Ecology: Adaptation and Organisation

Keyword	Definition
Abiotic	Non-living elements of an ecosystem, such as climate, temperature, water, and soil type.
Adaptations	A feature of an organism's body which helps it to survive.
Biotic	Living elements of an ecosystem, such as plants and animals.
Community	All the organisms that live in a habitat (plants and animals).
Deficiency	In the diet, a deficiency happens if there is too little of a particular nutrient.
Ecosystem	The living organisms in a particular area, together with the non-living components of the environment.
Evolution	The change of inherited characteristics within a population over time through natural selection, which may result in the formation of a new species.
Extinct	A species that has completely died out.
Food chain	A sequence of feeding relationships between organisms, showing which organisms eat what and the movement of energy through trophic levels.

EC 02 + 03 Adaptations

A

Survival of the fittest means survival of those best adapted.
Adaptations make organisms better suited to their **ecosystem** and provide them with a better chance of survival and reproduction. The adaptations that arise from competition are essential for the process of **evolution**.

Adaptations to the environment in plants

- Structural adaptations in plants such as spines to prevent animals eating them
- Behavioural adaptations in plants such as plant shoots grow quickly towards the light to maximise photosynthesis.
- Physiological adaptations in plants such as poisons for defence.

Adaptations to the environment in animals

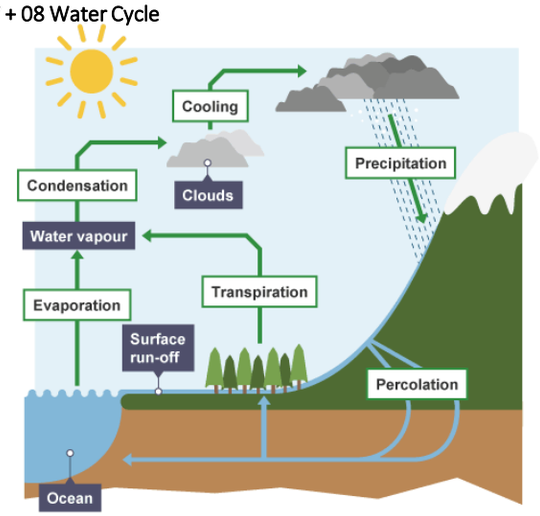
- Structural adaptations in animals such as sharp claws to catch prey, dig burrows or scratch trees to signal territories.
- Behavioural adaptations in animals such as mating rituals, or hunting like wolves in a pack.
- Physiological adaptations in animals such as the production of venom.

EC 04 Abiotic and Biotic Factors

D

Abiotic	Biotic
Non-living factors that affect a community	***Living factors that affect a community***
Light intensity.	Availability of food.
Temperature.	
Moisture levels.	New predators arriving.
Soil pH, mineral content.	
Wind intensity and direction.	New pathogens.
Carbon dioxide levels for a plant.	One species outcompeting so numbers are no longer sufficient to breed
Oxygen levels for aquatic organisms.	

EC 07 + 08 Water Cycle



EC01 Communities and competition

A

- An **ecosystem** is the interaction of a **community** of living organisms (**biotic**) with the non-living (**abiotic**) parts of their environment.
- To survive and reproduce, organisms require a supply of materials from their surroundings and from the other living organisms there.
- Plants in a **community** or **habitat** often compete for light and space, and for water and mineral ions from the soil.
- Animals often compete for food, mates and territory. Within a **community** each species depends on other species for food, shelter, pollination, seed dispersal etc. If one species is removed it can affect the whole community.
- This is called i**nterdependence**. A stable community is one where all the species and environmental factors are in balance so that population sizes remain fairly constant.

Required Practical:
Field Investigations

Mathematical skills (required practical):

- Interpret graphs used to model predator-prey cycles.
- Calculate and understand the terms mean, mode and median as applied to ecological data.
- Plot and draw appropriate graphs selecting appropriate scales for the axes.

