MEGA LECTURE

AQA Biology GCSE

Topic 7: Ecology

Notes

Content in bold is for higher tier only.
Content is for both separate science and double award students unless indicated in heading.

Adaptations, Interdependence and Competition (7.1)

Communities (7.1.1)

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.

Organisms which need the same resources compete for it.

- There can be **competition** within a species or between different species.
- Plants may compete for light, space, water and mineral ions.
- Animals may compete for space, food, water and mating partners.

Interdependence describes how organisms in a community depend on other organisms for vital services.

- These include for food, shelter and reproduction (pollination, seed dispersal), e.g. birds take shelter in trees, flowers are pollinated with the help of bees.
- The removal or addition of a species to the community can affect the populations of others greatly, as it changes prey or predator numbers
- A stable community is one where all the biotic (living) and abiotic (non-living) factors are in balance.
    - As a result the population sizes remain roughly constant.
    - When they are lost it is very difficult to replace them.
    - Examples include tropical rainforests, oak woodlands and coral reefs.

Abiotic Factors (7.1.2)

An abiotic factor is a non-living factor. You need to be able to explain the effect of a change in an abiotic factor.

Abiotic factors which can affect a community:

1. **Light intensity**
    - Light is required for photosynthesis.
    - The rate of photosynthesis affects the rate at which the plant grows.
    - Plants can be food sources or shelter for many organisms.
2. **Temperature**
    - Temperature affects the rate of photosynthesis.
3. **Moisture levels**
    - Both plants and animals need water to survive.
4. **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.

5. **Wind intensity and direction**
    - Wind affects the rate of transpiration (movement of water from root to leaves) in plants.
    - Transpiration affects the temperature of the plant, and the rate of photosynthesis because it transports water and mineral ions to the leaves.
6. **Carbon dioxide levels**
    - CO_2 affects the rate of photosynthesis in plants.
    - It also affects the distribution of organisms as some thrive in high CO_2 environments.
7. **Oxygen levels for aquatic animals**
    - Levels in water vary greatly, unlike oxygen levels in air.
    - Most fish need a high concentration of oxygen to survive.

Biotic Factors (7.1.3)

A **biotic factor** is a living factor. You need to be able to explain the effect of a change in a biotic factor.

Biotic factors that can affect a **community**:

1. **Food availability**: more food means organisms can breed more successfully and therefore the population can increase in numbers
2. **New predators**
3. **New pathogens**: when a new pathogen arises the population has no resistance to it so they can be wiped out quickly
4. **Competition**: if one species is better adapted to the environment than another, then it will outcompete it until the numbers of the lesser adapted species are insufficient to breed.

Adaptations (7.1.4)

Organisms have adaptations that allow them to survive in the conditions where they live.

1. **Structural**: shape or colour of a part of an organism, e.g.
    - Sharp teeth of a carnivore to tear meat apart
    - Camouflage, such as the tan/brown colour of a lionesses coat, to avoid prey from spotting her
    - Species in cold environments may have a thick layer of fat for insulation
2. **Behavioural**: the way an organism behaves, e.g.
    - Individuals may play dead to avoid predators
    - Basking in the sun to absorb heat
    - Courting behaviour to attract a mate
3. **Functional**: involved in processes such as reproduction and metabolism
    - Late implantation of embryos
    - Conservation of water through producing little sweat

Extremophiles live in environments which have extreme conditions. These include high temperatures, pressures or salt concentrations. An example is bacteria which live in deep sea vents where the pressure is very high.

Examples of adaptations for different scenarios:

1. Cold climates: Smaller surface area to volume ratio to reduce heat loss, lots of insulation (blubber, fur coat)
2. Dry climates: Adaptations to kidneys so they can retain lots of water producing very concentrated urine, being active in the early morning and evenings when it is cooler, resting in shady areas, larger surface area ratio to increase heat loss
3. Examples of plant adaptations: Curled leaves to reduce water loss, extensive root systems to take in as much water as possible, waxy cuticle to stop water evaporating, water storing tissue in stem

Organisation of an Ecosystem (7.2)

Levels of Organisation (7.2.1)

Feeding relationships are shown by food chains.

