plant remains constant);

active transport continues in N against a concentration gradient (after 10 hours);

reference to appropriate figs (linked to an explanation of different absorption rates);

4 max

(iii) no ions in distilled water; **R** low ions

concentration gradient out of the roots;

ions lost by diffusion;

ions, used in amination/amino acid synthesis/protein synthesis;

A ions assimilated **R** used/utilised **2 max**

[Total 14]

Q17.

1 **(a)** **H;**
C;
G;
B; **[4]**
R multiple answers.

(b) *oxygen to max 3*

from, air/atmosphere, into pneumatophores/breathing roots;
A roots suitably qualified.
diffusion, down concentration gradient/from high concentration to low concentration;
through/between, cells;
air spaces between cells;

water to max 3

osmosis;
from soil/mud into, root hair/epidermal cell/epidermis;
down water potential gradient/from high water potential to low water potential;
A into lower water potential/more negative water potential
root cell (vacuoles) have, salts/solutes/ions/minerals, to lower water potential/lower solute potential; **[5]**

[Total: 9]

Q18.

2 **(a)** nucleus/nuclear membrane/nuclear envelope/nucleolus;
ER/SER/RER;
Golgi (body/apparatus)/lysosomes;
larger ribosomes/80S ribosomes;
linear DNA/chromosomes/protein + DNA (in chromosomes);
mitochondrion/mitochondria;
cell wall made of cellulose; **R** cell wall unqualified
microtubules; **A** spindle fibres/centriole
large vacuole/tonoplast;
plasmodesmata; **[max 3]**

(b) high(er) resolution;
because of shorter wavelength;
more detail can be seen/much clearer, at the same magnification/can see two points that are close together/quote appropriate figs;
can see cell structures, that are not visible in the LM/
A e.g. ribosomes/membranes;
can see detail of structures just visible in LM with e.g.
A mitochondrion/chloroplast; **[max 2]**

(c) nitrogen fixation; **A** fixes nitrogen
converts nitrogen to ammonia; **A** NH_3/NH_4^+
further detail; e.g. nitrogenase/anaerobic conditions/ATP needed/H^+ needed
ammonia converted to amino acid(s);
(amino acids) exported to cells of legume;
in return for carbohydrate/sugars/sucrose/glucose/fructose;
symbiosis/mutualism;
helps legume survive in areas with low, N/nitrates;
A competitive advantage **[max 3]**

(d) they have the same/similar function, to combine with oxygen;
idea of similar/same, primary sequence/sequence of amino acids;
idea of same/similar, tertiary structure/3D shape; **A** quaternary

common ancestry/both are eukaryotes,because they share some of the same genes; **[max 2]**

[Total: 10]

Q19.

6 **(a)** *definition of ecosystem*

community (of organisms) ;
physical / abiotic, factors / environment ;
ref to interaction between organisms ;
ref to interaction between organisms and physical environment ;
ref to 'self-contained' / delimited by some physical feature ;
use of named example to illustrate one above point ; [3 max]

(b) these (fierce) animals are, at the top of food chain / last in food chain ;
secondary / tertiary, consumer / top carnivores ;
ref to energy loss along food chains / energy lost between trophic levels / insufficient energy transfer ;
further detail, e.g. little energy trapped by (primary) producers / only 10% transfer / loss in, respiration / decomposition ;
large animals, require much energy / find it difficult to obtain sufficient energy ;
need large habitat to provide sufficient food ;
ref to fierce and maintaining territories ;
AVP ; e.g. hunting / competition [3 max]

(c) (legumes have) *Rhizobium* ;
in their root nodules ;
carry out nitrogen fixation ;
(legumes) not dependent on nitrate ions from soil ;
nitrogen / ammonium / nitrate, required for making, amino acids / proteins ;
ref to growth / reproduction ;
AVP ; e.g. have mycorrhiza [3 max]

Q20.

6 **B** 3
C 4
D 9
E 6
F 2 [5]

[Total: 5]

Q21.

