Name: ________________

GCSE Ecology Booklet

Lesson	Title	Tick
1	Food chains, food webs and interdependence	
2	Biotic factors and predator-prey cycles	
3	Plant and animal adaptations for Biotic factors	
4	Abiotic factors and competition	
5	Plant and animal adaptations for Abiotic Factors	
6	Adaptations to extreme environments	
7	Population size: measuring through Random Sampling	
8	Effect of abiotic factors: measuring through line transects	
9	Sampling: analysis of data (mean mode and median and calculating area etc)	
10	Water cycle	
11	Biodiversity, communities and interdependence	
12	Maintaining biodiversity	
13	Land use, peat bogs and deforestation	
14	Waste management and pollution of air, water and land	
15	Carbon Cycle	
16	Climate Change	

Biology Knowledge Organiser
Topic 20: How do Organisms Relate to Each Other and the Environment?

Ecology and Interdependence

Ecology is the study of everything from individual organisms to the whole biosphere (everywhere that life is found on Earth). An ecosystem is an interconnecting network of living organisms and their environment.

The feeding relationships are one way in which organisms depend on each other. To begin with, almost all organisms rely on the Sun as the original source of energy for their ecosystem. **Plants and algae** can make use of the Sun's energy to produce food molecules, in the process of photosynthesis. This is why they are called **producers**. Other types of organism can't do this, so they rely on the plants and algae. **Consumers** eat the producers, so the energy from the sun flows through the ecosystem. Molecules (which are stores of energy) also flow through, and get recycled when organisms produce waste (poo and wee!) and after they die and decay. The diagram helps to show this.

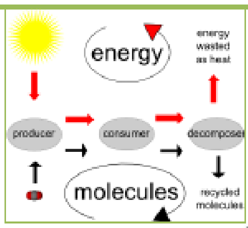
You can see that all the organisms in the ecosystem depend on each other. This is called **interdependence**. The consumers wouldn't survive without the producers capturing energy from the sun, the producers wouldn't survive without the decomposers recycling molecules for them to use (e.g. nutrients from the soil), and the decomposers need the waste from other organisms, and their bodies once they die. A stable community is one where all the species' populations and the abiotic factors are in balance; as a result, population sizes don't change much in stable communities.

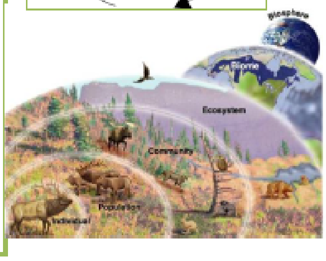
Biotic and abiotic factors affecting organisms

Communities of organisms are obviously affected by the environmental factors of their habitat. Factors that are non-living are called **abiotic** factors; those that are living are called **biotic** factors. These may affect the distribution of organisms (i.e. how they are spread out in the environment), their population size, their growth, behaviour or anything else really.

Examples of abiotic factors: light intensity; temperature; moisture levels; soil pH and mineral content; wind intensity and direction; carbon dioxide level for plants; oxygen levels dissolved in water for aquatic animals.

Examples of biotic factors: food availability; new predators arriving; new pathogens; competition between species. Competition can actually lead to extinction of a species – if another species outcompetes it, the first one may end up without sufficient numbers to breed.





Key Terms	Definitions
Biosphere	Wherever life is found on Earth (and in the atmosphere).
Biome	A large zone of life with particular characteristics – e.g. tropical rainforest, arctic tundra.
Ecosystem	A complex network of **communities** of organisms, which all depend on each other and which are adapted to the biotic and abiotic conditions they live in.
Community	A group of **interdependent** organisms. Communities interact with each other and with the physical environment – **ecosystem** refers to the interaction of living communities with the non-living environment.
Habitat	A specific set of conditions, usually a specific location, where an organism (or organisms) is adapted to live.
Population	A whole group of organisms – for instance, all the buffalo on the savannah, or all the greenfly on one rose bush.
Interdependence	All organisms in a community rely on one another – for food, shelter, pollination, seed dispersal, nutrient recycling and so on.
Biotic	Living factors affecting a community.
Abiotic	Non-living factors affecting a community (e.g. light intensity, temperature, soil pH).

