4 Ecology and the environment

Edexcel IGCSE Biology (Higher) DOUBLE AWARD - Question and answer notes

How to use these notes

For each question and answer:

- Read it carefully and make sure you **understand** it
- **Memorise** the answer
- **Practice** applying your understanding to past exam questions

You can memorise the answers by using **retrieval practice** - which is when you practise retrieving information from your memory. This can be done using flashcards or a flashcard app, by asking someone to quiz you, or by covering up the answers with a piece of paper and testing yourself. Past paper practice can also be a form of retrieval practice.

4a The organism in the environment

Define habitat
The place where an organism lives

Define population
All the organisms of one species in a habitat

Define community
All the organisms of all species in a habitat

Define ecosystem
An ecosystem is a system made up of:

- A habitat
- All of the organisms living in the habit (the community)
- The interactions between the organisms (biotic factors)
- The interactions the organisms have with their physical environment (abiotic factors)

What are biotic factors?
Ways in which living organisms are affected by other living organisms.

Give five examples of biotic factors

- Infectious diseases
- Predators
- Availability of food
- Competition for resources
- Pollination

What are abiotic factors?
Ways in which living organisms are affected by non-living aspects of their environment.

Give five examples of abiotic factors

- Temperature
- Humidity
- Soil pH
- Concentration of nitrates in soil
- Light intensity

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What is biodiversity?
Biodiversity is the variety of different species of organisms living in a habitat.

4b Feeding relationships

What are trophic levels?
The different positions that organisms occupy within food chains - such as producer, primary consumer, secondary consumer and tertiary consumer

What is a producer?
An organism that produces food through photosynthesis (e.g. plants, algae, some bacteria)

What is a primary consumer?
An organism that eats producers.

What is a secondary consumer?
An organism that eats primary consumers.

What is a tertiary consumer?
An organism that eats secondary consumers.

What is a decomposer?
An organism that breaks down dead material and waste.

What types of organisms do decomposers tend to be?
Fungi and bacteria.

What types of material do decomposers break down?

- Dead bodies of animals
- Dead plants
- Fallen leaves
- Faeces

What happens to dead material that is broken down by decomposers?

- As decomposers break down dead material, nutrients are released from the dead material (for example, sugars, amino acids and fatty acids).
- Some of these nutrients are absorbed by the decomposers and used as their food.
- Some of the nutrients are released into the environment - for example, into the soil - where they can be absorbed by plants, which may then be eaten by primary consumers.

What is a food chain? How do you draw a food chain?

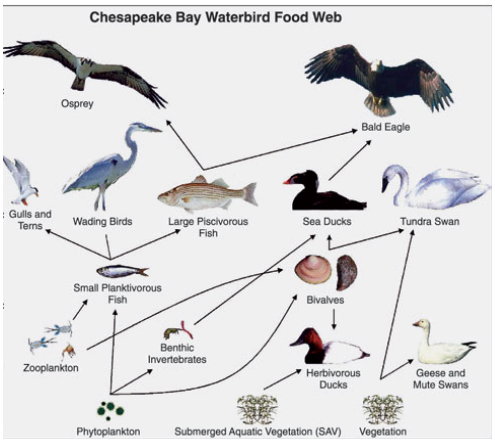
- A food chain is a diagram showing a series of organisms that feed on each other.
- A food chain starts with a producer, then goes on to a primary consumer and so on.
- To draw a food chain, write the names of the organisms in the order in which they eat each other.
- Then connect them with arrows, with each arrow going from the organism that is eaten and to the organism that eats it.

EXAMPLE:

Grass ---> Rabbit ---> Fox ---> Wolf

What is a food web?
A food web is a diagram showing how multiple different food chains connect together.

