Communities Notes

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Ecology is the scientific study of the interactions between organisms and their environments. Ecologists study how interactions between organisms and their environments affect such things as the cycling of nutrients in a habitat, or the growth of populations. This great scope makes ecology an enormously complex and exciting area of biology to study, but before we get into it let's get to grips with a few definitions 😊

Population: the number of organisms of a species living in an area. When we talk about the population of a town, for example Colchester, we are talking about how many humans live in that area.

Community: all the living organisms in an area.

Ecosystem: all the living organisms and physical conditions present in an area.

Interdependence: how different organisms depend on each other within a community.

Abiotic factor: non-living factors in an ecosystem. For example, wind, temperature and light are all abiotic factors in an ecosystem.

Biotic factor: living factors in an ecosystem. For example, animals, birds, plants, fungi, and other similar organisms are all biotic factors in an ecosystem.

Parasitism: a relationship in which the parasite benefits and the host is harmed.

Mutualism: a relationship in which both organisms benefit.

Levels of Organisation

An **organism** forms part of a **population** and a population forms part of a **community** which, in turn, forms part of an **ecosystem**.

Smallest → Largest

Organism → **Population** → **Community** → **Ecosystem**

In order to stay alive an organism must absorb energy from another source. Organisms cannot create their own energy. We normally show these levels of organisation in either a food chain or a food web.

Trophic Levels

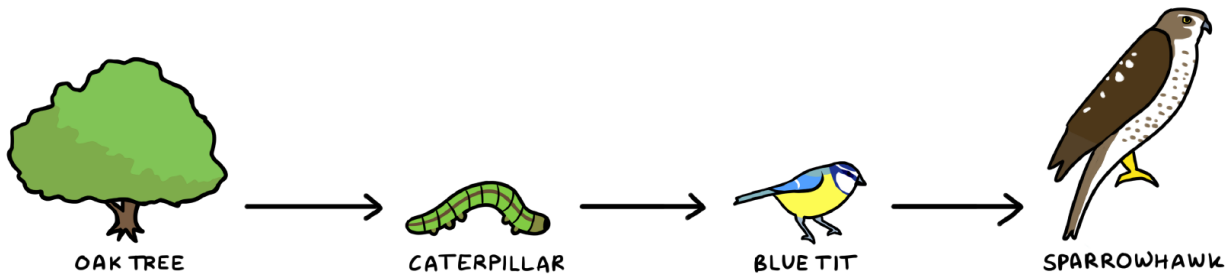
Food chains or food webs both start with producers. Energy moves along the food chain or web from one organism to another when one eats the other.

A trophic level: the feeding level of an organism in a food chain.

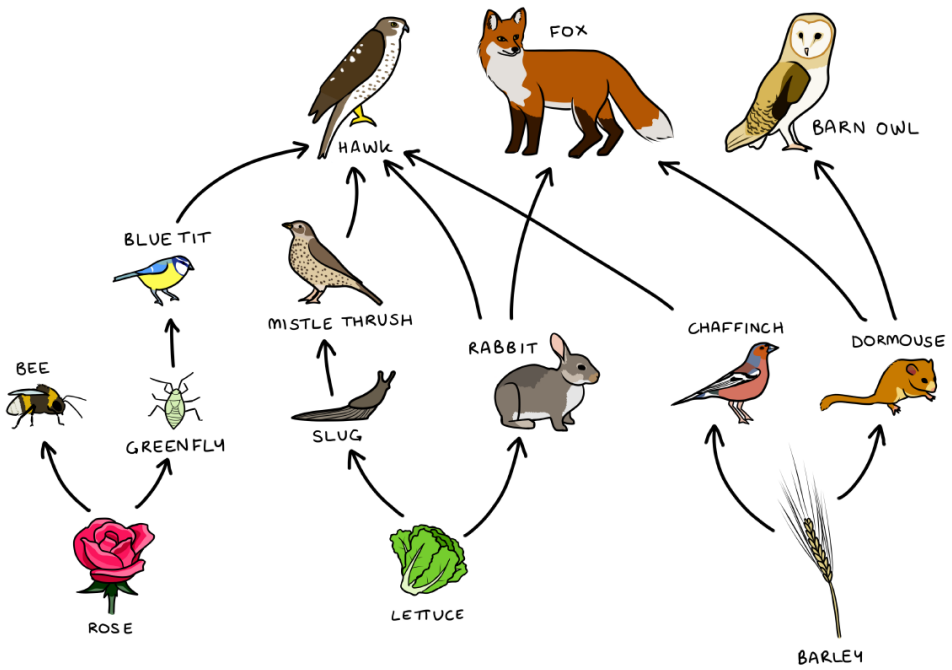
In most food chains that we see there are usually between three and four trophic levels.

