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A2 Biology OCR

Unit F215: Control, genomes and environment

Module 3.1 Ecosystems

Notes & Questions

Define the term *ecosystem*.

- Ecosystem
 - A group of living and non-living components which occur together and the interrelationships between them
- Habitat
 - A place where an organism lives
- Population
 - All the individuals of a species in one place
- Community
 - All the individuals of all species in one place
- Niche
 - The role an organisms plays in an ecosystem
 - This involves; what it feeds on, what it excretes, how it reproduces etc
 - It is impossible for two organisms to occupy the same niche.

State that ecosystems are dynamic systems.

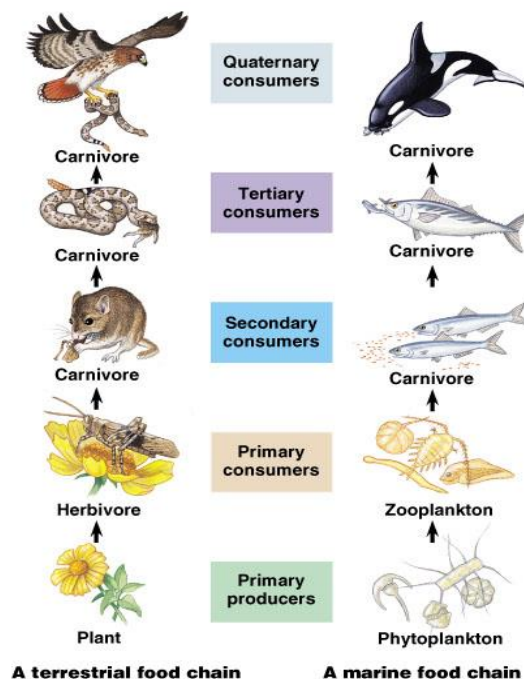
- Ecosystems are dynamic systems. They are constantly fluctuating and changing.

Define the terms *biotic factor* and *abiotic factor*, using named examples.

- Biotic – Living components of an ecosystem
 - Disease
 - Food (prey/grazing)
 - Competition (Intraspecific or interspecific)
 - trampling
- Abiotic – Non-living components of an ecosystem
 - Water availability (soil or pools)
 - Mineral availability
 - Space
 - Light
 - Temperature
 -

Define the terms *producer*, *consumer*, *decomposer* and *trophic level*.

- **Producer**
 - Organisms that convert light energy (photoautotroph) or chemical energy (chemoautotroph) into chemical energy which is then available to consumers
 - Autotrophs
- **Consumer**
 - Living organisms that feed on other organisms
 - Heterotrophs
 - Herbivores (feed on plants)
 - Carnivores (feed on animals)
 - Omnivores (feed on both)
- **Decomposer**
 - Organisms that feed on dead organic matter, releasing molecules, minerals and energy that then become available to other living organisms in that ecosystems.
 - Saprotrophs
 - Secrete enzymes onto the dead organic matter, digestion takes places outside the decomposer and the digested material is then take in by the decomposer, although some remains in the ecosystem.
 - Bacteria & Fungi
- **Trophic level**
 - The level at which an organism feeds in a food chain.



Describe how energy is transferred through ecosystems.

- 1 sun is the energy source (for the system);
- 2 producers trap / use / absorb (sun's energy);
- 3 Photosynthesis;
- 4 not all energy trapped and reason;

- 5 energy used for, plant metabolism / plant processes / e.g. respiration
- 6 so this energy not, passed on / available, to consumer;
- 7 (some energy) used for, growth / storage;
- 8 so this energy is, passed on / available, to consumer;

- 9 1⁰ consumer / herbivore, eats, producer
- 10 some producer, not edible / not accessible / e.g. cellulose or fallen leaves etc
- 11 some, not digested / egested / lost as faeces;

- 12 2⁰ consumer / carnivore / omnivore, eats, 1⁰ consumer / herbivore;
- 13 some parts of animal not edible / e.g.;

- 14 energy used by animal in moving (to feed);
- 15 energy, used / lost, in, digestion / excretion / sweating / e.g.; **A** respiration

- 16 transfer / loss, to, decomposers / bacteria / fungi / saprotrophs;
- 17 energy lost as heat from respiration;
- 18 net productivity = gross productivity – respiration;