Adaptations

ALL organisms, now matter how simple they might seem, are adapted to their natural environment. Their features, or adaptations, enable survival in the particular conditions where they live. Adaptations can be:

- **Structural**: adaptations in terms of body form and shape. This would include examples like: streamlined shape for speed; long stem to maximise light exposure
- **Behavioural**: adaptations of behaviour – for instance, hunting behaviours, using tools, plants growing in the direction of a source of light.
- **Functional**: adaptations in terms of how the body works. For instance: being able to digest a certain food, maintaining a constant body temperature and so on.

Some organisms are adapted to live in what we would consider to be extreme environments – for instance, very high temperatures, high pressures, high salt concentration. The organisms that can survive in these kinds of conditions are called **extremophiles**. A great place to find extreme conditions and extremophiles is around and inside deep sea hydrothermal vents.

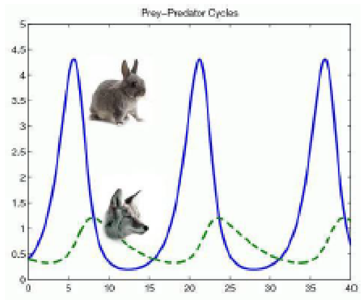
Biology Knowledge Organiser
Topic 20: How do Organisms Relate to Each Other and the Environment?

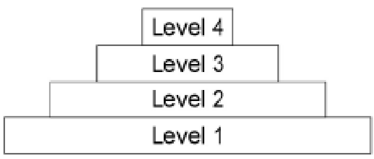
Organisation of ecosystems and trophic levels

Apart from some ecosystems in deep sea vents, ALL biomass on Earth is produced by **photosynthetic** organisms. So, these organisms are called **producers (trophic level 1)**. This is vital for other organisms, since these producers start off food chains. **Food chains** represent the feeding relationships in a community. The producer is usually a green plant or algae, and they make **glucose** by photosynthesis.

The producers are eaten by **primary consumers (trophic level 2)**, which might be eaten by the next trophic level – **secondary consumers (trophic level 3)**. The secondary consumers may be eaten by **tertiary consumers (trophic level 4)**. Of the consumers, if they kill and eat other animals, they are called **predators**. The animals eaten by predators are their **prey**. Carnivores that don't get eaten by anything else are called **apex predators**.

In a *stable* community (one that stays pretty steady in terms of population sizes), the population size of predators and their prey rise and fall in cycles, as the graph shows. When there aren't many predators, the prey population grows rapidly. When it rises, there is more food for predators so their population increases. This puts pressure on the prey so their population drops – cycles, see graph.





Key Terms	Definitions
Photosynthetic	Describes any organism that can carry out photosynthesis, producing biomass from simple chemicals (CO_2 and H_2O)
Biomass	The materials that living things are made from: proteins, carbohydrates and lipids.
Food chain	Used to represent the feeding relationships in a community. Starts with a producer and shows what organism eats what, as well as how energy and biomass are transferred in the community.
Trophic level	Position in a food chain. Producers = level 1.
Ingest	Eat/consume
Egest	Excrete as faeces

Pyramids of biomass

Biomass is simply living mass/material. Biomass is made by producers, but bear in mind they only transfer about 1% of the energy from light that hits them. A pyramid of biomass has trophic level 1 at its base, and each block of the pyramid has a width to represent the amount of mass at each trophic level. See diagram.

The blocks HAVE TO get smaller, because not all biomass is transferred from one trophic level to the next (only about 10% in fact). This is because:

- Not all of the organisms in each trophic level actually get eaten by the trophic level above
- Not all the material that is eaten (**ingested**) is actually absorbed into the body – some is **egested** as faeces
- Large amounts of the biomass absorbed at each trophic level is used in **respiration** (especially glucose, of course) – meaning that the biomass is converted to carbon dioxide and water. These products are released in urine and breathing out. (furthermore, urea is lost in urine, so it isn't available for the next trophic level).

As a result of all this, usually the number of organisms decreases as you go up the trophic levels (although it also depends on the size of the organisms!).

Biology Knowledge Organiser
Topic 20: How do Organisms Relate to Each Other and the Environment?

Decomposition

Decomposition is the breaking down, or decay, of biological material. Microorganisms digest dead organic material to simpler molecules, so the complex molecules bodies are made from (like proteins, lipids and carbohydrates) are recycled in the environment. They do this be secreting enzymes into their immediate environment and absorbing the soluble products of digestion by diffusion.