6 **(a)** 'self contained' / 'self-sustaining' / determined by same physical feature / defined area ;

community / all organisms / biotic factors, **and**, physical factors / abiotic factors / non-living factors / environment ;

ref. to interaction between, organisms (and physical environment) ; [2 max]

(b) *award two marks for the correct answer (5.5%)*
if no answer or incorrect answer or answer to too many decimal places, award one mark for working (88 / 1609)
88 / 1609 (× 100)
5.5 (%) ;; [2]

(c) *these are points for producers to primary consumers – accept ora for secondary consumers to tertiary consumers*
1 some parts inedible ;
2 indigestible / cannot digest cellulose or lignin ;
3 more material goes to decomposers (rather than consumers) ;
4 plant material is less energy rich / animal flesh is more energy rich ;
5 manipulated data in support ; e.g. ×2 to decomposers from producers
0.8% (energy available to primary consumers divided by the energy available to plants)
[3 max]

(d) *decomposers in recycling nitrogen*
protein → ammonia / ammonium ions = 1 mark
1 convert protein → amino acids ;
2 deamination ;
3 urea / amino acids → ammonia / ammonium ions ; **A** ammonification
4 make, ammonia / ammonium ions, available to nitrifying bacteria ;
A role of nitrifying bacteria / correctly named [2 max]

[Total: 9]

Q22.

6 **(a)** *community*

all populations / all organisms / all plants + animals (+ microorganisms) ;
R all the species

in same, place / ecosystem / area / (common) habitat, (at same time) ; [2 max]

(b) (i) *award two marks for the correct answer (4.5%)*

if no answer or incorrect answer or answer to too many decimal places, award one mark for working (2946/65 800 × 100)

2946 / 65 800 (× 100)

4.5 (%) ;; [2 max]

(ii) energy available (from secondary consumers) is too small ; **R** no energy
2 kJ m^{-2} (per week) ; [2]

(iii) decomposers are, saprophytes / saprotrophs / saprobionts / bacteria / fungi ;

plant matter provides little, protein / AW ; ora **A** high carbon / low nitrogen
plant matter / cellulose / lignin, not easy to decompose ;
ref. to organic matter / energy source, in plants not easy to obtain ;
supply of nitrogen is, limiting factor / limits growth of decomposers ;
(animal waste) protein / amino acids / urea, provides nitrogen ;
(animal wastes) provide materials for growth of, decomposers ;
further detail e.g. amino acids for proteins / membrane proteins / (hydrolytic) enzymes / other named protein(s) / nucleotides / nucleic acids ;

more decomposers leads to faster decomposition (hence more energy flow) ; [3 max]

[Total: 9]

Q23.

1 (a) community ;
niche ; **A** role
second trophic level / first level consumers / primary consumer level ;
A *other appropriate terms* [3]

(b) *loss (of energy-containing food in producers or in grazers) in*
indigestible parts / not being absorbed / faeces / egestion ;;
one mark for producer, one mark for grazer

excretion (in, grazers / herbivores / primary consumers) ;
respiration (in, grazers / herbivores / primary consumers) ;
loss of energy in movement / AW (in, grazers / herbivores / primary consumers);
AVP ; e.g. heat energy [max 2]

[Total: 5]

Q24.

5 **(a)** glycogen ; [1]

(b) xerophyte / xerophyllic ; **A** phonetic e.g. zerophyte [1]

(c) haploid (cell) ; **A** monoploid [1]

(d) (primary) producer ; **R** first ***ignore*** autotrophic [1]

(e) (nitrogen) fixation ; **A** nitrogen fixing bacteria [1]

[Total: 5]

Q25.

6 **(a)** **(i)** (for) chlorophyll (structure / synthesis) ;
(for) ATP functioning ;
(for) enzyme functioning / enzyme cofactor ;
signalling ion / regulates carbon fixation ;
(for) DNA / RNA, synthesis ;
stabilises, DNA / RNA, structure ; **A** required in translation
(matrix of) bone ; [max 1]

(ii) mutualistic association / AW ; **A** ref. to mycorrhiza
qualified; e.g. further detail of relationship, named nutrients

arrow from plant to fungi
ref. (some) fungi are, parasitic / pathogenic (on plants) ; **A** pathogens
leakage (from plants) of assimilates ;

arrow from fungi to plant
plants absorb nutrients, excreted by fungi / from decomposition by fungi ; [2]

(b) **(i)** 5th / 6th ; **A** top carnivore [1]

(ii) idea of little energy available, at / towards, top / end, of food chain ;
too few organisms in level below ;
expend much energy catching animals in trophic level below ;
to obtain, a wider range of / varied, nutrients ;
reduced competition ; [max 2]

(c) (i) *community*
all, populations of all species / organisms, living in a particular area, at one time / AW ; (1)

habitat
place / location / environment / AW, where, a population / an organism, lives ; **A** community (1) [2]

(ii) soil is source of nutrients for, plants / producers ;
plants / producers, provide energy for ecosystems ;
ref. recycling nutrients (by soil organisms) ;
ref. to importance of, carbon / nitrogen, in, organic / complex molecules ;
AVP ; e.g. detail of nutrient cycling, maintains balance of nitrogen in air [max 3]

[Total: 11]

Q26.