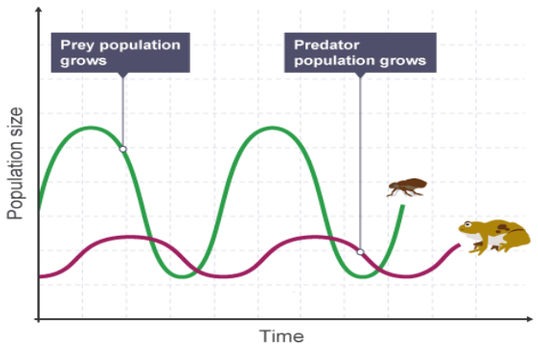
EC04 Levels of organisation

A

Photosynthetic organisms are the producers of biomass for life on Earth.

Feeding relationships within a **community** can be represented by **food chains**. These then add together to make food webs for a habitat.

- All food chains begin with a **producer** which synthesises molecules. This is usually a green plant or alga which makes glucose by photosynthesis.
- Producers are eaten by primary consumers, which in turn may be eaten by secondary consumers and then tertiary consumers.
- Consumers that kill and eat other animals are **predators**, and those eaten are **prey**.



- In a stable community the numbers of predators and prey rise and fall in cycles.

Relevant Modules:

AQA

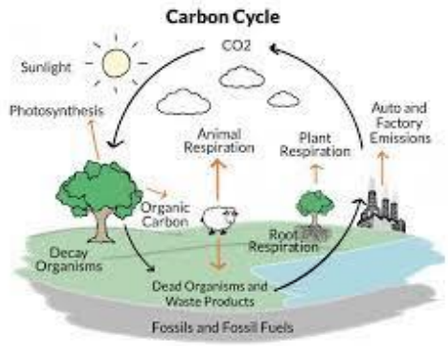
- Cell Biology
- Organisation
- Homeostasis

EC 10 + 11 How materials are cycled

C

How materials are cycled in an ecosystem

- Atoms exist in different forms or compounds at different times in history and cycle between them. We can see this cycling in the element carbon and the compound water. Just as rocks can cycle between igneous, sedimentary and **metamorphic**, carbon and water can exist in different forms at different times.
- Other elements and compounds also exist in cycles.
- **Decomposers** are bacteria and fungi, which break down dead organisms in a process called decomposition or rotting. They do this by releasing **enzymes** onto the dead matter and afterwards, consume the broken down substances. They form a vital role in the recycling of matter. When organisms die and **decompose** plants absorb the broken down nutrients through their roots.
- Carbon is an essential element for life on Earth and parts of each of the cells in our bodies are made from it. The carbon cycle shows how atoms of this element can exist within different compounds at different times.



Process	Carbon starts as	Carbon ends as
Photosynthesis	Carbon dioxide	Glucose
Respiration	Glucose	Carbon dioxide
Combustion (burning)	Fuel (eg methane or wood)	Carbon dioxide

Useful YouTube links:

Carbon Cycle

Biotic and Abiotic Factors

Ecology: Biodiversity and the effect of human impact on ecosystems

Keyword	Definition
Habitat	The place where an organism lives.
Indicator species	The presence, abundance or absence of these organisms provides information such as the level of pollution in the environment.
Interdependence	Refers to the fact that all organisms that live in an ecosystem depend upon each other, for food, protection, shelter, etc, in order to survive.
Population	All of the members of a single species that live within a geographical area.
Predator	An animal that hunts, kills and eats other animals for food.
Prey	Organisms that predators kill for food.
Producer	Plants that begin food chains by making energy from carbon dioxide and water.
Quadrat	A square frame of known area used for sampling the abundance and distribution of slow or non-moving organisms.

A

EC 15 Biodiversity

Biodiversity is specifically the number of different species. An area with large populations of few species is not biodiverse.

- Areas like tropical rainforests have millions of different **species** and are very **biodiverse**. Other areas like the Polar Regions have far fewer species and are less biodiverse.