1. They begin with a **producer**.
    - These are always photosynthetic organisms (usually a green plant or algae)
    - Through photosynthesis they make glucose
    - Glucose is used to make other biological molecules in the plant, which make up the biomass
2. Producers are eaten by **primary consumers** – energy is transferred through organisms in an ecosystem when one is eaten by another.
3. Primary consumers are eaten by **secondary consumers** – The animals eaten are called the prey and the consumers that kill and eat them are predators.
4. Secondary consumers are eaten by **tertiary consumers**.

To work out the distribution and abundance of species in an ecosystem, tools called **transects** and **quadrats** are used. You can then process this information by calculating the mean, mode and median and then drawing a graph.

A stable community will show population cycles between the predators and prey.

- If the population of prey increases, the population of predators will also increase.
- This will result in the number of prey decreasing after some time as more would be consumed by the increased number of predators.
- When there isn't enough prey to feed all the predators, the population of predators will decrease, which will allow the population of prey to increase again.

How Materials are Cycled (7.2.2)

Lots of different materials are cycled through an ecosystem. The carbon and water cycles are vital for life on Earth.

The Carbon Cycle

- CO_2 is REMOVED from the air in photosynthesis by green plants and algae – they use the carbon to make carbohydrates, proteins and fats. They are eaten and the carbon moves up the food chain.
- CO_2 is RETURNED to the air when plants, algae and animals respire. Decomposers (a group of microorganisms that break down dead organisms and waste) respire while they return mineral ions to the soil.
- CO_2 is RETURNED to the air when wood and fossil fuels are burnt (called combustion) as they contain carbon from photosynthesis.

The Water Cycle

- The sun's energy causes water to evaporate from the sea and lakes, forming water vapour.
- Water vapour is also formed as a result of transpiration in plants.
- Water vapour rises and then condenses to form clouds.
- Water is returned to the land by precipitation (rain, snow or hail), and this runs into lakes to provide water for plants and animals.
- This then runs into seas and the cycle begins again.

Decomposition (7.2.3 - Biology Only)

A number of factors affect the rate of decomposition.

1. Temperature: Chemical reactions generally work faster in warmer conditions, but if it is too hot the enzymes can denature and stop decomposition.
2. Water: Microorganisms grow faster in conditions with water as it is needed for respiration. Water also makes food easier to digest.
3. Availability of oxygen: Most decomposers respire aerobically.

Compost

- When biological material decays it produces this.
- It is used by gardeners and farmers as a natural fertiliser.
- To do this they have to provide optimum conditions for decay.
    - If more oxygen is available they respire aerobically, producing heat.
    - The increased temperature increases the rate of decay so the compost is made quicker.

Methane gas

- Microorganisms decompose waste anaerobically to produce methane gas.
- This can be burnt as a fuel.

- **Biogas generators** are used to produce methane.
    - Require a constant temperature (30 degrees) so the microorganisms keep respiring.
    - It cannot be stored as a liquid so needs to be used immediately.

You can investigate the effects of temperature on decay by measuring the pH change of fresh milk in the presence of the enzyme lipase.

- Make a solution of milk and phenolphthalein indicator.
- Add sodium carbonate which will cause the solution to become alkaline and therefore appear pink.
- Place the tube in a water bath at a specific temperature.
- Add the lipase enzyme and begin stopwatch.
- Time how long it takes for the pink colour to disappear (i.e. when the pH has decreased).
- Repeat this at different temperatures to see at which temperature the pink colour disappears the quickest, indicating the quickest decomposition.

Impact of Environmental Change (7.2.4 - Biology Only)

Environmental changes affect the distribution of species in an ecosystem:

- **Temperature: Climate change may lead to insects migrating to places in the world which are becoming hotter**
- **Water availability: Populations will migrate to find water**
- **Atmospheric gas composition: Certain pollutants can affect the distribution of organisms, e.g lichen cannot grow in places where sulfur dioxide is present.**

These changes may be seasonal, geographic or caused by human interaction.