3 (a) (i) active, transport / uptake ;

max 2
movement, against the concentration gradient / from low to high concentration ; **A** diffusion gradient
requires energy (from ATP) ;
specificity / specific binding site ; **A** complementary shape
conformational change / change in 3-D shape ; **A** ref. to, 'flip-flop' / 'kissing gate' mechanism [max 3]

(ii) (70S) ribosomes ; *ignore size* [1]

(iii) ammonia / ammonium / ammonium ions ; **A** NH_3 / NH_4^+ [1]

(b) (i) *two marks for correct answer*
35(%) ;;

1 mark if correct working but not to whole number
90 / 255 × 100 = 35.29 / 35.3 [2]

(ii) idea that nitrogen removed is replaced by nitrogen added ;
denitrification / denitrifying bacteria ; **A** named bacteria e.g. *Pseudomonas aeruginosa* / *Thiobacillus denitrificans*
convert / AW, nitrate / nitrite (to nitrogen gas) ;
AVP ; e.g. occurs, when oxygen depleted / waterlogged soils
volcanic action adds nitrogen [max 2]

(c) **1** increase / maintain, nitrogen content of soil ; **A** add, ammonium / nitrates, to soil
2 increase / maintain, soil fertility ;
3 uptake / absorption, of, ammonium ions / nitrates /fixed nitrogen (by plants) ;
4 (plants use) for, amino acid / protein, production ;
5 increased, growth / yield, of (crop) plants ;
6 ref. feeding, livestock / human populations ;
7 reduced need for fertilisers ;
8 example of environmental benefit of reduced fertilisers ;
9 cost saving from reduced use of fertilisers ;
10 qualified ref. to, *Rhizobium* / legumes ; [max 3]

[Total: 12]

Q27.

6 **(a)** **(i)** population ; [1]

(ii) ecosystem ; [1]

(iii) denitrification ; [1]

(b) **(i)** *if more than one answer – take first answer only*

secondary consumer ; **A** second consumer / 2° consumer
A third trophic level **R** carnivore [1]

(ii) *do not award marks unless it is clear there are energy losses in the crabs (not the mangrove)*
energy losses in
respiration ;
movement / muscle contraction ;
reproduction / AW ;
digestion ;
egestion / food not absorbed / loss in faeces ;
excretion / loss in urine / ref to named excretory product ;
ecdysis / moulting ;
(named) inedible parts ; *there is energy in shells*
dead crabs eaten by, other consumers / detritivores / decomposers ; [max 2]

(c) **1** protein / amino acids, (in leaf litter) ;
2 ref to, decomposition / decay / decomposers / saprobiotic bacteria or fungi ;
3 deamination ;
4 amino acid converted to, ammonia / ammonium ;
5 ammonia / ammonium, converted / oxidised , to nitrite (ions) / NO_2^- ;
6 nitrite (ions) / NO_2^-, converted to, nitrate (ions) / NO_3^- ;
7 by, nitrification / nitrifying bacteria / named example ; e.g. *Nitrosomonas / Nitrobacter*
8 nitrate (ions) / NO_3^-, taken up / absorbed, by mangrove / plant (roots) ;
9 AVP ; e.g. ammonia / ammonium, taken up [max 4]

[Total: 10]

Q28.

4 **(a)** *ignore reference to, first / third / fourth, trophic level*

(primary) producer ;
secondary consumer ; **A** second / 2°, consumer
tertiary consumer ; **A** third / 3°, consumer [3]

(b) 1 polar bear is, tertiary / quaternary consumer / top carnivore ; **A** in fourth / fifth, trophic level
2 feeds (only) on ringed seals ;
3 therefore limited, food / energy, supply ;
4 reference to ringed seals competing for food / food for seals shared with, others / named ;
5 reference to energy loss, within / between, trophic levels ; **A** approx 90% loss from one trophic level to the next
6 any two examples of, energy / heat, loss in lower trophic levels ; e.g. heat loss from, respiration / movement / digestion / excretion / egestion / indigestible parts / to decomposers / death but not eaten [max 4]

(c) *decrease in population of Arctic cod so higher trophic levels*
1 less, food / energy, (for consumers of cod / higher consumers) ;
2 more competition for food ;
3 consumers / named consumers, of cod feed on other levels ;
4 starvation / decrease in population / extinction(s) (of other species) ;
5 migration to areas where food is more plentiful ;

lower trophic levels
6 increase in numbers of
either, copepods / AW *or*
arrow worms / AW ;
7 (so) decrease in population of phytoplankton ; *only if mp 4 not scored*
8 (so) increased competition with bivalve molluscs ; *only if mp 2 not scored* [max 3]

[Total: 10]

Q29.