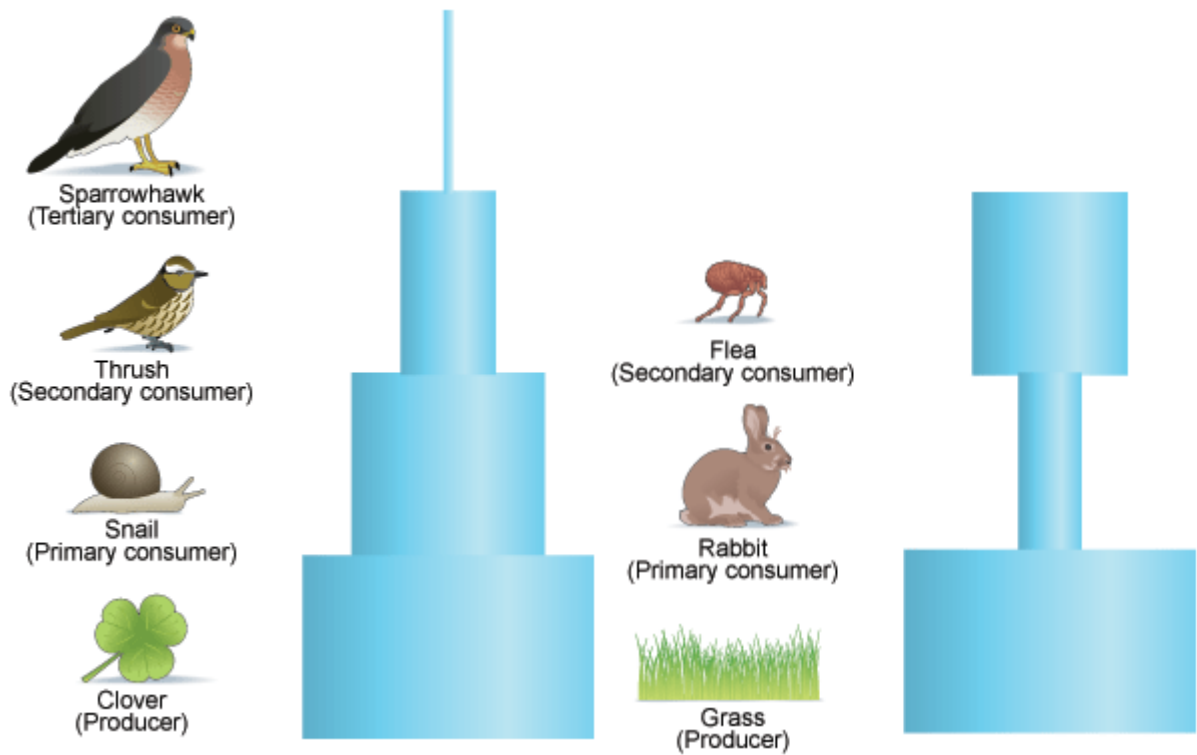
AVP; e.g. loss out of ecosystem
available energy limiting length of chain

Outline how energy transfers between trophic levels can be measured.

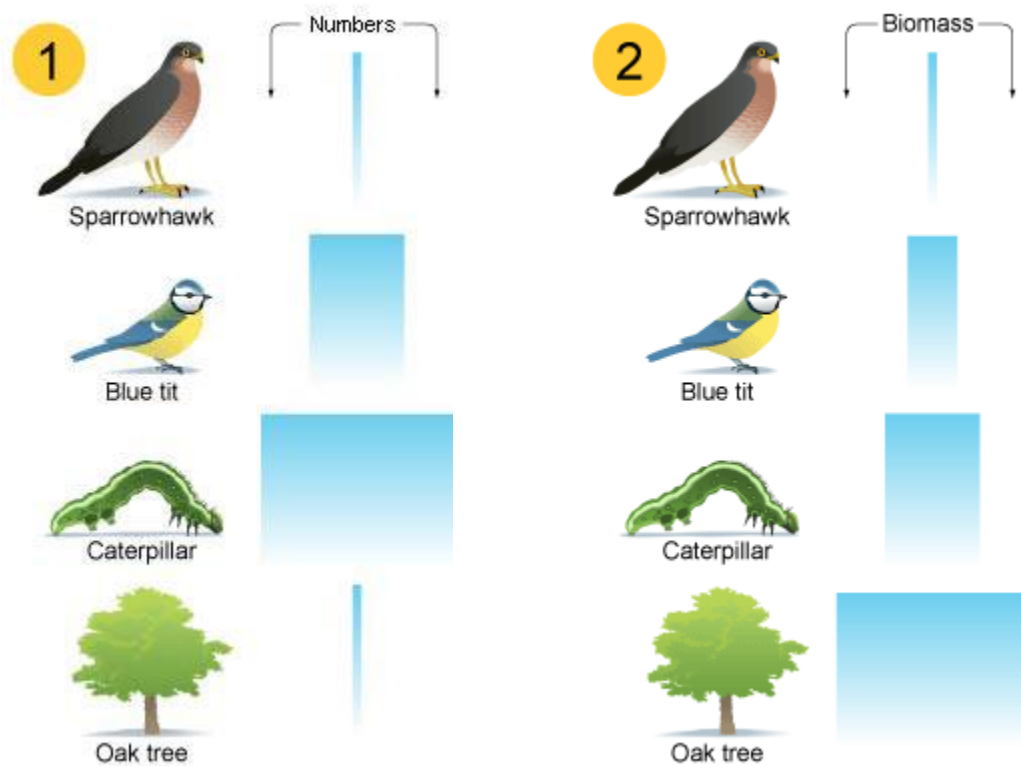
- Energy is lost from the food chain at each trophic level leaving it unavailable to the next.
- This results in fewer higher level organisms