Biodiversity and the Effect of Human Interaction on Ecosystems

Biodiversity (7.3.1)
Waste Management (7.3.2)

Biodiversity: the variety of different species of organisms on Earth or within an ecosystem.

High biodiversity means the ecosystem will be stable.

- Biodiversity means that species are less dependent on each other for things such as food and shelter.

Many human activities are having a negative effect on biodiversity.

The future of humans on Earth depends on maintaining biodiversity – for example for food and new medicines.
The impact of our activities is getting bigger as the population is increasing, as more resources are being used and more waste is being produced.

- More land is being used for houses, farming, shops, roads and factories, which destroys habitats.
- Pollution kills plants and animals.
    - Sewage, fertiliser and toxic chemicals pollute the water.
    - Smoke and acidic gases pollute the air.
    - Landfill and toxic chemicals can result in the pollution of the land.
- We are using up raw materials quicker than they are being produced.

Humans have only recently tried to reduce their impact.

Land Use (4.7.3.3)

Humans take up land and therefore reduce the number of habitats for animals and plants by building, quarrying (cutting into ground to obtain stone and other materials), farming and dumping waste.

Peat bogs

- Peat is a material that forms when plant material has not fully decayed as there is not enough oxygen.
- It accumulates in bogs that are acidic and waterlogged.
- These bogs are a habitat for many species, in particular for migrating birds
- Peat bogs are being destroyed – they are being drained in order to create space for farming, peat is used as compost, or dried to use as fuel as it contain carbon (releasing CO_2 into the atmosphere).
- It is being used up quicker than it is being formed, as the formation process is slow.

Deforestation (7.3.4)

Deforestation: the cutting down of a large number of trees in the same area, in order to use the land for something else.

It happens in tropical areas to:

- Provide land for cattle and rice fields
- To grow crops (e.g. sugarcane, maize) for biofuels which are used to produce energy

The problems caused by deforestation:

1. As trees contain carbon, burning them results in more CO_2 being released into the environment which contributes to global warming. Following deforestation, microorganisms decompose the dead vegetation, producing CO_2 as they respire.

2. Trees take in CO_2 when they photosynthesise, so less trees means less CO_2 is taken in.
3. The number of habitats are reduced, decreasing biodiversity.

Global Warming (7.3.5)

The term **global warming** refers to the fact that the temperature around the world is increasing. This is because we are producing more **greenhouse gases** (carbon dioxide and methane), resulting in more heat being absorbed and reflected back to Earth, heating it up.

The consequences of this temperature increase are:

- Melting of the ice caps, reducing habitats
- Rising sea levels, reducing habitats as low lying areas will be flooded with salty water
- Temperature and rainfall levels will affect migration and therefore the distribution of different species, as they may no longer be able to survive where they live
- Organisms will become extinct as their habitats are lost, reducing biodiversity

Maintaining Biodiversity (7.3.6)

Positive human interactions with ecosystems	Negative human interactions with ecosystems
Maintaining rainforests, ensuring habitats here are not destroyed.	Production of greenhouse gases leading to global warming.
Reducing water pollution and monitoring the changes over time.	Producing sulfur dioxide in factories which leads to acid rain – affects habitats.
Preserving areas of scientific interest by stopping humans from going there.	Chemicals used in farming leak into the environment.
Replanting hedgerows and woodlands to provide habitats which were previously destroyed.	Clearing land in order to build on, reducing the number of habitats.

To reduce our negative impact on ecosystems, programs have been put in place to maintain biodiversity.

1. Breeding programs: to stop endangered species from becoming extinct.
2. Protection of rare habitats: to stop the species here from becoming extinct, if damaged they may even be regenerated to encourage populations to live here
3. Reintroduction of hedgerows and field margins around land where only one type of crop is grown: maintains biodiversity as the hedgerows provide a habitat for lots of organisms (because a field of one crop would not be able to support many

organisms) and field margins provide areas where wild flowers and grasses can grow.