3 **(a)** **(i)** all arrow heads in correct direction (phytoplankton to herring / krill, krill to herring, herring and krill to whale); [1]

(ii) secondary / tertiary, consumer;
A third / fourth (trophic level) [1]

(iii) 1 plenty of food available / AW;
A feeding on more than one trophic level
2 further detail; e.g. phytoplankton efficient at converting light energy
phytoplankton blooms
little / no competition
ref. efficient feeding mechanism
3 short food chains / fewer links of the food chain;
4 less energy lost overall;
A *idea in terms of* percent lost at each level
5 few, indigestible / inedible parts; [max 3]

(b) 1 fat / blubber = triglyceride;
2 fat / blubber / triglyceride, used as energy, store / reserve;

decreases
3 less fat in cells; ora
A fewer fat-filled cells / less adipose tissue
4 mobilised / respired / converted to fatty acids (**A** glucose), to release energy (during non-feeding season);
5 energy (from fat mobilisation) used, qualified; e.g. for movement

increases
6 food eaten / during feeding season, conversion to, fat / AW (for storage);
7 ref. thermal insulation;
A *idea of* prevents heat loss **R** keeps it warm [max 2]

(c) 1 (good) solvent / AW; e.g. (many) ions / minerals dissolve (in water)
A idea of (sufficient) dissolved respiratory gases (to support life)
2 provides, buoyancy / support / AW;
A *idea of floating*
3 (buoyancy / support) enables some to attain a large size / supports large mass / enables phytoplankton to remain, near / at surface;
4 high specific heat (capacity);
5 qualified; aquatic environment, more temperature stable / slow to change temperature / helps whale to maintain constant body temperature
6 ice, floats / less dense than water;
7 acts as insulator / prevents heat loss from water / water is underneath allowing survival in the winter;
8 transparent, for light penetration / for photosynthesis / for visual cues;
9 (density changes causing convection) currents, maintain circulation of nutrients / make nutrients available to support phytoplankton;
10 **AVP**; e.g. ref. to surface tension prevents sinking (small organisms) ref. to gamete movement [max 3]

[Total: 10]

Q30.

6 **(a)** biotic and abiotic, components / AW ;
A alternatives to biotic and abiotic
including community / AW for biotic and habitat / environment, for abiotic
interacting / AW ; *idea of* interactions between organisms *or* interactions between organisms and abiotic environment
in an identifiable / a defined / a self-contained area / place / unit / environment / AW ;
A *idea of place if qualified with correct example* [2]

(b) **(i)** grasses / shrubs / trees ;
A singular or plural [1]

(ii) spider / predatory insect ;
A singular or plural [1]

(c) *energy loss at each level because of*
1 inedible parts / not all of the organism can be eaten ;
2 indigestible parts / not all is digested / egestion / faeces ;
3&4 *energy / heat, losses from* ;;
respiration **R** energy used for respiration
movement **A** energy used for movement
excretion
digestion
ignore *energy not utilised by plants by e.g. reflection from leaves, etc.* [max 3]

(d) *following death of organisms or excretion of nitrogenous waste*
1 decomposers / saprotrophs / bacteria / fungi / scavengers / detritivores ;
2 digest / breakdown / hydrolyse, protein / urea ;
3 *idea of* assimilation in / growth of, decomposers / AW ;
4 deamination ;
5 production of ammonium (ions) / ammonification ; **A** ammonia / NH_3
6 nitrification described *or* denitrification described ;
A formulae for ammonium ions, nitrite ions and nitrate ions but must be correct including signs
A nitrification described in terms of ammonium (ions) to nitrate (ions)
ignore nitrogen fixation as used correctly (N_2 to fixed N)
ignore uptake of nitrate ions or ammonium ions by plants
do not credit nitrification if any confusion with nitrogen fixation [max 3]

[Total: 10]

Q31.