Interdependence

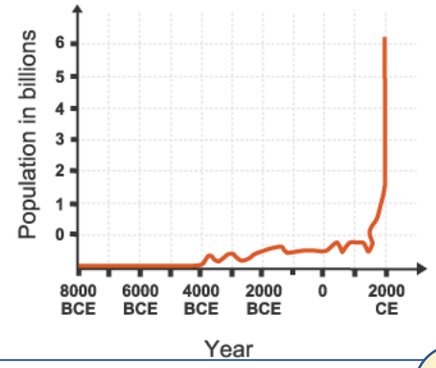
- If the numbers of one species are affected, there are almost always knock-on consequences. A simple **food chain** is:

  algae → zooplankton → sand eel → puffin → arctic skua

- If the numbers of zooplankton are reduced by pollution, such as plastic waste, then more algae will grow and the population of other consumers will fall.
- Ecosystems with higher biodiversity are more stable as they can easily adjust to changes as they don't depend on one resource.
- Activities that create air and water pollution, are reducing biodiversity in many ecosystems. Conservation of species and habitats by charities, governments and individuals helps to maintain the range of biodiversity.

Human population growth

The number of people alive now is at a record level and is increasing. In 2012, the human **population** exceeded seven billion for the first time.
Each year about 75 million more people are born than die. This is known as the net increase.



D

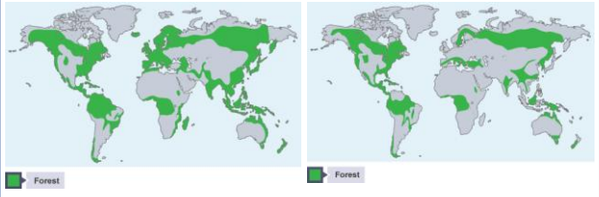
EC 16 Deforestation

Large-scale deforestation in tropical areas has occurred to:

- provide land for cattle and rice fields
- grow crops for biofuels

The increase in the human **population** and development of industrial machinery has meant that much larger areas have been cleared.

In the last 75 years we have cut down over half of the world's rainforests. Scientists estimate that 32 000 hectares of rainforest are destroyed each day. The picture below shows the difference from 8000BC to 2000AD



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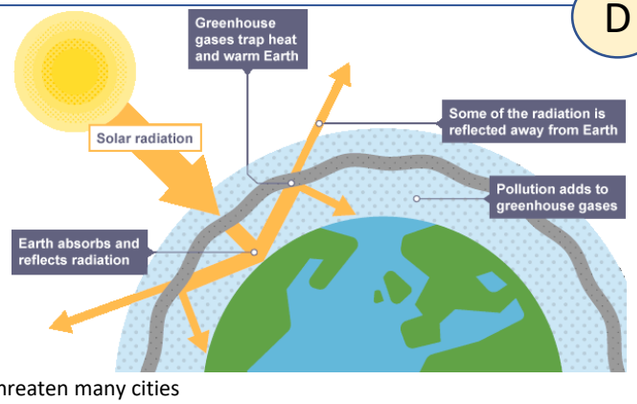
EC 14 Global warming



The effects of global warming include:

- melting of the polar ice caps
- the rise in sea level may one day threaten many cities
- weather patterns will change with more unusual weather
- animals will migrate towards the poles to find habitats with suitable temperatures
- tropical diseases may become more common in other regions,
- many species will become **extinct**

D

EC 17 Maintaining biodiversity

Scientists and concerned members of the public help maintain biodiversity by:

- breeding programs to help preserve **endangered species**, like the panda
- protection and development of new endangered **habitats**, often by making National Parks
- replanting hedgerows because there is higher biodiversity in them than the fields they surround
- reducing deforestation and the release of **greenhouse gases**
- **recycling** rather than dumping waste in **landfill sites**

Useful YouTube links:

Global Warming

Biiodiversity

TPS

D

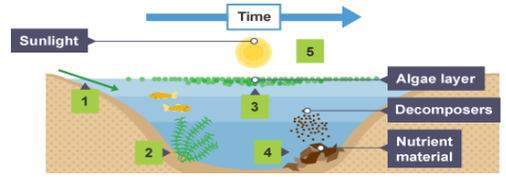
EC 16 Waste management

As the human **population** increases, the volume of waste and **pollution** that is produced also increases. Polluting an **ecosystem** harms or kills the organisms that live within it.

