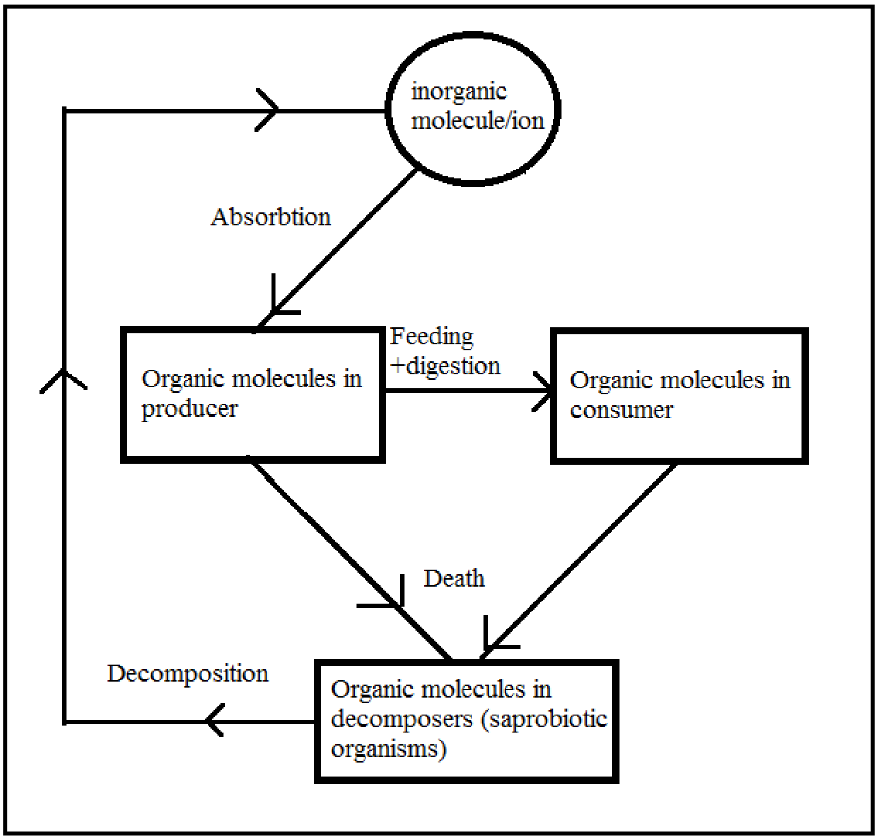
Section 6.1 – The carbon cycle

Nutrients must be recycled or they'd run out

There is usually a fairly simple sequence to a nutrient cycle:

- The nutrient is taken up by the producers as simple inorganic molecules
- The molecule is incorporated into more complex molecules within the producer
- When the producer is eaten, the nutrient passes into consumers
- It then passes through the food chain
- When the organism dies, its more complex molecules are broken down back into simple molecules by saprobiotic organisms.



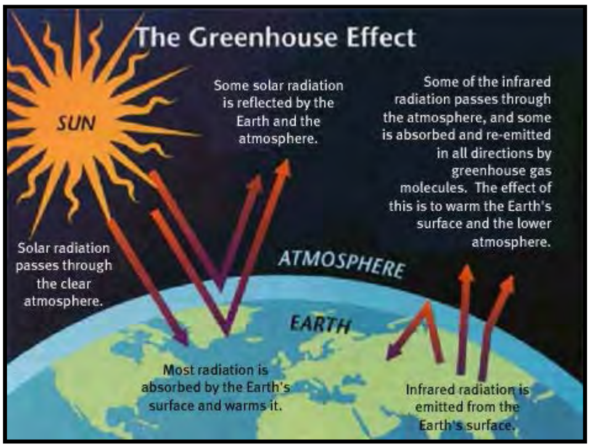
Variations in the rates of respiration and temperature give rise to brief fluctuations of oxygen and carbon dioxide in the air.

CO_2 concentration has dramatically increased in recent years. This is possible due to:

The combustion of fossil fuels, such as coal, oil and gas which releases previously locked up carbon
Deforestation – released large amount of photosynthesising biomass that can remove CO_2 the air.

The sea allows for large amounts of CO_2 from the air to dissolve thus lowering the concentration.
When the reverse is true, the sea will release CO_2

Section 6.2 - The greenhouse effect and global warming



When solar radiation reaches the earth, some is reflected back into space, some is absorbed by the atmosphere and some reaches the earth.
The radiation that reaches the earth is absorbed, and reemitted back into space. However, some of this radiation is absorbed by clouds and greenhouse gases that will reflect the radiation back to earth. This causes a heating effect known as the greenhouse effect

Greenhouse gases

CO_2 - Responsible for approx. 50 – 70% of global warming
Remains in the atmosphere for >100 years
Its increase is mainly due to human activity (burning fossil fuels)

Methane - Remains in the atmosphere for ~ 10 years
Produced when microorganisms breakdown the organic molecules of which other organisms are made (decomposers/intestinal dwellers)