Level	Name	Explanation
1st trophic	Producer	Producers are always at the first stage of a food chain. Producers are always photosynthetic organisms (organisms that photosynthesise).
2nd trophic	Primary consumer	Are herbivores that eat the producer. For example, a caterpillar.
3rd trophic	Secondary consumer	Are carnivores that eat the primary consumers. For example, a spider or blackbird.
4th trophic	Tertiary consumer	Are carnivores that eat the secondary consumer. For example, a fox or owl.

Example of a food chain



Example of a food web



Energy transfer between organisms

A common exam question asks "*How is energy or biomass lost between different trophic levels or between different organisms in either a food chain or food web?*"

Energy/ biomass is lost between each organism due to the **life processes** of the organism.
Life processes that use energy/ biomass include:

1. **Respiration.** 2. **Excretion.** 3. **Movement (if the organism is an animal).** 4. **Reproduction.**

This makes sense, as the animal must use some of its energy to do things and even if an organism ate it whole it would not get the energy that the first organism had already used.

In addition to these four life processes energy/ biomass is also lost as not all of the matter eaten by an organism is digested by the consumer. This energy loss limits the number of organisms in a food web, as the energy will eventually run out.

Energy is always converted to a less useful form. This is true of any energy transfer.

About 90% of energy is lost at each trophic level!

Calculations involving transfers of energy

You could be asked to calculate the energy that is lost from one tropic level to the next. This is quite straight forward it is a subtraction question.
Method: You will need to take one value away from another to find the difference between them.
You could be asked to calculate the efficiency of energy transfers between trophic levels.

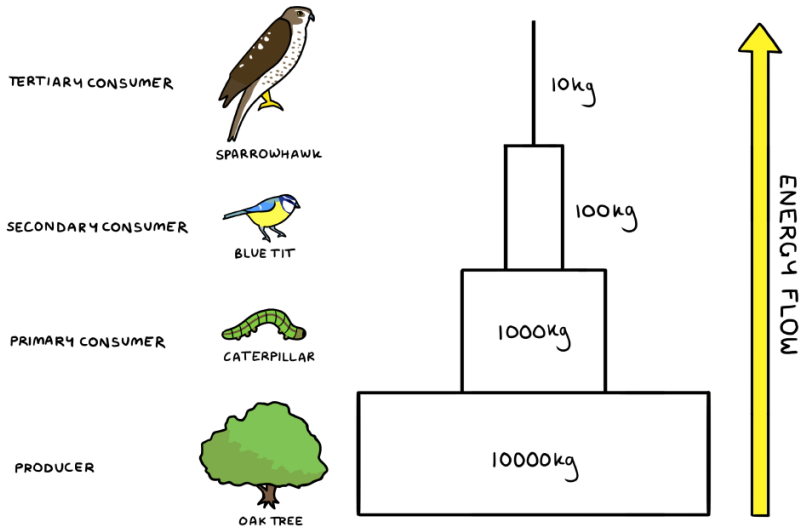
To calculate efficiency, we use this formula: it is identical to calculating efficiency in physics 😊

$$efficiency = \frac{energy\ in\ higher\ tropic\ level}{energy\ in\ lower\ tophic\ level} \times 100$$

Pyramids of Biomass

Pyramids of biomass: shows the **mass** of the organisms in each trophic level in a food chain.