- **This can be demonstrated by**

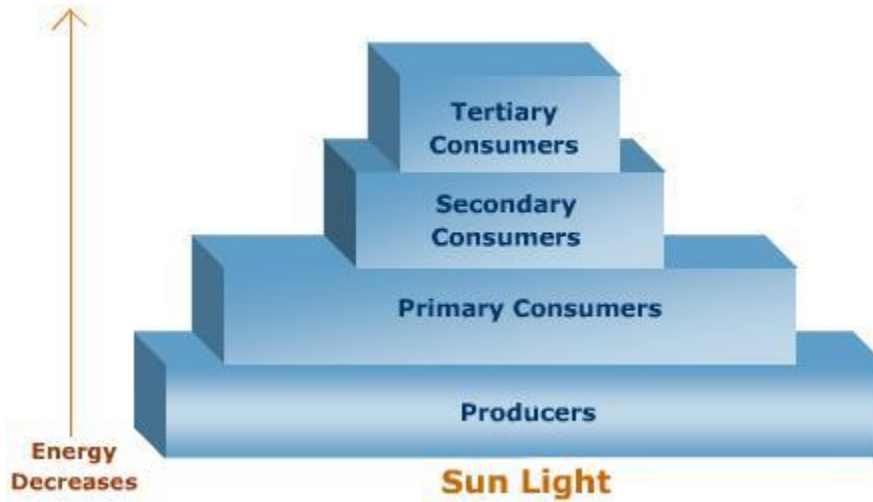
- Pyramids of numbers
 - Presenting the number of individuals at each trophic level as a horizontal bar.
 - Should produce a pyramid shape with each bar getting smaller with each trophic level.
 - Can be problematic as not all individuals are the same size and therefore not of an equal value.



- Pyramids of biomass
 - Presenting the biomass of each trophic level as a horizontal bar.
 - This is achieved by heating the sample in an oven at 80°C to evaporate out the moisture.
 - This is a very destructive method. Nowadays a wet mass is taken and the dry mass calculated using previously published data.
 - Can still be problematic as not all biomass will release the same amount of energy.



- Pyramids of energy
 - Presenting the energy of each trophic level as a horizontal bar
 - This is achieved by using a calorimeter. This measures the temperature increase in a known volume of water.



- Productivity
 - The rate of energy flow through each trophic level
 - It provides an idea of how much energy / particular trophic level / m² / year
 - Sunlight
 - Only 1% absorbed
 - Most reflected
 - Does not hit photosynthetic material
 - Passes through the leaf
 - Some turns into heat energy
 - Gross primary productivity – total energy received at trophic level
 - Lost by respiration / dead material
 - Net primary productivity – total energy left available to next trophic level

Discuss the efficiency of energy transfers between trophic levels.

- **Sun to producer**
 - Most energy is not incorporated into the plant, because;
 - Light is reflected (off plant) / only certain wavelengths of light can be, absorbed /used;
 - Absorbed by / hits, non-photosynthetic parts; e.g. bark
 - Passes through leaf / misses chlorophyll / misses chloroplasts;
 - Some is heat that is used in evaporation / respiration;

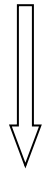
- **Producer to 1° Consumer**
 - Producers have, cell walls / cellulose; ora
 - Difficult to digest / much material, wasted / egested;
 - Energy used by gut microorganisms; ora
 - Much material cannot be eaten (by primary consumer); ora
 - Some food not, eaten / accessible; **A an example**
 - (some assimilated) food / energy, lost in excretion;
 - ref to decomposers;
 - (some assimilated) food / energy, lost in respiration;
 - energy lost, as heat / in movement / in metabolism;
 - small proportion energy used for, growth / material, and is available to next trophic level;

- **1° Consumer to 2° Consumer**
 - plant material difficult to digest / animal material can be digested easily;
 - ref to, cellulose / lignin / wood;
 - No cellulase;
 - (animal) gives similar spectrum of amino acids (as consumer);
 - less of the producer available to the 1° consumer than 1° consumer available to the 2° consumer;
 - (some assimilated) food / energy, lost in excretion;
 - ref to decomposers;
 - (some assimilated) food / energy, lost in respiration;
 - energy lost, as heat / in movement / in metabolism;
 - small proportion energy used for, growth / material, and is available to next trophic level;

Explain how human activities can manipulate the flow of energy through ecosystems.

- **Agriculture**

- Gross Primary productivity - total energy received at trophic level



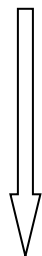
Lost by respiration / dead material

- Net primary Productivity - total energy left available to next trophic level

- Farmers want to maximise the net productivity as it means more produce.
- Farmers cannot reduce the amount of energy lost by respiration but they can increase the gross primary productivity and so as a result can increase the net primary productivity.
- They can do this by;
- Increasing limiting factors such as
 - Light intensity
 - Temperature
 - Soil water content
 - Humidity
 - Available nutrients
- Decreasing limiting factors such as
 - Pests
 - Disease
 - Competition / weed.

- **Husbandry**

- Gross secondary productivity - total energy received at trophic level



Lost by;
Respiration
Dead material
Faeces
Excretion

- Net secondary Productivity - total energy left available to next trophic level

- Farmers want to maximise the net productivity as it means more produce.
- They can do this by;
 - Application of steroids
 - Application of antibiotics
 - Selective breeding
 - Reducing movement
 - Killing animals when they are young
 - Reducing pests

Describe one example of primary succession resulting in a climax community.