EXAMPLE: (Note: you do not usually need to draw pictures of the organisms when drawing a food chain or food web - just write their names)



What is a pyramid of numbers? How do you draw one?
A pyramid of numbers is a diagram showing the population size (number of individuals) of each species in a food chain. To draw a pyramid of numbers:

- Draw a set of rectangles stacked directly on top of each other. The bottom rectangle represents the producer, the next one up represents the primary consumer, and so on.
- Make all of the rectangles the same height.
- Make the width of each rectangle proportional to the population size of that organism.
- Centre the rectangles on each other horizontally (in other words, make sure the middles of all the rectangles are directly on top of each other).
- Label each rectangle with the name of the organism that it represents.

What is a pyramid of biomass? How do you draw one?
A pyramid of biomass is a diagram showing the mass of living material of each species within a food chain.

To draw one, follow the same steps as drawing a pyramid of numbers, but make the widths of the rectangles proportional to the biomass of each species rather than the population size.

What is a pyramid of energy transfer?
A pyramid of energy transfer is a diagram showing the amount of energy in each species within a food chain.

To draw one, follow the same steps as drawing a pyramid of numbers, but make the widths of the rectangles proportional to the amount of energy in each species rather than the population size.

What do pyramids of numbers typically show?
Pyramids of numbers typically show that the population size gets smaller as you move along the food chain.

What do pyramids of biomass typically show?
Pyramids of biomass typically show that the amount of biomass gets smaller as you move along the food chain.

Why does the amount of biomass typically get smaller as you move along the food chain?
Whenever an organism eats another organism, only some of the biomass is passed on. Reasons for this include:

- Not all parts of the organism are eaten (e.g. bones or woody stems may not be eaten).
- Not all parts that are eaten are fully digested (e.g. many animals cannot digest cellulose).
- The organism that is eaten has already used some of its biomass in respiration, forming carbon dioxide which has diffused into the atmosphere, removing biomass.
- The organism that is eaten has already lost some of its biomass in the form of faeces or fallen leaves.

What do pyramids of energy typically show?
Pyramids of energy typically show that the amount of energy in the organisms gets smaller as you move along the food chain.

What proportion of the energy is typically passed on when an organism is eaten?
Around 10%

Why is only around 10% of energy transferred from one trophic level to the next?
Only around 10% of energy is transferred from one trophic level to the next because:

- Not all parts of the organism are eaten (e.g. bones or woody stems may not be eaten).
- Not all parts that are eaten are fully digested (e.g. many animals cannot digest cellulose).
- The organism that is eaten has already carried out respiration, which converts some energy to heat, which is then dissipated into the environment.
- The organism that is eaten has already used some of the energy for growth and movement.

4c Cycles within ecosystems

What is the carbon cycle?
The carbon cycle is a connected set of processes that move carbon around between different parts of the living and non-living world.

What are the different types of molecules that carbon can be found in?

- Carbon dioxide molecules in the air (and water)
- Biological molecules within living organisms (e.g. carbohydrates, proteins, lipids, DNA)
- Biological molecules within dead organisms and waste (e.g. fallen leaves, faeces)
- Nutrient molecules in the soil
- Hydrocarbon molecules within fossil fuels

What are the main processes in the carbon cycle?

- Respiration
- Photosynthesis
- Decomposition
- Combustion (burning)

What is the role of respiration in the carbon cycle?

- All living organisms carry out respiration.
- During respiration, food molecules such as sugars are broken down. This produces carbon dioxide gas.
- The carbon dioxide gas then diffuses out of the organism and into the air (or into the water if the organism lives under water).
- This decreases the amount of carbon atoms that are in biological molecules in living organisms, and increases the amount of carbon atoms that are in carbon dioxide molecules in the air (and water).

What is the role of photosynthesis in the carbon cycle?

- Photosynthesis is carried out by photosynthetic organisms such as plants, algae and some bacteria.
- During photosynthesis, carbon dioxide from the air (or water) is absorbed by the photosynthetic organism and incorporated into sugars and other biological molecules.
- This decreases the amount of carbon atoms that are in carbon dioxide molecules in the air (and water), and increases the amount of carbon atoms that are in biological molecules in living organisms

What is the role of decomposition in the carbon cycle?