The rate of decay is affected by:

- **Temperature** – the activity of decomposers increases as it gets warmer (although decomposers are killed by very high temperatures)
- **Water** – moist conditions speed up decay because molecules to be digested may be dissolved
- Availability of **oxygen** – decay is fastest if there is a good supply of oxygen, simply because the decomposers can then respire more efficiently. This is why compost bins should have hole sin the side!

Compost is just the material left after decay of waste organic material has happened. Compost is very useful to farmers and gardeners as a natural fertilisers for crops.

Where decay happens <u>without</u> oxygen, **anaerobic** decay takes place. This produces **methane** gas. This can be very helpful – methane is a good fuel, so it is deliberately produced like this in many places, especially warm countries. The decay happens in a **biogas generator** – biogas just refers to the methane.

The water cycle and the carbon cycle

Like carbon, water is constantly cycled in ecosystems between abiotic and biotic components of the ecosystem. Water is released in aerobic respiration by all organisms. In terms of the abiotic components, water is constantly evaporated and precipitated (so, goes from land/waterways to the atmosphere and back again). The water precipitated provides fresh water for organisms on land before draining into the sea.

In all ecosystems, many materials have to be cycled through the biotic and abiotic components of the ecosystem – e.g. water, carbon, minerals, nitrogen. Microorganisms play a key role in cycling such materials. Carbon can appear in abiotic locations (the air as CO_2, in soil minerals) and biotic locations (in the carbohydrates, lipids and proteins that living organisms are built from). When we say it is cycled through these components, we mean that carbon atoms don't stay in any material for ever. They are cycled by various processes:

- **Photosynthesis** – takes carbon from the atmosphere (in the form of CO_2) and converts it to biomass
- **Respiration** – all living organisms, including plants and microorganisms, respire, which converts biomass into CO_2, which enters the atmosphere. While decay is taking place, carried out by microorganisms, they respire, which releases CO_2.
- **Feeding** – when consumers eat other organisms, the carbon in the other organism's biomass is transferred to the consumer.

Key Terms	Definitions
Decomposer	An organism that digests dead organic material.
Distribution	Describes how organisms are spread in an ecosystem.
Abundance	How many individuals of a particular species there are.
Quadrat	A square frame used for sampling plants in an ecosystem. Can be used for counting plants for measuring the coverage of the ground by a particular species.
Transect	Sampling method where a quadrat is laid down at regular intervals along a line. This is used to measure the change in distribution of organisms when a particular factor changes, such as light intensity.
Interval	The spaces between measurements – e.g. on a transect, the interval might be 1 m.

Measurements of ecosystems

Biologists measure both the **distribution** and **abundance** of organisms in ecosystems to help us understand them (see definitions). It would be impractical to attempt to count e.g. all the seaweed on a beach, so biologists use <u>sampling</u> techniques. If you just want to measure the abundance in an area, or to compare two locations for abundance of e.g. seaweed, ***random sampling*** would probably be used of the area. To count plants, quadrats are used. If, however, you are interested in how the distribution (spread) of organisms changes as a factor changes, you measure along a **transect**. For instance, with the seaweed example, you could set up your transect line down the beach towards the water (just using a long tape measure) and measure the coverage by seaweed at 2 metre **intervals**, or some other suitable interval. Data may be summarised using means, modes or medians, and graphs can be produced to represent differences between locations, or the change in distribution along a transect.

Biology Knowledge Organiser
Topic 20: How do Organisms Relate to Each Other and the Environment?

The impact of environmental change

Environmental changes affect the **distribution** of species in an ecosystem. Environmental changes can be seasonal (summer vs. winter), geographic (e.g. flooding, volcanic activity and so on) or caused by human interaction with the environment (e.g. anthropogenic climate change). Changes that affect organisms include temperature, availability of water and the composition of gases in the atmosphere. Be ready to evaluate the impact of examples of environmental changes on distribution of species.