- **Succession**
 - A natural directional change in species composition in a community of organisms over time.
- **Primary Succession**
 - Succession from bare earth/rock
 - Example: after a volcanic eruption
- **Secondary Succession**
 - Succession from a disturbed
 - Example: from a clear felling
- **Deflected Succession**
 - An area or habitat in which the influences of humans have prevented the ecosystem from developing further.
 - The ecosystem may have been stopped from reaching its full climatic climax or deflected towards a different climax by activities such as:
 - Leads to a Plagioclimax community.
 - Examples:
 - Cutting down the existing vegetation
 - Burning as a means of forest clearance
 - Planting of trees or crops
 - Grazing and trampling by domesticated animals
 - Harvesting of planted crops
- **Sere**
 - An intermediate stage in succession.

- **Stages of Primary succession**
 - Colonisers established on bare, rock / soil;
 - Give an example; (if not sand dunes)
 - ref to pioneer species;
 - organic matter builds up / humus content increases;
 - forming soil / depth of soil increases;
 - roots stabilise soil structure;
 - other species take over due to pioneer being outcompeted; **A** named example
 - a number of recognisable stages / seres / seral stages ;
 - one sere changes the conditions for the next ;
 - diversity of species increases;
 - climax eventually reached;
 - AVP; reference to deflected succession,

Describe how the distribution and abundance of organisms can be measured, using line transects, belt transects, quadrats and point quadrats.

- **Measuring distribution and abundance of an area**
- use grid and random numbers to generate co-ordinates
- throwing keys biased ; AW
- use of quadrat; e.g. 50 cm × 50 cm
- ref to how quadrat is placed; **R** random
- identify species/use of keys
- count number of plants / percentage cover of plants
- estimate, percentage cover / abundance ;
- point (frame) quadrat – ensure that bare ground is also recorded
- Record in a table
- may be single plants in some samples and many in others ;
- bigger study area / more data ;
- improves reliability / AW ;
- record other plants ;
- measure / note, abiotic variables ; **A** example

- **Measuring distribution – Line transects**
 - 1 lay, tape / string,
 - 2 ref to setting grid/area to be sampled;
 - 3 suitable systematic method chosen/ref line transect;
 - 4 ref to repetition of line transects;
 - 5 identify species/use of keys
 - 6 presence or absence along line

- **Measuring abundance – Belt transect**
 1. lay, tape / string,
 2. use of quadrat; e.g. 50 cm x 50 cm
 3. ref to how quadrat is placed; **R** random
 4. identify species/use of keys
 5. count number of plants / percentage cover of plants;
 6. plot a graph;
 7. repeat the transect;
 8. carry out statistical test (Mann-Whitney / Spearman's rank);
 9. AVP; e.g. detail of sampling technique

Describe the role of decomposers in the decomposition of organic material.

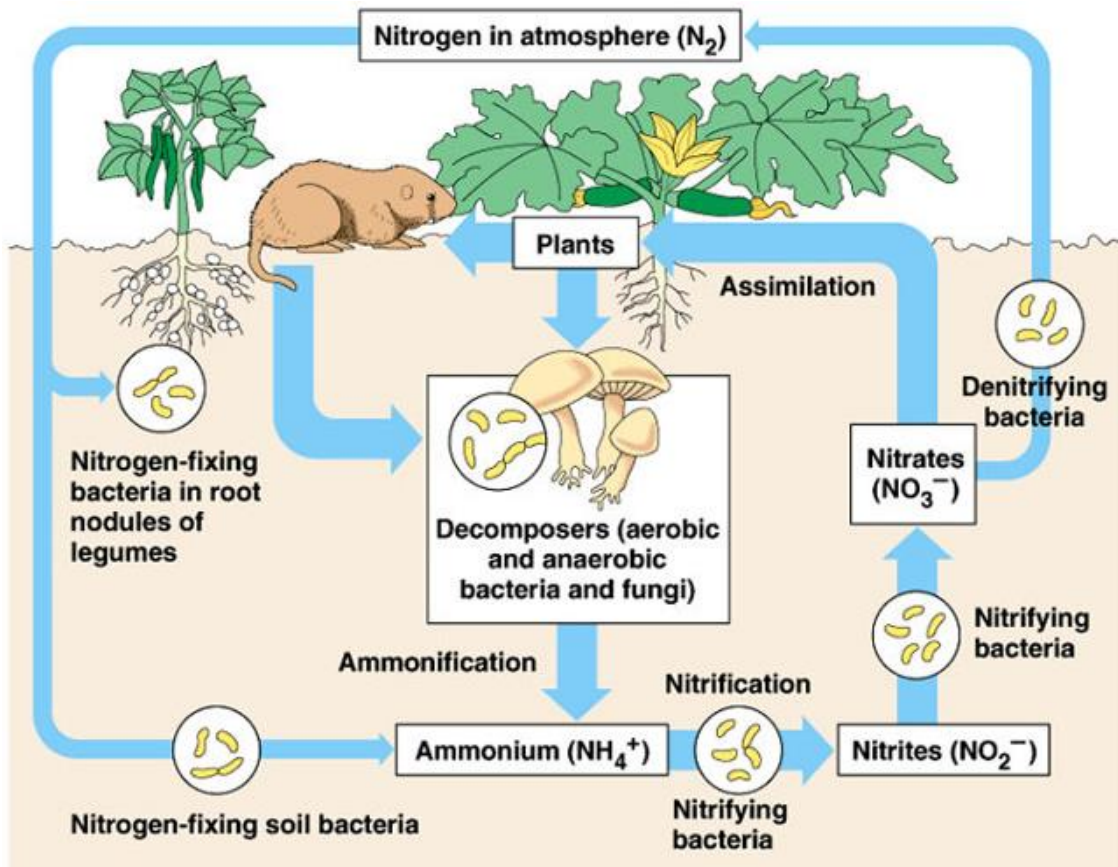
- Decomposer
 - Organisms that feed on dead organic matter, releasing molecules, minerals and energy that then become available to other living organisms in that ecosystems.