6 **(a)** *niche*
functional role / function / role / AW, of a species within an ecosystem ;
A population / organism, *for species*
accept description

community
all populations of all species / all organisms / AW, living in a (particular) area / AW, (at the same time) ; [2]

(b) 1 changing / increasing / decreasing, numbers of sea otters has (large) effect on the rest of the ecosystem ;

effect on kelp

2 prey on sea urchins, which, graze / feed on, kelp ;
3 if, no / few, otters numbers of urchins increase, so kelp decreases ; ora
4 sea urchins have no other predator ;

role of kelp

5 kelp, is a producer / initial input of energy into ecosystem ;
6 so less kelp means less energy available for the ecosystem ;
7 kelp provides habitats for many other species ;
8 loss of kelp (significantly), changes structure of ecosystem / ref. to 'deforestation' ;

effect on other organisms

9 decrease in numbers (of sea otters) leads (initially) to increase in numbers of their prey / named organism from Fig. 6.1; ora
10 *for any one example* ref. to consequence / knock-on effect ;
11 AVP ; e.g. ref. to effect on, energy flow through ecosystem / regulation of populations within the ecosystem / community structure [max 4]

(c) 1 (determine) energy content of consumed kelp, absorbed / that can be used, by sea urchins ; AW
2 (determine) energy content of kelp consumed by sea urchins ;

allow other reasonable suggestions for mps 1 and 2

3 *idea of* comparing energy contents and expressing as a, percentage / proportion / ratio ; **A** equation *or* worded e.g. mp 1 divided by mp 2

4 (calculated as) per unit, area / volume, per unit time ;
A example e.g.(J) m^{-3} $year^{-1}$ [max 3]

[Total: 9]

Q32.

5 (a) *max 2 if no examples from passage given*
population

1 all individuals / all organisms / AW, of,
Trichophilus welckeri
three-toed sloths / *Bradypus variegatus*
one / a, species of roundworm
one / a, species of insect *any one* ;
one / a, species of saprotrophic fungi
one / a, species of algae
A one (particular), species / kind / type
I e.g. the roundworms etc.
treat as neutral same organisms

2 *idea of* in, an (specified) area / AW ; e.g. place / habitat e.g. (sloths) in the, forest / trees (at one time)in central / south America
in the sloth's fur / on the sloth

3 at the same time ; *allow once only*

4 (named organisms) share same gene pool / ref. isolated from other populations (of the same species) ;
community

5 all populations of all species / all organisms / AW, living in a (particular) area / AW ;

6 examples ; all the organisms living on the sloths fur
or
roundworms, insects, fungi, algae, on sloth's fur/ in same area
in second example do not need ref. to fur or area if mp 5 given

7 at, the same / one, time ; *allow once only* [max 4]

(b) 1 has biotic and abiotic components / biological and physical components ;
A living and non-living components

2 described by use of examples from text ; e.g. water and organisms
A fur as an abiotic factor

3 ref. energy flow / nutrient cycling ;
A described e.g. food web, algae as producers, fungi as decomposers
A food chains *look for at least one link*

4 ref. interactions / functional entity ; AW e.g. self-contained / self-sustaining / inter-relationships [max 3]

[Total: 7]

Q33.

2 **(a)** 1 nitrogen, converted / reduced / fixed, to, ammonium / ammonia (in root nodules) ;
A correct equation $N_2 \left(+ 6e^- + 8H^+\right) \rightarrow (2)NH_4^+ / (2)NH_3$
R if nitrogen fixation is said to happen in the soil
I nitrogen fixation is carried out by leguminous plant

2 (catalysed by) nitrogenase ; *accept if part of equation*

3 ATP, hydrolysed / AW ; *accept if part of equation*

4 ref. to anaerobic conditions ;

5 ammonia (converted) to amino acids to protein (in plants) ;

6 plant protein, digested / hydrolysed / broken down, by animals (into amino acids and absorbed) ;

7 amino acids used to synthesise (animal) protein ; [max 5]

Q34.

(ii) more digestion means that there is more energy available to the animal ;
ora = undigested material means less energy to the animal

2 more digested material means more energy for, secondary consumers / carnivores / next trophic level / for the food chain ; ora

3 more digested material means more trophic levels ; ora

4 more undigested material provides more energy to decomposers / AW ;

5 AVP ; e.g. ref. to (named) animal productivity
A secondary, production / productivity [max 2]