- Modern society consumes more, which means humans manufacture more products and replace them more often. This consumption is not **sustainable**. Many natural materials, including fossil fuels, will soon run out.

Water pollution

- In some parts of the world, open sewers can lead into water courses, such as streams and rivers, which can cause serious illness in humans that may drink the contaminated water.
- Some farmers use too many fertilisers, which can run off fields during heavy rain. This can pollute nearby streams and rivers leading to **eutrophication**.



1. Nutrient load up: excessive nutrients from fertilisers are flushed from the land into rivers or lakes by rainwater.
2. Plants flourish: these pollutants cause aquatic plant growth of algae, duckweed and other plants.
3. Algae blooms, oxygen is depleted: algae blooms prevent sunlight reaching other plants. The plants die and oxygen in the water is depleted.
4. Decomposition further depletes oxygen: dead plants are broken down by bacteria decomposers, using up even more oxygen in the water.
5. Death of the ecosystem: oxygen levels reach a point where no life is possible. Fish and other organisms die.

Air pollution

- **Combustion** of fossil fuels and other fuels releases carbon dioxide. This contributes to the **greenhouse effect** and leads to **global warming**. It also releases sulfur dioxide and nitrogen oxides which can cause acid rain. Air pollution can also be caused by tiny particulates from smoke which can cause **smog**.

Land pollution

- The rubbish we throw out that is not **recycled** goes into a land fill. These are huge holes in the ground into which our rubbish is dumped. Some things like batteries cannot be put into **landfill sites** because of the toxic chemicals they contain. They must be recycled.

D

EC 16 Land Use

The larger the human population gets, the more land we require.

- More houses must be built, more resources found, more food must be grown and more waste is produced. This often means less space and fewer resources for other animals and plants. **Biodiversity** is significantly reduced when land is cleared for human uses.

Peat bog destruction

- **Bogs** are very wet areas of land without trees in which many types of moss grow. Here **decomposition** is very slow and peat is formed from partially decayed plants. It is a **non-renewable** energy resource like fossil fuels.
- **Peat bogs** are a very important store of carbon. We call them **carbon sinks**. If all the peat was removed and burned this would quickly release a huge volume of carbon dioxide into the atmosphere and contribute to the **greenhouse effect**.

Ecology: Decomposition, trophic levels and food production [BIO only]

Keyword	Definition
Species	A type of organism that is the basic unit of classification. Individuals of different species are not able to interbreed successfully.
Transect	A line created, for instance, with a tape measure, along which sampling occurs.

C

EC 13 Decomposition

Decomposition is the breakdown of dead matter. Decomposing bacteria and fungi are organisms that help decomposition. This is crucial to the cycling of elements, such as carbon.

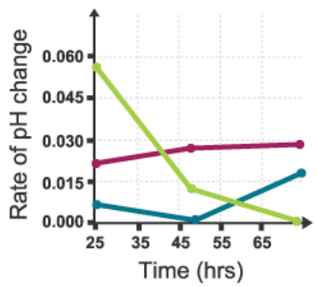
The rate of **decay** is the speed at which dead matter is broken down by **decomposers**.

Rates of decay are affected by a number of key factors.

- **Temperature**

At colder temperatures decomposing organisms will be less active. At extremely high temperatures decomposers will be killed and decomposition will stop.

- **Water**
- **Oxygen**



Compost and manure

Gardeners and farmers improve the quality of their soil by adding **compost** or **manure**. Compost is made from dead plants and manure is the waste from animals.