 - Saprotrophs
 - Secrete enzymes onto the dead organic matter, digestion takes places outside the decomposer and the digested material is then take in by the decomposer, although some remains in the ecosystem.

 - Bacteria & Fungi

- Their role in the decomposition of organic matter is very important
- Carbon availability
 - release of carbon dioxide;
 - from fungal respiration;
 - available for photosynthesis/carbon fixation;
- Nitrogen compounds availability
 - extracellular digestion;
 - named enzyme(s);
 - release of, inorganic substance/minerals/named mineral;
 - Rejected** *nutrients, nitrogen*
 - Accepted** *nitrogenous compound*
 - uptake through, roots/root hairs;
 - named use of mineral in plants;
 - ref. to humus;
 - ref. to beneficial role of humus in soil; e.g. increase water retention, improve soil structure, stabilize soil

Describe how microorganisms recycle nitrogen within ecosystems.



- **Nitrogen-Fixing Bacteria**
 - Fix Nitrogen gas (N_2) into nitrogen compounds
 - Can occur as free-living varieties or associated to Leguminous plants in their root nodules.

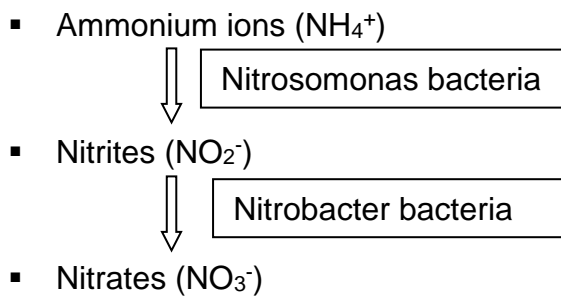
 - **Free-living varieties**
 - Conduct this conversion directly in the soil and the nitrogen compounds are readily available to all plants

 - **Leguminous plants**
 - **E.g.** Clover, Beans, Peas, Trefoil species
 - These plants form a mutualistic relationship with ***Rhizobium*** a type of nitrogen-fixing bacteria.
 - The plant provides the ***Rhizobium*** with glucose as a respiratory substrate and the ***Rhizobium*** provides the legume with nitrogen compounds.
 - The ***Rhizobium*** attaches to the roots of leguminous plants and the plant grows its roots over the bacteria forming root nodules.
 - These root nodules contain leghaemoglobin (a globular protein with an iron prosthetic group similar to haemoglobin).
 - The leghaemoglobin has an affinity for oxygen and so creates anaerobic conditions in the root nodule
 - This creates the ideal conditions for the ***Rhizobium*** to live.
 - The ***Rhizobium*** uses an enzyme known as nitrogen reductase which reduces Nitrogen gas (N_2) to ammonium ions (NH_4^+)

 - Nitrogen fixation can also occur without the use of bacteria in two ways
 - Naturally as a result of Lightning
 - Artificially as a result of the Haber process which makes artificial fertiliser of Ammonium ions (NH_4^+) and Nitrates (NO_3^-).

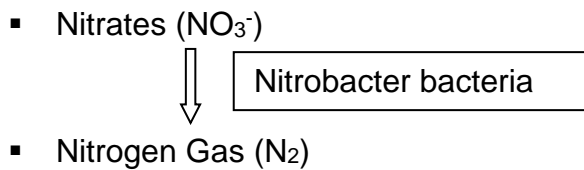
- **Nitrifying Bacteria**

- Chemoautotrophic bacteria absorb ammonium ions (NH_4^+)
- Obtain energy from oxidising ammonium ions (NH_4^+)
- Make nitrogen in ammonium ions available to plants as nitrate ions
- Occurs under aerobic conditions