- Decomposition is carried out by decomposers such as bacteria and fungi.
- As decomposers break down dead organisms and waste, they release nutrient molecules into the soil
- This decreases the amount of carbon atoms that are in biological molecules in dead organisms and waste, and increases the amount of carbon atoms that are in nutrient molecules in the soil

What is the role of combustion (burning) in the carbon cycle?

- Combustion is burning. This includes the burning of fossil fuels, as well as the burning of biomass - for example wood.
- During combustion, carbon atoms from the fuel combine with oxygen atoms from the air to form carbon dioxide gas, which then enters the air.
- This reduces the amount of carbon atoms that are in fossil fuels or biomass, and increases the amount of carbon atoms that are in carbon dioxide molecules in the air.

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What is the nitrogen cycle?

The nitrogen cycle is a connected set of processes that move nitrogen around between different parts of the living and non-living world.

What are the different types of molecules that nitrogen can be found in?

- Nitrogen gas in the air
- Proteins, amino acids and DNA in living organisms
- Ammonia
- Urea
- Nitrate in the soil

What types of microorganisms are involved in the nitrogen cycle?

- Nitrogen fixing bacteria
- Decomposers
- Nitrifying bacteria
- Denitrifying bacteria

What are nitrogen fixing bacteria and what do they do in the nitrogen cycle?

- Nitrogen fixing bacteria are a type of bacteria that live in the soil and in the roots of some plants.
- They convert nitrogen gas from the air into nitrogen-containing compounds that plants then absorb through their roots.
- Plants use these nitrogen-containing compounds to make proteins, amino acids and DNA.

What role do decomposers play in the nitrogen cycle?

- When decomposers break down dead plants and animals, they break down proteins to produce ammonia, which they release into the soil.
- When decomposers also break down urea found in animal waste into ammonia.

What role do nitrifying bacteria play in the nitrogen cycle?

- Nitrifying bacteria convert ammonia in the soil into nitrite.
- They then convert this nitrite into nitrate.

- This nitrate can then be absorbed by plants through their roots.

What role do denitrifying bacteria play in the nitrogen cycle?

- Denitrifying bacteria convert nitrate from the soil into nitrogen gas, which enters the air.

4d Human influences on the environment

How does human activity increase the concentration of sulfur dioxide gas in the atmosphere?
When humans burn fossil fuels, sulfur impurities in the fossil fuels react with oxygen gas in the air to form sulfur dioxide gas.

How does an increased concentration of sulfur dioxide gas in the atmosphere affect living things?

- Sulfur dioxide gas dissolves in clouds to form sulfuric acid.
- This sulfuric acid then falls from the clouds as acid rain.
- Acid rain can kill trees.
- Acid rain can cause a lake to become more acidic, which can cause plants and animals living in the lake to die.

How does human activity increase the concentration of carbon monoxide gas in the atmosphere?
When humans burn fossil fuels without enough oxygen present, incomplete combustion takes place, which produces carbon monoxide gas. This happens in the engines of cars that use fossil fuels (e.g. petrol and diesel cars).

How does an increased concentration of carbon monoxide gas in the atmosphere affect living things?

- Carbon monoxide is a poisonous gas.
- When animals breathe it in, the carbon monoxide molecules bind to haemoglobin molecules in their red blood cells.
- This prevents oxygen from binding to the haemoglobin, which reduces the ability of the red blood cells to transport oxygen around the body.
- This means the animal does not have enough oxygen for aerobic respiration, meaning the animal cannot release enough energy to meet its needs.

What are greenhouse gases?
Gases that trap heat within the Earth's atmosphere.

Name five greenhouse gases

- Carbon dioxide
- Methane
- Nitrous oxide
- Water vapour
- CFCs

In what ways do human activities lead to increased concentrations of greenhouse gases in the Earth's atmosphere?