The example below shows the mass of one oak tree, followed by the mass of caterpillars that feed on the tree, followed by the mass of bluetits that feed on the caterpillars and finally the mass of the sparrowhawks that feed on the bluetits.



What are the advantages of pyramids of biomass?

1. **They are always pyramid shaped** 😊 : A pyramid of biomass for a healthy ecosystem is always a true pyramid. The total mass of organisms decreases as we move up the pyramid from one trophic level to another.
2. This correctly shows that the producer level contains the most stored energy and material.
3. **More Accurate Representation**: biomass is a much better proxy for the amount of stored chemical energy at each trophic level than the number of individuals.

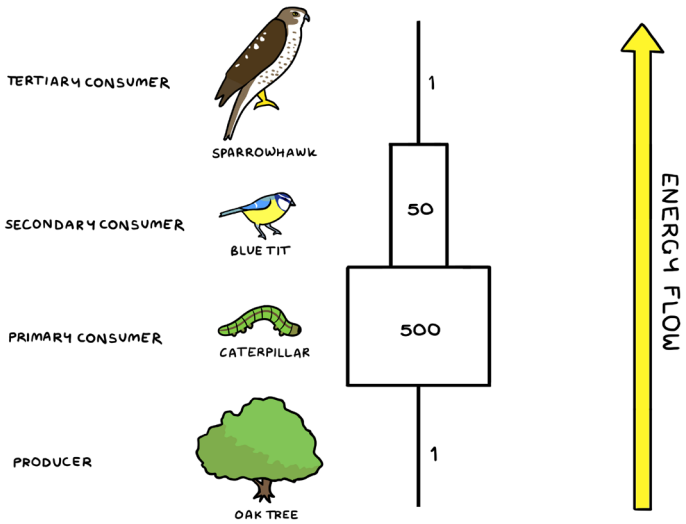
What are the disadvantages of pyramids of biomass?

1. To measure dry mass, the organisms must be killed, which is destructive and often impractical or unethical.
2. They only show the biomass at one specific moment in time (a "snapshot"). They don't account for seasonal changes or rates of reproduction.

Pyramids of Numbers

Pyramids of numbers: shows the number of each of the organisms in each trophic level in a food chain.

The example below shows one oak tree, followed by the hundreds of caterpillars that feed on the tree, followed by dozens of bluetits that feed on the caterpillars and finally one sparrowhawk that feeds on the bluetits.



What are the advantages of pyramids of numbers?

1. **Simple and quick to draw**: They are very easy to put together. All you need to do is count the number of individual organisms in a sample area. This makes them quick to do and simple to understand at a glance.
2. **Good for comparisons**: Because they are simple to create, it's easy to compare different ecosystems or to see how a single ecosystem changes over time (for example, after a very dry season or a pollution event).

What are the disadvantages of pyramids of numbers?

1. **They don't account for the size of organisms:** A pyramid of numbers treats every individual as equal. One giant oak tree is counted as '1', and one tiny blade of grass is also counted as '1'. This can be very misleading about how much energy or living tissue (**biomass**) is actually present at each level.
2. **Numbers can be too large to draw:** When dealing with producers like algae (phytoplankton) or decomposers like bacteria, the numbers can be in the millions or billions. It is impossible to draw these huge numbers to an accurate scale on a pyramid.

Abiotic and Biotic Factors

Abiotic (non-living) factors and biotic (living) factors have a huge impact on how organisms are distributed in a habitat. You wouldn't find a tree from a rainforest growing in a desert. There wouldn't be enough water available for transpiration, the temperature would be too high during the day and this would denature the plant's enzymes.