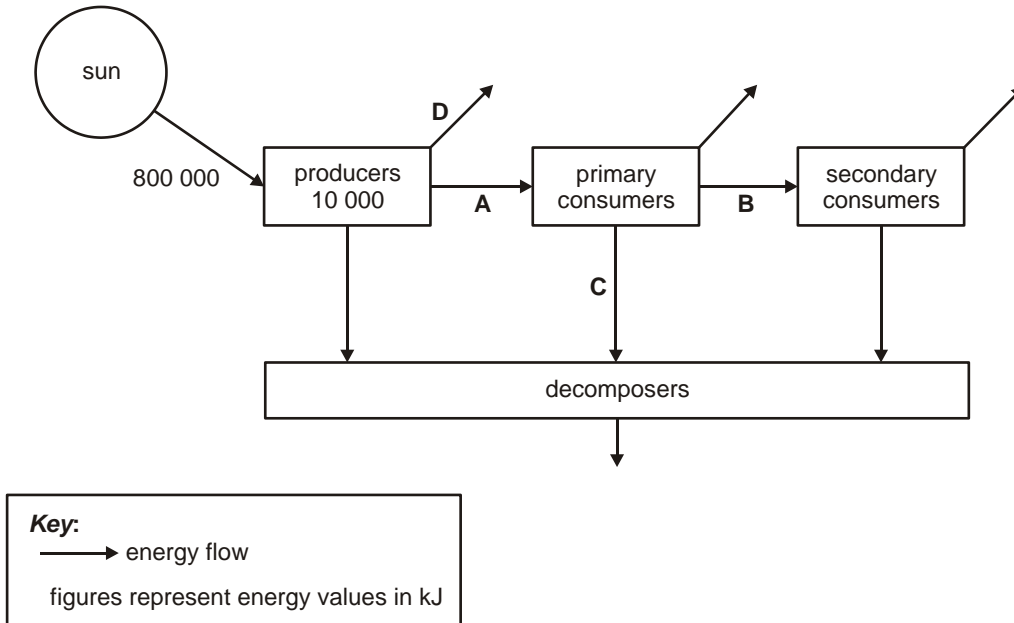
- **Denitrifying Bacteria**

- Convert Nitrates into nitrogen gas (N_2)
- This allows the nitrogen to cycle and not be locked in underground stores
- Occurs in waterlogged soils under anaerobic conditions as the bacteria use the nitrates as a source of oxygen.



Questions

1. The figure below represents the transfer of energy through a woodland ecosystem.



- (a) Of the 800 000 kJ of energy which reaches the producers, only 10 000 kJ of energy is converted to growth in the producers.
- (i) Calculate the percentage of the energy reaching the producers that is converted to growth in the producers. Show your working.

Answer = %

[2]

- (ii) Explain what happens to the energy reaching the producers that is **not** converted to growth.

.....

[2]

(iii) Name **one** decomposer.

.....

[1]

(iv) State two ways in which energy is transferred from primary consumers to decomposers at **C**.

1

2

[2]

(b) Suggest why the percentage energy transfer between producers and primary consumers at **A** is less than that between the primary consumers and secondary consumers at **B**.

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[3]

[Total 10 marks]

2. (a) Explain the meaning of the term *primary succession*.

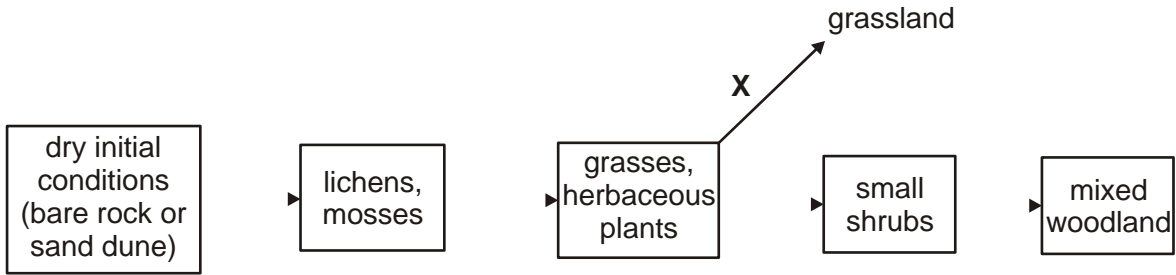
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[2]

5.3.1

The figure below shows a primary succession in a temperate climate.

X represents an example of deflected succession.



(b) Explain the role of pioneer plants in succession on a bare rock or sand dune.

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[3]

(c) Suggest two ways in which deflected succession at **X** could be caused.

1

.....

2

.....

[2]

(d) Explain how biomass changes during a **primary** succession.

.....
.....
.....
.....

[2]

[Total 9 marks]

3

(a) Plants rely on the cycling of nitrogen to supply them with nitrogen in a form that they can absorb.

Select, from the list, the most suitable word or term that matches the statements (i) to (iv) below.

- | | |
|-------------------------------|--------------------------|
| active transport | nitrogen fixation |
| denitrification | <i>Nitrobacter</i> |
| denitrifying bacterium | <i>Nitrosomonas</i> |
| diffusion | osmosis |
| endocytosis | <i>Rhizobium</i> |
| nitrification | |

(i) The conversion of nitrate ions into nitrogen gas.

.....

[1]

(ii) A bacterium that fixes nitrogen.

.....

[1]

(iii) A method by which nitrate ions pass into root hair cells.

.....

[1]

(iv) The conversion of ammonium ions into nitrite ions.

.....

[1]

(b) Before the widespread use of artificial fertilisers, farmers used a variety of methods to improve the fertility of the soil and so improve the yield of their crops. Two of the methods in common use were:

- **Ploughing-in**
In which legumes, such as beans, alfalfa or clover, were grown in a field and then harvested. The roots were then ploughed back into the soil rather than being dug up or burnt.
- **Crop rotation**
In which different crops were grown in a field in each year for three years. In the fourth year, the 'fallow' year, the field was not used for crops. In the following year the crop cycle was started again.

Explain how ploughing-in and crop rotation are able to improve the fertility of the soil.