- Humans burn fossil fuels, which releases carbon dioxide.
- Humans cut down forests (deforestation), removing trees that would have otherwise removed carbon dioxide from the atmosphere through photosynthesis.
- Humans farm cows and rice, both of which release methane (though cows release a lot more).
- Methane is released during the extraction and processing of fossil fuels.
- Humans place waste in landfills, where it decomposes, which releases methane.
- Humans spread fertilisers on farmland, which are then broken down by soil bacteria. This releases nitrous oxide.
- Humans used to use CFCs in aerosol sprays and refrigerators. CFCs have been banned worldwide because it was found that they were damaging the Earth's ozone layer (unrelated to their role as greenhouse gases). However, some are still released as leaks from old refrigerators and other equipment.

What are the consequences of increased greenhouse gas concentrations in the Earth's atmosphere?
Greenhouse gases trap heat, causing the temperature of the Earth's atmosphere to increase. This is called global warming.

Consequences of global warming include:

- Rising sea levels
- More extreme weather events, such as heatwaves, wildfires, floods and droughts
- Damage to coral reefs
- Loss of habitats
- Disrupted animal migration

What is sewage?
Sewage is the wastewater that comes from homes and businesses including the material that it contains, such as faeces, food waste and detergents.

How does sewage cause pollution and what are its consequences?
Sewage causes pollution if it is released into habitats such as rivers and lakes. As bacteria decompose the sewage, they use up all the oxygen in the water (through aerobic respiration). This leads to the death of aquatic animals such as fish.

What is eutrophication?
Eutrophication is when fertiliser enters a body of water such as a lake or pond and leads to a series of changes that ultimately causes fish and other aquatic animals to die.

What are the steps by which eutrophication happens?

- Farmers spread fertiliser on their fields.
- Rain washes some of the fertiliser into a lake or other body of water.
- The extra nutrients from the fertiliser cause algae to grow and reproduce quickly, causing them to cover the surface of the water, preventing light from entering the water.
- Without light, plants living under the water cannot photosynthesise, meaning that they die.
- Bacteria decompose the dead plants and in the process they use up all the oxygen in the water.
- Due to the lack of oxygen, fish and other animals living in the water die.

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What is deforestation?
Deforestation is the large-scale removal of trees by humans.

Why do humans carry out deforestation?

- To clear land for agriculture (growing food)
- To obtain wood

What are the negative effects of deforestation?

- Leaching
- Soil erosion

- Disruption to evapotranspiration
- Disruption to the carbon cycle and the balance of gases in the atmosphere

What is leaching and how does deforestation cause it?

- Leaching is when nutrients from the soil are washed away by rain water.
- When trees are present, they absorb the nutrients from the soil and also stabilise the soil, both of which prevent leaching.
- Therefore, removing trees leads to an increase in leaching.

What is soil erosion and how does deforestation cause it?

- Soil erosion is when the top layer of the soil is removed - for example, washed away by rain water or blown away by wind.
- Tree roots hold the soil together, preventing soil erosion.
- Therefore, removing trees leads to an increase in soil erosion.

What is evapotranspiration and how does deforestation disrupt it?

- Evapotranspiration is the combination of:
    - Evaporation of water from the Earth's surface (e.g. from the soil, from lakes and rivers etc.) into the atmosphere.
    - Transpiration - the evaporation of water out of plants
- Evapotranspiration creates humidity and clouds in the atmosphere, leading to rain. This makes it an important part of the water cycle.
- When trees are removed, this reduces the amount of evapotranspiration, which can lead to less rainfall, which can cause droughts.

How does deforestation disrupt the carbon cycle and the balance of gases in the atmosphere?

- When trees are growing, they absorb carbon dioxide from the atmosphere and use it to make carbon-containing compounds that form part of the trees themselves.
- Therefore, as trees grow they remove carbon from the atmosphere and lock it away within themselves.
- Trees also produce oxygen through photosynthesis and release it into the atmosphere.
- Removing trees will mean that less carbon dioxide is removed from the atmosphere and less oxygen is released into the atmosphere.
- If the trees that are removed are burned, this releases carbon dioxide into the atmosphere.