Edexcel IGCSE Biology

Topic 4: Ecology and the environment

Notes

(Biology only in bold)

The organism in the environment

Populations in ecosystems (4.1 and 4.2)

An individual is part of a species, but lives in its habitat within a population. Many different populations interact in the same habitat, creating a community. The populations are often dependent on each other. An ecosystem is the interaction of a community with non-living (abiotic) parts of the environment. Organisms are adapted to live in the conditions of their environment.

Practical: investigate the population size of an organism in two different areas using quadrats

- Quadrats are used to study ecology, as they make it easier to estimate distribution and abundance of organisms within a large area by looking at a few smaller representative samples.
- A transect is a defined area where the samples will be taken and is used to estimate the number of the organism across the whole area, such as across a whole field.
- The quadrats are placed along the transect and the amount of the chosen organism is counted.
- The quadrats can also be randomly placed across the whole area, rather than using a transect.
- Alternatively, percentage cover can also be estimated but this is subjective and less accurate than counting which gives a quantitative value.
- The accuracy of the quadrat estimations can be improved by doing more samples, repeat testing or completing the sampling over larger transects.

Biodiversity (4.3B and 4.4B)

Biodiversity is a measure of the range of species living within an ecosystem.

Practical: investigate the distribution of organisms in their habitats and measure biodiversity using quadrats

- Using the same method as above we can measure biodiversity, but instead of counting how many of a single organism is found in each quadrat, we count the populations of different species
- The reliability is improved by placing the quadrat randomly (e.g. using a random generator), using the same size quadrats each time, increasing the number of samples taken in each area

Abiotic and biotic factors (4.5)

Abiotic (non-living)	Biotic (living)
Light intensity Light is required for photosynthesis and the rate of photosynthesis affects the rate at which the plant grows. Also, plants can be food sources or shelter for many organisms.	Food availability More food means organisms can breed more successfully and therefore the population can increase in numbers
Temperature Temperature affects the rate of photosynthesis.	New predators
Moisture levels Both plants and animals need water to survive	New pathogens When a new pathogen arises, the population has no resistance to it so they can be wiped out quickly
Soil pH and mineral content Soil pH affects the rate of decay and therefore how fast mineral ions return to soil (which are then taken up by other plants). Different species of plants thrive in different nutrient concentration levels	Competition If one species is better adapted to the environment than another, then it will outcompete the other species, reducing the population of the less adapted species

Feeding relationships (4.6-4.9)

Trophic levels

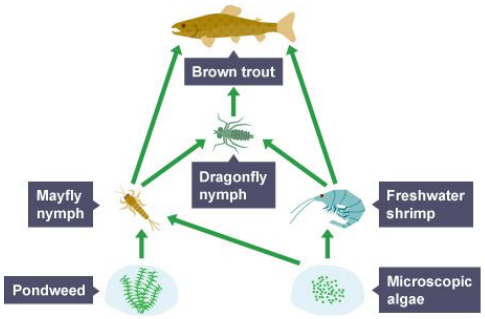
Trophic levels are the feeding levels in a food chain

Producers	Organisms that make their own food by photosynthesis, e.g. plants and algae
Primary consumers	Herbivores that only eat plants (producers)
Secondary consumers	Carnivores that eat primary consumers
Tertiary consumers	Carnivores that eat secondary consumers. They have no predators and so are called the apex predators
Decomposers	Bacteria and fungi that break down dead animal's body and waste for energy, using enzymes

Food chains and food webs

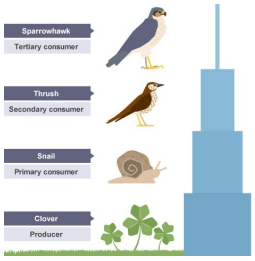
Food chains show the feeding relationships between organisms.They are organised by trophic levels.

Food webs are a collection of different food chains to show how all the organisms in the habitat interact, showing interdependence and therefore how population number changes can affect the entire ecosystem. On the right, you can see an example of a food web. You can see that if the population of microscopic algae reduces, then the freshwater shrimp population will decrease, but the mayfly nymph population is likely to remain the same as they can also consume pondweed.



Pyramids of numbers

- Shows the population of each organism at each trophic level of food chain
- Producers are at the bottom and bars usually get smaller the further up you go
- However, if the producer is a large plant, e.g. a tree, the size of the bar is very small as one tree can feed many insects (primary consumers)



Pyramids of biomass

Pyramids of biomass show the relative biomass at each trophic level.

- It shows the relative dry mass of material at each level.
- There is less biomass as you move up the trophic levels.
- Not all the food consumed by an animal is converted into biomass – this means the biomass of the organism in the level above another will always be lower, as not all the organism can be consumed and converted into biomass.

Energy transfer

Producers (e.g plants and algae) transfer about 1% of the incident energy from light for photosynthesis, as not all the light lands on the green (photosynthesising) parts of the plant.

Only approximately 10% of the biomass of each trophic level is transferred to the next, as:

- Not all biomass can be eaten.
    - Carnivores cannot generally eat bone, hooves, claws and teeth.
- Not all of the biomass eaten is converted into biomass of the animal eating it.
    - Lots of glucose is used in respiration, which produces the waste product carbon dioxide
    - Urea is a waste substance which is released in urine
    - Biomass consumed can be lost as faeces - herbivores do not have all the enzymes to digest all the material they eat, so it is egested instead

Efficiency of biomass transfers: (Biomass transferred to the next level / Biomass available at the previous level) x 100

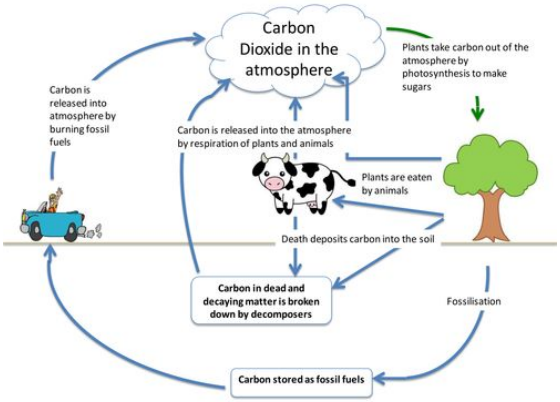
Because less biomass is transferred each time, it is common to have a limited number of trophic levels and to find less animals in the higher trophic levels.