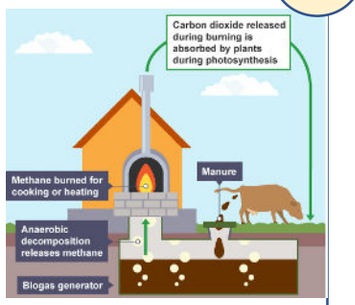
One key element which is recycled is nitrogen. This element is needed by plants to make proteins in order to grow and repair themselves. Plants cannot absorb nitrogen gas, and need it to be provided as nitrate ions in the soil.

C

EC 14 Anaerobic decay and Biogas

Anaerobic decay occurs when bacteria and fungi break down dead matter without oxygen.

The products of anaerobic decay are methane and carbon dioxide. We use methane as a renewable energy resource, biogas.



EC 18 + 19 Impact of environmental change

Environmental changes affect the distribution of species in an ecosystem. These changes include:

- temperature
- availability of water
- composition of atmospheric gases

The changes may be seasonal, geographic or caused by human interaction

E

EC 08 + 09 Pyramids of Biomass

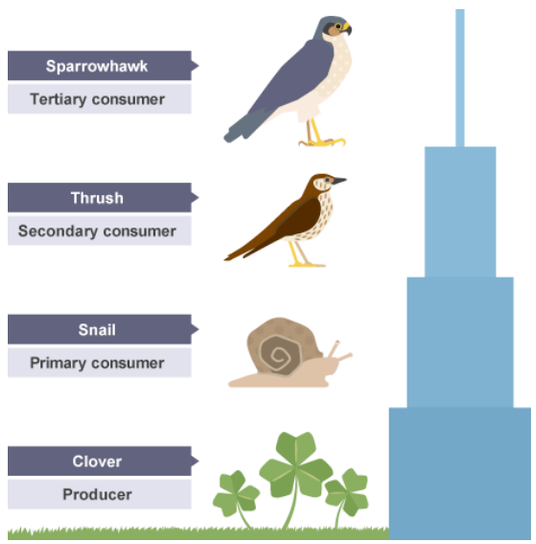
Biomass is living or recently dead tissues. Wood is considered biomass because it was recently a plant. from the original living tissue.

Pyramids of biomass can be constructed to represent the relative amount of biomass in each level of a food chain. Trophic level 1 is at the bottom of the pyramid.

In a **food chain** from a healthy **ecosystem** the biomass at each trophic level must reduce. An example of a food chain is:
clover → snail → thrush → sparrow-hawks

Pyramids of biomass must be drawn with the:

- bars equally spaced around the midpoint
- bars touching
- bar for the **producer** at the bottom
- length of each bar is proportional to the amount of biomass available at each trophic level



E

EC 08 Trophic Levels

Trophic levels can be represented by numbers, starting at level 1 with plants and algae. Further trophic levels are numbered subsequently according to how far the organism is along the food chain.

- Level 1: Plants and algae make their own food and are called producers.
- Level 2: Herbivores eat plants/algae and are called primary consumers.
- Level 3: Carnivores that eat herbivores are called secondary consumers.
- Level 4: Carnivores that eat other carnivores are called tertiary consumers.

Apex predators are carnivores with no predators.

Decomposers break down dead plant and animal matter by secreting enzymes into the environment. Small soluble food molecules then diffuse into the microorganism.

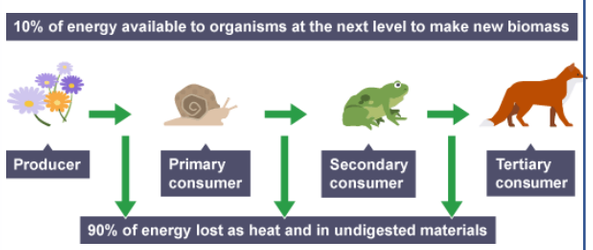
E

EC 09 Transfer of Biomass

Producers are mostly plants and algae which transfer about 1% of the incident energy from light for photosynthesis.

Only approximately 10% of the biomass from each trophic level is transferred to the level above it. Losses are due to:

- not all the ingested material is absorbed
- some absorbed material is lost as waste,
- Large amounts of glucose are used in respiration.