Ploughing-in

.....
.....
.....
.....

Crop rotation

.....
.....
.....
.....

[4]

[Total 8 marks]

4

Primary succession is the simplest type of succession, beginning with a bare surface such as rock or sand. The first organisms to colonise the area form the pioneer community.

Describe **two** effects of the pioneer community on the habitat.

.....
.....
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.....

[Total 2 marks]

5.3.1

5

Chalk grassland communities are found in areas of southern England such as the South Downs. Woodland rather than grassland is the climax community for this habitat. Grazing by sheep and rabbits maintains the grassland.

- (i) Define the term *climax community*.

.....

[1]

- (ii) Suggest how grazing by sheep and rabbits could prevent a woodland climax community from developing.

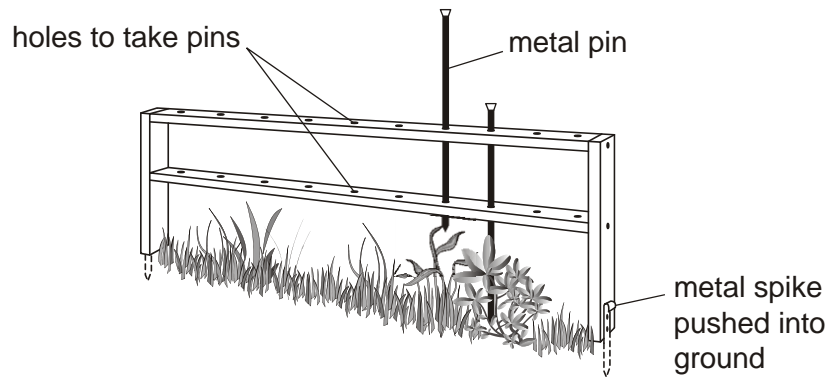
.....

[1]

[Total 2 marks]

6

A common plant found in chalk grassland communities is bird's foot trefoil. A group of students used a point quadrat to determine the percentage cover of bird's foot trefoil in an area of chalk grassland. They placed the point quadrat at one position on the grassland and lowered the metal pins, as shown in the figure below. They recorded the first hit on each species made with each pin. This was repeated at nine other randomly selected locations within the area of grassland. Their results are shown in the following table.



quadrat number	1	2	3	4	5	6	7	8	9	10
number of hits on bird's foot trefoil	3	8	7	8	9	3	2	1	2	1
number of hits on other species	16	21	20	13	16	21	24	16	20	28

5.3.1

An estimate of percentage cover for a species can be made by calculating the number of hits as a percentage of the total hits.

- (a) Using the results in the table above, calculate the percentage cover for bird's foot trefoil. Show your working and express your answer to the nearest 0.1%.

Answer =%

[2]

- (b) A footpath runs through the area of grassland and one student observed that very few bird's foot trefoil plants were found on the trampled areas.

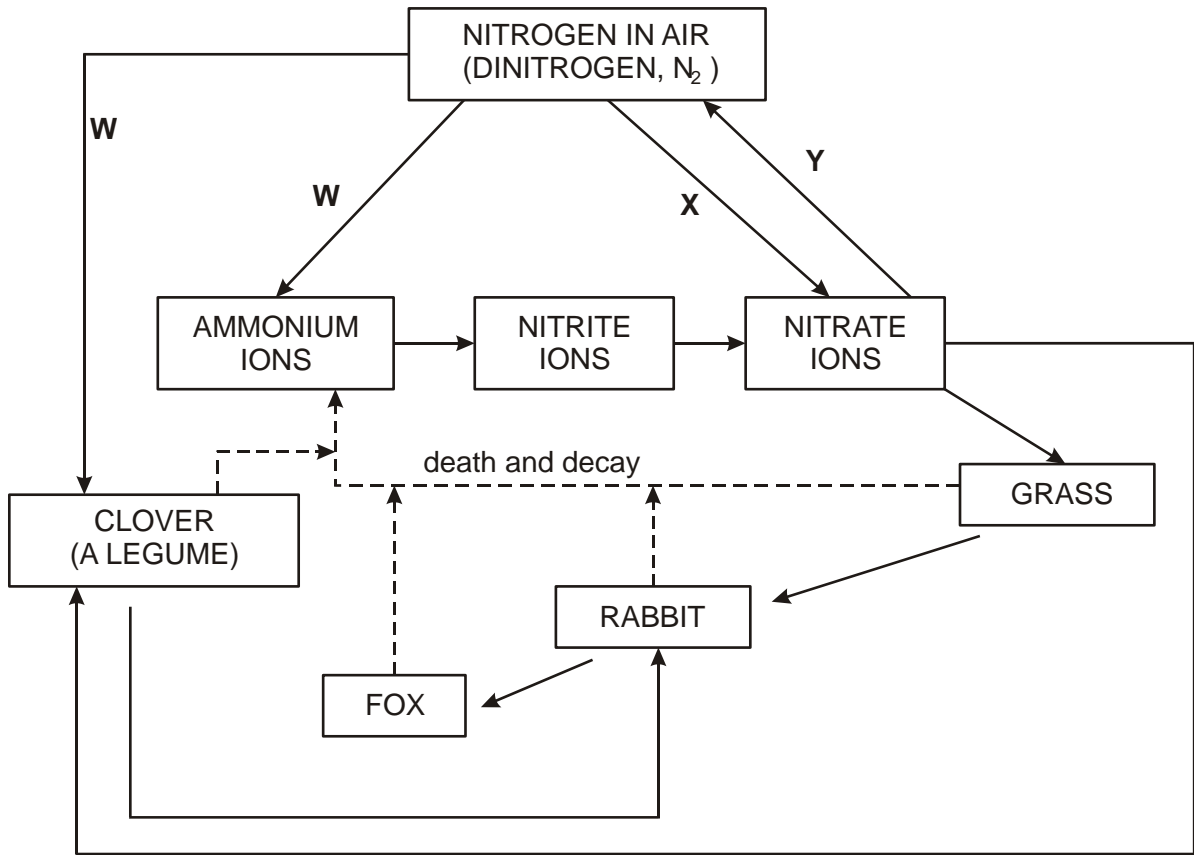
Explain how the students could use a transect to determine whether there is a link between trampling and the abundance of bird's foot trefoil on this footpath.