4. Reduction of deforestation and carbon dioxide production: reduces the rate of global warming, slowing down the rate that habitats are destroyed
5. Recycling rather than dumping waste in landfill: reduces the amount of land taken up for landfills, and slows the rate we are using up natural resources.

Trophic Levels in an Ecosystem (7.4)

Trophic Levels (7.4.1)

Trophic levels are the different stages in the food chain. They are represented by numbers.

1. Level 1
   - Organisms at the first level are called producers such as plants and algae.
   - They make their own food by photosynthesis.
2. Level 2
   - Organisms at the second level are called primary consumers.
   - These are herbivores that only eat plants.
3. Level 3
   - Organisms at the third level are called secondary consumers.
   - These are carnivores and they eat herbivores.
4. Level 4
   - Organisms at the fourth level are called tertiary consumers.
   - These are carnivores that eat other carnivores.
   - They have no predators and are at the top of the food chain – called **apex predators**.

Decomposers break down dead plant and animal matter.

- They do this by secreting enzymes
- The matter is broken down into small soluble food molecules and they move into the microorganism by diffusion.

Pyramids of Biomass (7.4.2)

Transfer of Biomass (7.4.3)

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

- It shows the relative weights 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 higher, as not all the organism can be consumed and converted into biomass.

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.

- 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 find less animals in the higher trophic levels.

Food Production (7.5 - Biology Only)

Factors Affecting Food Security (7.5.1)

Food security: having sufficient food to feed the population

Factors which affect it:

1. Increasing birth rate means more food is required.
2. Changing diets in developed countries means food resources which are already in low amounts become even more scarce as the demand for them increases.
3. New pests and pathogens can destroy crops.
4. Climate change affects food production (such as no rain resulting in crops failing).
5. Conflicts in some countries can affect the availability of water and food.

To feed everyone on Earth sustainable methods are needed.

Farming Techniques (7.5.2)

- Farmers aim to increase the amount of energy (from food) that is converted to biomass in livestock because this is more efficient.
- This is done by reducing the energy transfer from the animals to the environment.
    - Raising them in small cages so there is less movement and therefore less energy wasted on this
    - Areas where they are kept have high temperatures so less energy is wasted on controlling body temperature
- To increase growth they are also given high protein foods.

This type of farming has many ethical objections because lots of animals are kept in a small place , causing distress. It also increases the risk of spread of infection. It is carried out to increase profit and efficiency, but the standard of living is very low for the animals.

Sustainable Fisheries (7.5.3)

The number of fish in the oceans is decreasing.

- This is because humans are fishing at a faster rate than the populations can regenerate.
- To avoid species disappearing in some areas, the populations need stay above a certain level so breeding can continue.
- Some restrictions have been put in place:
    - There are limits of **net sizes** (making them bigger) so smaller fish are not caught and can reach breeding age and produce more fish.
    - **Fishing quotas** mean only a certain number of a species of fish can be caught (in an area and over a time period) to prevent overfishing.

Role of Biotechnology (7.5.4)

Biotechnology can be used to help feed the population and potentially provide treatments for a number of diseases.

1. The fungus *Fusarium* can produce **mycoprotein**.
    - Protein-rich food source
    - Suitable for vegetarians
    - Grown on glucose syrup in aerobic conditions
    - The fungus is harvested and purified so it can be consumed
    - Protein without animals
        - Reduces land use, as a lot of land is required to rear animals and also areas to grow crops to feed them.
        - Reduces our methane contribution (because cows produce methane)
2. Genetically modified bacteria produces insulin
    - The insulin is taken and purified
    - Used to treat people with diabetes

3. Genetically modifying crops to have certain properties can have many advantages
    - Modifying them to be resistant to pests or extreme weather conditions can increase yields
    - Modifying them to increase their nutritional value is beneficial in places where they lack access to certain vitamins (such as ‘Golden rice’)