Cycles within ecosystems

Carbon cycle (4.10)

Respiration

- Plants and animals aerobically respire, which releases CO_2 into the air
- Decomposers also respire while they break down compounds



Photosynthesis

- Plants remove CO_2 from the air through photosynthesis

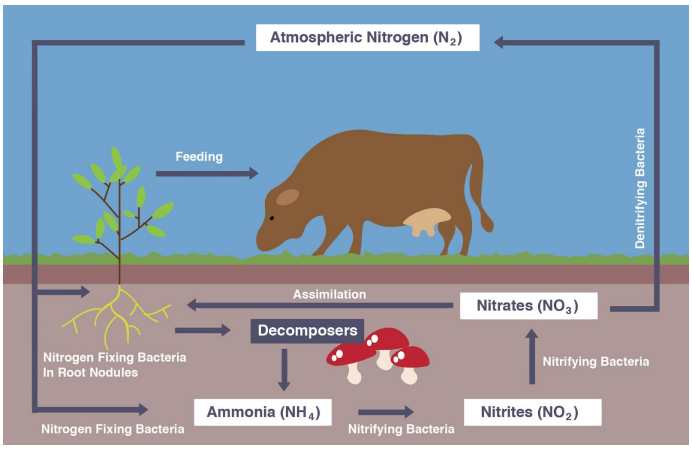
Decomposition

- Dead plants and animals are broken down by decomposers
- The carbon is then returned into the atmosphere

Combustion

- When plants and fossil fuels (remains of dead animals) are burnt, the carbon dioxide are released into the atmosphere

Nitrogen cycle (4.11B)



- **Nitrogen gas in the atmosphere is too unreactive so cannot be used directly by plants**
- **Nitrogen-fixing bacteria present in the root nodules of legume plants (e.g. peas) convert nitrogen gas into nitrates that can be used for growth**
- **Lightning can convert nitrogen gas into nitrates too.**
- **Decomposers (bacteria and fungi) break down the proteins in dead and decaying matter into ammonia.**

- **Nitrifying-bacteria convert the ammonia into nitrites and then nitrates. This process of nitrification requires oxygen**
- **Plants absorb nitrates through the roots by active transport**
- **Denitrifying bacteria convert nitrates into nitrogen gas. They work anaerobically and so thrive in waterlogged soil.**

Human influences on the environment

Air pollution (4.12)

Sulfur dioxide

- Released when fossil fuels are burnt
- Dissolves in water droplets in clouds to form dilute sulfuric acid which creates acid rain
- Acid rain makes rivers too acidic, which leads to aquatic organisms dying
- It corrodes metals and limestone in buildings
- It leeches minerals out of soil so plants and trees cannot survive

Carbon monoxide

- Released when fossil fuels are burnt through incomplete combustion
- Binds irreversibly to haemoglobin, which then reduces the oxygen carrying capacity of red blood cells
- This can lead to tiredness, unconscious or even death in severe cases
- In pregnant women, insufficient oxygen affects the growth of the foetus

Greenhouse gases (4.13 - 4.15)

Greenhouse gases: gases that absorb infrared radiation from the Sun, trapping it above the Earth's surface (greenhouse effect) which leads to the increase of the Earth's temperature (global warming)

Sources:

- Water vapour: from rivers, lakes
- Carbon dioxide: deforestation, fossil fuels
- Nitrous oxide**:** fertilisers, engines of vehicles
- Methane: cattle, rice paddy fields
- CFC: refrigerators, aerosol sprays

Effects of global warming

- Climate change
- Water levels will rise as glaciers melt from higher temperatures
- Loss of habitats
- Uninhabitable environments due to climate change means that some species will become extinct or they will migrate to more habitable areas

Biology consequences of pollution (4.16 and 4.17)

Pollution of water by sewage

- Sewage is rich in minerals and nutrients that will allow decomposers and algae to thrive
- Decomposers respire aerobically to break down sewage, which uses oxygen
- Sewage may also contain bacteria that also respire aerobically
- The algae bloom stops light from reaching aquatic plants, causing them to die
- These three lead to oxygen depletion, meaning that other aquatic organisms will die
- In sewage treatment works, a lot of oxygen is provided by stirring the waste of injecting jets

Leached minerals

- Eutrophication = when fertilisers are washed off from the land into nearby rivers and lakes by the rain
- The excess nutrients that are washed into the lakes encourages rapid growth of algae
- This algae blocks sunlight reaching the plants below, so they cannot photosynthesise leading to oxygen deprivation, as described in the previous paragraph.

Deforestation (4.18B)

Deforestation = the clearing of an area of trees on a mass scale

Effects

- **Leaching: trees normally take up nutrients and minerals from the soil to use for growth etc, so without trees, these run into rivers and lakes**
- **Soil erosion: tree roots help to stabilise the soil, so without trees, the soil will be washed away by the rain**
- **Disturbance to cycles: transpiration from trees release water vapour which contributes to the water cycle and the carbon cycles**
- **Imbalance in oxygen and carbon dioxide: removal and burning of trees will result in more atmospheric carbon dioxide levels and lower oxygen levels**