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[5]

[Total 7 marks]

The diagram below shows part of the nitrogen cycle.



(a) Using **only** the information in the diagram, state **one** example of each of the following:

(i) secondary consumer;

.....

[1]

(ii) producer.

.....

[1]

(b) (i) Name the process **W**.

.....

[1]

(ii) State a way in which nitrogen in air can be converted directly into nitrate ions, as indicated by arrow **X**.

.....

[1]

(iii) State the type of bacteria that carry out process **Y**.

.....

[1]

(iv) The bacterium *Rhizobium* also has a role in the cycle shown in the diagram. Explain the importance of *Rhizobium* in the nitrogen cycle.

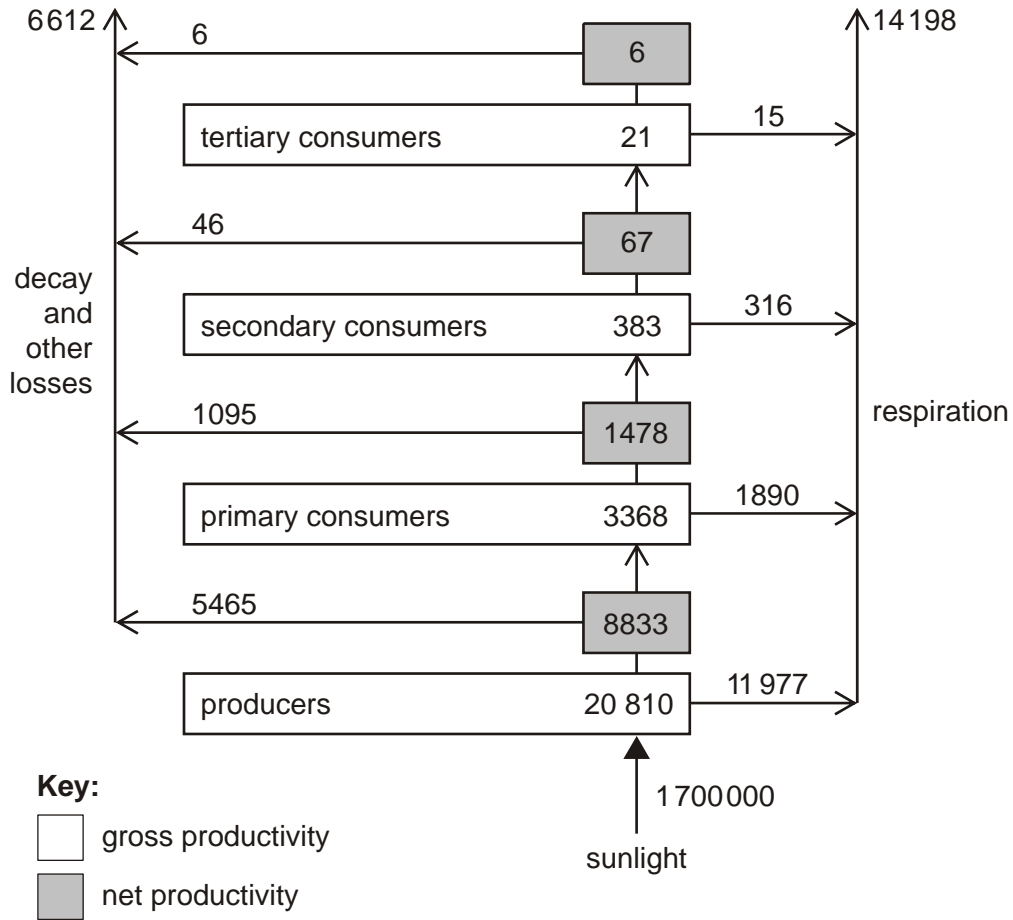
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[2]

[Total 7 marks]

In this question, one mark is available for the quality of spelling, punctuation and grammar.

The diagram below represents the energy flow through an ecosystem.



Explain how energy is transferred through food chains and food webs in an ecosystem. You should refer to the efficiency of this transfer in your answer. You will gain credit if you make use of the information in the diagram.

[9]

Quality of Written Communication [1]

[Total 10 marks]