Maintaining biodiversity

As you've seen, many human activities have negative effects on biodiversity. However, as the scale of our negative influence has become more and more apparent, scientists and concerned citizens have brought in programmes to try to reduce our negative influences. Here are the key examples you should know:

- **Breeding programmes** for endangered species. For instance, tigers and pandas are bred in captivity to ensure they do not become extinct.
- **Protection and regeneration** of rare habitats. This includes passing laws to ensure people leave certain areas alone (e.g. parts of the Great Barrier Reef). Regeneration means activity trying to bring a habitat back to its former glory.
- Reintroduction of **field margins** and **hedgerows** in agricultural areas where farmers only grow one kind of crop. Growing one sort of crop (called monoculture) is bad for biodiversity because it only provides a habitat for a few species. So, farmers are encouraged to used hedges (not fences) and leave a margin around the edge of their crop fields, so wild plants can grow there, which in turn allows other organisms (e.g. insects) to survive there too. This improves biodiversity on agricultural land.
- Reduction of **deforestation** and **carbon dioxide** by some governments. There have been numerous attempts, not always totally successful, to get governments of countries around the world to agree to specific targets for how much carbon dioxide they emit, since global warming is, of course, a worldwide problem. As with many things in politics, agreement is very difficult to obtain… but progress has been made in these international agreements.
- **Recycling** resources rather than dumping in landfill. You are used to recycling as much of your household waste as you can. Work continues to increase the range of materials that can be recycled so we can continue to reduce the amount of waste dumped in landfill.

Key Terms	Definitions
Breeding programme	Producing offspring, especially of endangered species to protect their population.
Field margin	The area around the edge of a field between the crop and the fence/hedge/wall.
Hedgerow	The barrier at an edge of a field made of growing plants, as opposed to a fence or wall.

A lovely big field margin, and hedgerow on the left

Biology Knowledge Organiser
Topic 20: How do Organisms Relate to Each Other and the Environment?

Biodiversity

Biodiversity, the variety of all the species of organisms, can be measured at the level of a community, ecosystem or the whole earth (biosphere). A large biodiversity increases the stability of ecosystems, because it reduces the dependence of one species on another, for instance for food. So, for example, if a species has only one food source (think: pandas and bamboo shoots), it may be easily threatened by environmental changes.

In spite of our future as a species on Earth depends totally on maintenance of biodiversity, many human activities threaten biodiversity. Indeed, in many ecosystems, we have already significantly reduced biodiversity. For instance, deforestation had damaged biodiversity in all kinds of forest. Our waste, polluting land, air and sea, has negatively affected biodiversity in many areas. And the big one: global warming is already having measurable effects on global biodiversity. It is only recently that humans have taken any measures to try to prevent our damage to biodiversity going too much further – obviously, we don't yet know if these measures will be enough.

Land use

Humans reduce the amount of land available for other organisms by: building, quarrying, farming and dumping waste (landfill). This in turn can reduce biodiversity.

Peat bogs are made of peat, a type of fossil fuel formed from dead plants. Peat bogs are destroyed as peat can be used as a fuel and is a very good fertiliser if you're growing plants. This has seriously reduced the area of this habitat and reduced biodiversity as a result. Furthermore, using peat as a fuel produces CO_2 (contributing to global warming) and using it as a fertiliser (in compost) allows it to decay, which also produces CO_2.

Key Terms	Definitions
Evaporated	Water changing state from liquid to vapour.
Precipitated	Water changing from vapour to liquid/solid form – i.e. rain, hail, snow.
Biodiversity	The variety of all the different species of organisms.

Waste management

Since the human population is growing at an incredible rate, and in general people's living standard is going up globally, we (the human population) is using more and more resources and producing more and more waste. Our waste causes pollution, which can occur:

- In water, thanks to sewage, fertilisers running off farmland, or toxic chemicals used in industry;
- In the air, from smoke, waste gases and acidic gases (e.g. sulphur dioxide)
- On land, from landfill (rubbish dumps) and from toxic chemicals.

Pollution kills organisms; therefore it can reduce biodiversity.

Deforestation

Deforestation on a large scale happens to provide land, with the largest areas cleared for raising cattle, to plant rice fields and to grow crops that can be made into biofuels. Our food and fuel needs conflict with the need to preserve forests and rainforests so biodiversity is maintained.

Global warming

As you'll know, since the industrial revolution, human activities have dramatically increased the levels of greenhouse gases in the atmosphere. The main gases involved are carbon dioxide and methane. The molecules of these gases absorb infrared (heat) radiation and re-radiate it, causing gradual but measurable increases the atmosphere's, and therefore Earth's, temperature. Global warming as caused by humans used to be controversial; now, thousands of peer-reviewed publications later, the global scientific consensus is that humans are definitely causing climate change through global warming.