Global warming

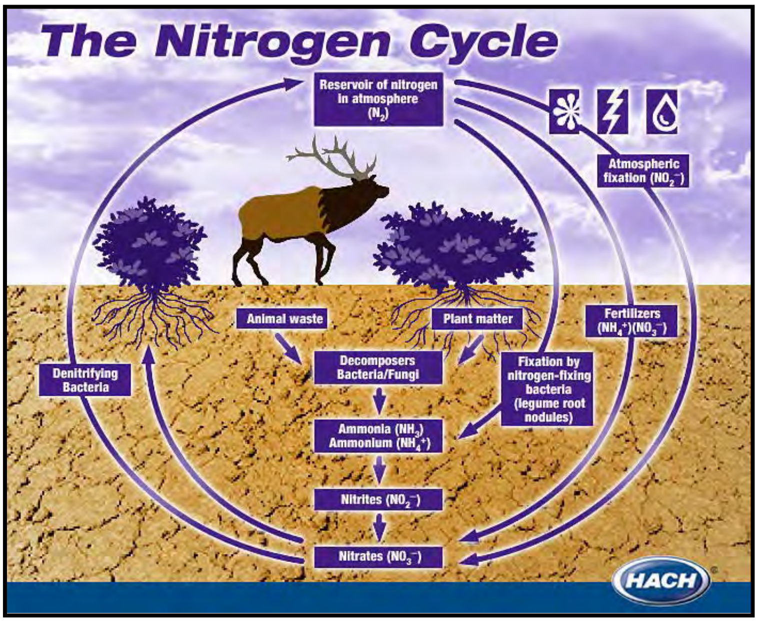
The mean average temperature increased by 0.6% since 1900
The earth has always shown periodic fluctuation in temperature so we cannot say for certain that human activity is to blame
What we can say however is that the atmospheric levels of carbon dioxide have increased since the start of the industrial revolution and that these seem to be linked with increasing temperature

Consequences of global warming

Affects the niches available in a community, leading to an alteration in the distribution of species
Melting of polar ice caps and therefore increasing sea levels
High temperature may lead to crop fail

Benefits – increased rate of photosynthesis, greater rain fall, possible twice a year harvest

Section 6.3 – The nitrogen cycle



Plants take up nitrates (NO_3^-) via active transport since they are moving against a concentration gradient. There are four main stages of the nitrogen cycle:

1.) Ammonification
2.) Nitrification
3.) Nitrogen fixation
3.) Denitrification

Ammonification

Production of ammonia from organic ammonium containing compounds
Saprobiotic bacteria feed on the materials releasing ammonia which converts to ammonium in the soil

Nitrification

Nitrification is carried out by saprophytic bacteria in the soil. They convert ammonium ions into nitrite ions (NO_2^-), and then into nitrate ions (NO_3^-).
Oxygen is required for nitrification and so oil is kept aerated by farmers to increase productivity

Nitrogen fixation

The process by which nitrogen gas is converted into nitrogen containing compounds
The most common forms of nitrogen fixation is carried out by either free-living bacteria found in the soil, or mutualistic bacteria, found on the nodules of plant roots

Free living bacteria – Reduces gaseous nitrogen into ammonia, which they then use to manufacture amino acids. Nitrogen rich compounds are released when they die

Mutualistic nitrogen-fixing bacteria – The bacteria on the nodules require carbohydrates from the plant and in turn they provide the plant with amino acids

Denitrification

When there is little oxygen present in soil, there are fewer aerobically respiring nitrogen fixing/nitrifying bacteria and more denitrifying anaerobically respiring bacteria. There denitrifying bacteria convert soil nitrates into gaseous nitrogen.

Section 6.4 – Use of natural and artificial fertilisers

The need for fertilisers

- All plants need mineral ions, especially nitrogen, from the soil.
- Specific areas of land are often used to grow crops
- When crops are grown, the plants use up the nitrogen containing compounds in the soil to create amino acids and proteins.

- Normally nitrogen containing compounds are recycled as the plant will die and be broken down by saprophytic bacteria However, in farming the plants are harvested and are therefore not replaced
- The amount of nitrates in the soil therefore decreases, and acts as a limiting factor on the crop growth

To offset the loss of minerals, fertilisers are used to replace what is lost

Natural – consists of decaying/dead organisms as well as animal waste. (yuck!)

Artificial – minerals obtained from rocks and stuff. Compounds containing the three elements, nitrogen, phosphorous and potassium are almost always present in artificial fertilisers.

It is important that not too much fertiliser is used as this will no longer increases productivity. This is because the rate of growth may be limited by other factors such as water and light

How fertilisers increase productivity

Nitrogen is need to make proteins and DNA
Where there are more nitrates available, plants are likely to develop earlier, grow quicker and taller and cover a greater area with their leaves. This therefore increases the rate of photosynthesis and also increases productivity.
Artificial fertilisers have been very beneficial in providing cheaper food.

Section 6.5 – Environmental consequences of using fertilisers

The effects of nitrogen fertilisers

Nitrogen containing fertilisers can have detrimental affects such as:

Reduced species diversity – nitrogen favours the growth of rapidly growing species such as grasses, nettles and weeds. Some species grow quickly and out compete the others.
Leaching – leads to pollution of watercourses
Eutrophication – caused by leaching of fertilisers into watercourses

Leaching

- Rain water can dissolve soluble nitrates and carry them deeper into the soil beyond the reach of plant roots.
- The nitrates may then be able to find there way to water courses and into water that is used for human consumption.
- High levels of nitrates in water can cause inefficient transport of oxygen to the brain.

Eutrophication

Eutrophication consists of the following sequence of events:

In most lakes, there are very few nitrates and so this is limiting factor on plant/algae growth
Nitrate levels increase due to leaching, there is no longer a limiting factor, and so plants/algae both grow exponentially
Algae grow and cover the upper layers of the water. This is called "algae bloom".
The algae on the top of the water, absorbs sunlight, preventing it from reaching the bottom of the lake.
Light becomes a limiting factor for plants/algae at the bottom of the lake and so they die
Saprophytic algae can now grow exponentially feeding on the decaying plant matter
More anaerobic saprophytic bacteria, more oxygen used up and more nitrates produced from decaying organisms.
Oxygen is a limiting factor for aerobic organisms such as fish and so they eventually die.
Without any aerobically respiring organisms, anaerobically respiring organisms no long have to compete and so they begin to reproduce exponentially.
Anaerobic organisms further breakdown other dead material thus producing more nitrates as well as some toxic wastes such as, hydrogen sulphide which makes the water putrid.