Let's look at how abiotic factors affect communities.

Abiotic factor	Effect on organisms in a community
Temperature	Plants and animals have evolved enzymes that work best at their optimum temperature. If the temperature is too high for too long the enzymes denature. This will kill the organism. Likewise, if temperatures are too cold for too long the rate of chemical reaction will drop too low and the organism will die.
Light intensity	Light is required for photosynthesis. In general, the greater the light intensity the greater the success of the plant. In places with less light, plants have evolved bigger leaves to increase the surface area available for photosynthesis.
Moisture level	For both plants and animals, a lack of water will cause death.
Soil pH	The pH of the soil affects what plants will grow there. Some plants prefer acidic soils while others prefer alkaline soils.
Wind intensity	The direction and strength of wind can have a great impact on the distribution of organisms. Most animals prefer to live in sheltered areas.
Pollutants	These can poison organisms or cause other problems for organisms for example when plastics are eaten by organisms.

Biotic factor	Effect on organisms in a community
Predation	The number of predators in a community directly affects the size of the prey population. More predators will eat more prey, fewer predators will eat fewer prey.
Competition	Members of the same species compete for food, habitats, mates and resources. Competition my result in the death of weaker individuals or see them leave the area.
Food	The availability of food is a major factor in how many animals live in an ecosystem. All animals require food to live. If there is not enough food there will be fewer animals.

How are plants adapted for extreme environments?

At GCSE questions appear on how cacti are adapted for their desert environment.

Adaptation	Benefit to the plant
Spines	These reduce the surface area of the plant and so also reduce water loss. The spines can also protect the cacti by discouraging animals from eating them.
Thick waxy cuticle	Reduces water loss by evaporation.
Less stomata	Reduces the water loss from transpiration.
Modified Stems	These can store large volumes of water for long periods.
Extensive root system	Allows the plant to absorb water from a very large area.

Competition

Different organisms compete for resources. Competition can happen between organisms of the same species but also between organisms of different species. What competes for what?

Plants				Animals			
Plants compete for the following resources:				Animals compete for the following resources:			
Mineral ions.	**Water.**	**Light.**	**Space.**	**Food.**	**Mates.**	**Habitats/ territory.**	**Shelter.**

Interdependence

Interdependence: how different organisms depend on each other within a community.

There are **three main types of interdependence** that we see in habitats.

1. **Predation**
2. **Mutualism**
3. **Parasitism**

Predation: a relationship between predator and a prey organism. The predator depends on prey, usually for food. If the numbers of predators increase, or if a new predator enters a habitat, this will reduce the numbers of prey. Over time, this will cause the predators to starve or leave the area. The prey numbers will then increase, this will attract the predators back again and the cycle will repeat itself. This cycle is called the **predator – prey cycle**. For example, barn owls hunting rodents.

Mutualism: a relationship in which both organisms benefit. For example, Oxpeckers. These are small birds which live on the backs of buffalo. They eat the parasites that try to feed on the buffalo. This way the Oxpecker has food to eat and the buffalo is kept free of parasites. Win, win 😊

Other examples of mutualism:

1. '**Cleaner**' fish, these fish feed off the dead skin and parasites of larger fish such as sharks.
2. **Leguminous plants** (such as peas and beans) have colonies of nitrogen-fixing bacteria in nodules attached to their roots. These give the plant nitrates and get sugars in return.

Parasitism: a relationship in which the parasite benefits and the host is harmed. An example of this would be a tapeworm in a digestive system. It gains nutrients from the host as it feeds. This damages the host as the tape worm digs itself into the wall of the small intestine. Or a tick biting and feeding off the blood of the host.

Interdependence is vital for a community, all organisms depend on each other for survival, including humans.

How are bacteria adapted for extreme environments?

Bacteria have evolved enzymes that do not denature at high temperatures. These bacteria can live around thermal vents under the sea. These organisms are called extremophiles.