The efficiency of **biomass** transfer is a measure of the proportion of biomass transferred from a lower **trophic level** to a higher one.

$$\text{Percentage efficiency transfer} = \frac{\text{biomass in higher trophic level}}{\text{biomass in lower trophic level}} \times 100$$

Required Practical:
Decay

F

EC 10, 19 + 20 Food production

Food security is having enough food to feed a population. Biological factors which are threatening food security include:

- the increasing birth rate has threatened food security in some countries
- changing diets in developed countries means scarce food resources are transported around the world
- new pests and pathogens that affect farming
- environmental changes that affect food production, such as widespread famine occurring in some countries if rains fail
- the cost of agricultural inputs
- conflicts that have arisen in some parts of the world which affect the availability of water or food.

Sustainable methods must be found to feed all people on Earth

Farming techniques

The efficiency of food production can be improved by restricting energy transfer from food animals to the environment. This can be done by limiting their movement and by controlling the temperature of their surroundings.

Sustainable fishing

Fish stocks in the oceans are declining. It is important to maintain fish stocks at a level where breeding continues or certain species may disappear altogether in some areas. Control of net size and the introduction of fishing quotas play important roles in conservation of fish stocks at a sustainable level.

Role of Biotechnology

Biotechnical and agricultural solutions, including genetic modification, can help meet the demands of the growing human population.

Biotechnology techniques enable large quantities of microorganisms to be cultured for food.

The fungus Fusarium is useful for producing mycoprotein, a protein-rich food suitable for vegetarians. The fungus is grown on glucose syrup, in aerobic conditions, and the biomass is harvested and purified.
A genetically modified bacterium produces human insulin. When harvested and purified this is used to treat people with diabetes.

GM crops could provide more food or food with an improved nutritional value such as golden rice.

Useful YouTube links:

Decomposition

Pyramids of Biomass

Relevant Modules:

- Cell Biology
- Organisation
- Homeostasis

BI 09 Required Practical – Measure the population size of a common species in a habitat

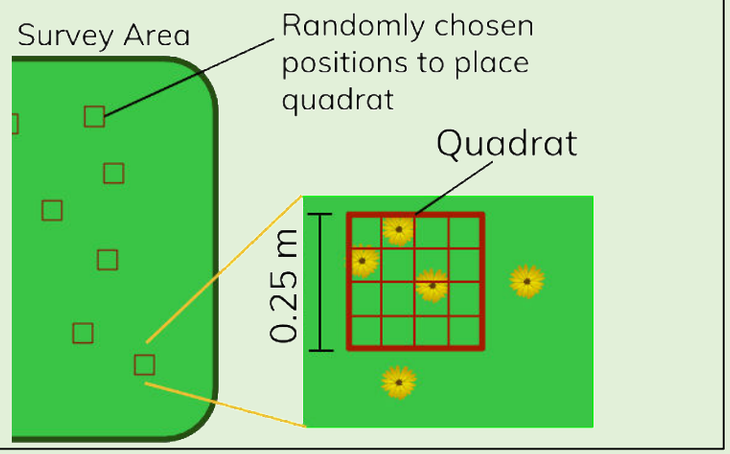
B

Aim

To measure the species richness on the school field in areas in which the grass is regularly and irregularly cut.

Method

- Choose a starting point on the school field in an area where the grass is often cut
- use **random** numbers to generate a set of coordinates to place your first **quadrat**
- count the number of different plant **species** within this quadrat (the species richness)
- return to your starting position and repeat steps two and three a further 14 times using different random numbers
- repeat steps one to four for a part of the school field which the grass is infrequently cut
- compare your results by calculating a **mean** for each location



Variables
- **Independent Variable:** location of quadrat
- **Dependent Variable:** the number of different plant species
- **Control Variables:**
  - Size of the quadrat

Results

Quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of plants species (uncut)	1	2	1	2	3	1	3	1	1	1	2	3	2	1	1
Number of plants species (uncut)	3	2	4	6	1	1	1	4	5	3	6	4	5	3	4

What are the totals and means for the two different locations?

A total of 25 and a mean of 1.7 on cut school field and a total of 52 and a mean of 3.5 on uncut school fields.

Scientific calculations

Mean
The mean is the most common type of average we use. To calculate the mean you add all the values together and divide by the total number of values.
Median
To calculate the median, a set of numbers are placed in increasing order of size. The median is the middle number in the list.
Mode
The mode is the value that appears the most often. In the shade, the mode is four because there are three values of four. In the sun, it is five because there are three values of five.

What conclusions can you draw here?

The mean of the number of plant species in the cut school field is lower than on the uncut school field. There is a mean of 1.7 different species per quadrat on the cut grass. The number of plant species per quadrat on the uncut field is over twice this at 3.5. Therefore, there is greater species richness on the school field in uncut areas.

What limitations might there be in drawing these conclusions?

The two students only placed 15 quadrats. Completing more would allow them to be more confident in their conclusions.

BI 10 Required Practical – Decomposition (BIO only)

C

Aim

To investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change.

Method

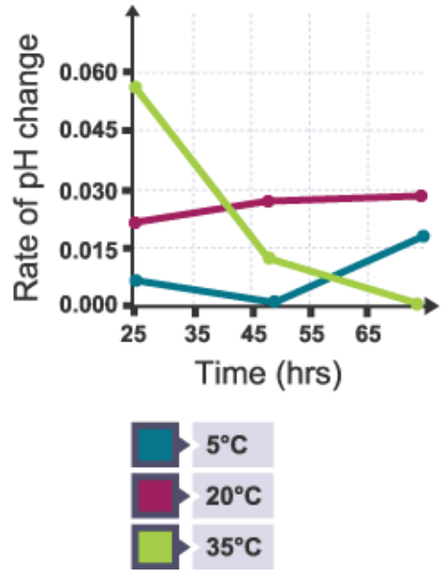
- Place 20 cm^3 of fresh milk into three beakers
- Decide the three temperatures you will investigate. Write these onto the sides of the beakers. They may be 5, 20 and 35°C.
- Use universal indicator paper or solution to determine the pH of the milk in the three beakers
- Cover each beaker in cling film and incubate at the appropriate temperature
- Use universal indicator paper or solution to determine the pH of the milk in the three beakers after 24, 48 and 72 hours

Ecology Required Practicals

Variables
- **Independent Variable:** Temperature
- **Dependent Variable:** pH
- **Control Variables:**
  - Volume of milk, pH solution

Results

Hours	0	24	48	72
5°C	6.5	6.4	6.4	6.0
20°C	6.5	6.1	5.5	4.8
35°C	6.5	5.1	4.8	4.8



What conclusions can you draw here?

At 5°C the pH of the milk reduced the least [1 mark]. This suggests that the least decay has occurred at this temperature [1 mark]. The milk incubated at 20°C and 35°C both reduced to pH 4.8 [1 mark]. This suggests that the decay after 72 hours is similar at these temperatures [1 mark]. However, the reduction in pH occurs much quicker at 35°C [1 mark]. The pH reaches its lowest after 48 hours not 72 hours as is the case with the milk incubated at 20°C. These results show the decay of milk occurs quickest at 35°C [1 mark] and then stops.

What limitations might there be in drawing these conclusions?
The students did not take repeat readings to look for concordant results. They could be more confident in their conclusions if they took repeat readings.

How would you modify the procedure described above to find out if skimmed milk decayed less quickly than fresh milk?

Use similar quantities of fresh and skimmed milk but keep both samples at 35°C. The pH of the milk would need to be measured at the start, and after 24 and 48 hours, but not 72 hours.

Scientific Calculations
Rate changes show how quickly something is happening. The rate of change can be calculated using this equation:

$$rate\ of\ change = \frac{change\ in\ value}{change\ in\ time}$$

Rate of change can also be calculated from graphs.

$$rate\ of\ change = \frac{vertical\ change}{horizontal\ change}$$