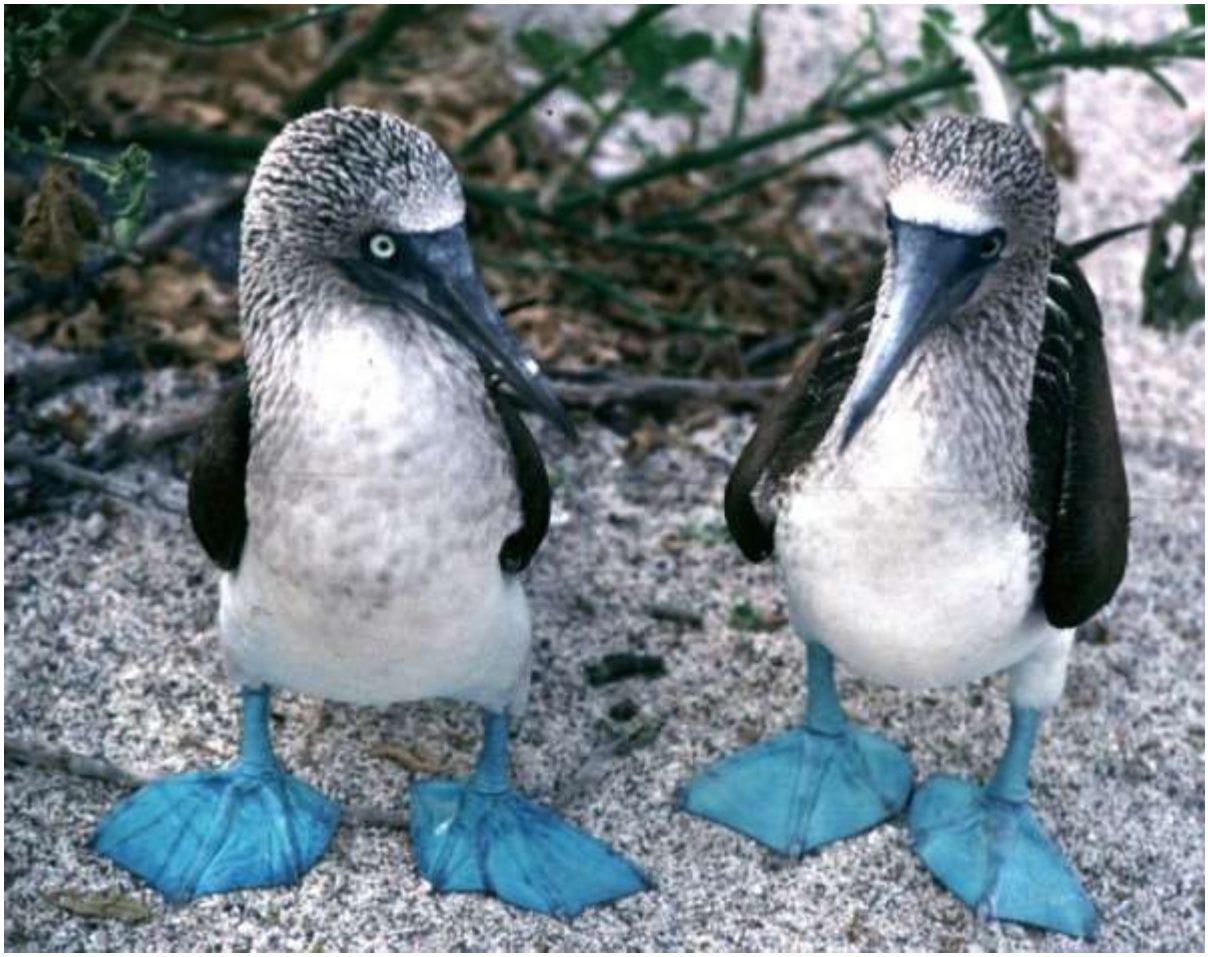
Life on Earth



Human impact on the Environment

Unit 3 Life on Earth

Sub-topic 4 – Human Impact on the Environment

a Increasing Human Population

↓

b Algal Blooms

↓

c Pesticide accumulation in Food Chains

↓

d Indicator Species

↓

e Biological Control

Learning Outcomes – Increasing Human Population

- To describe the changes in the human population over the last 200 years.
- To state the need for increasing quantities of food in the world
- To explain the methods of farming used to increase the quantities of food for an increasing world population

Activity 1 – Population Changes

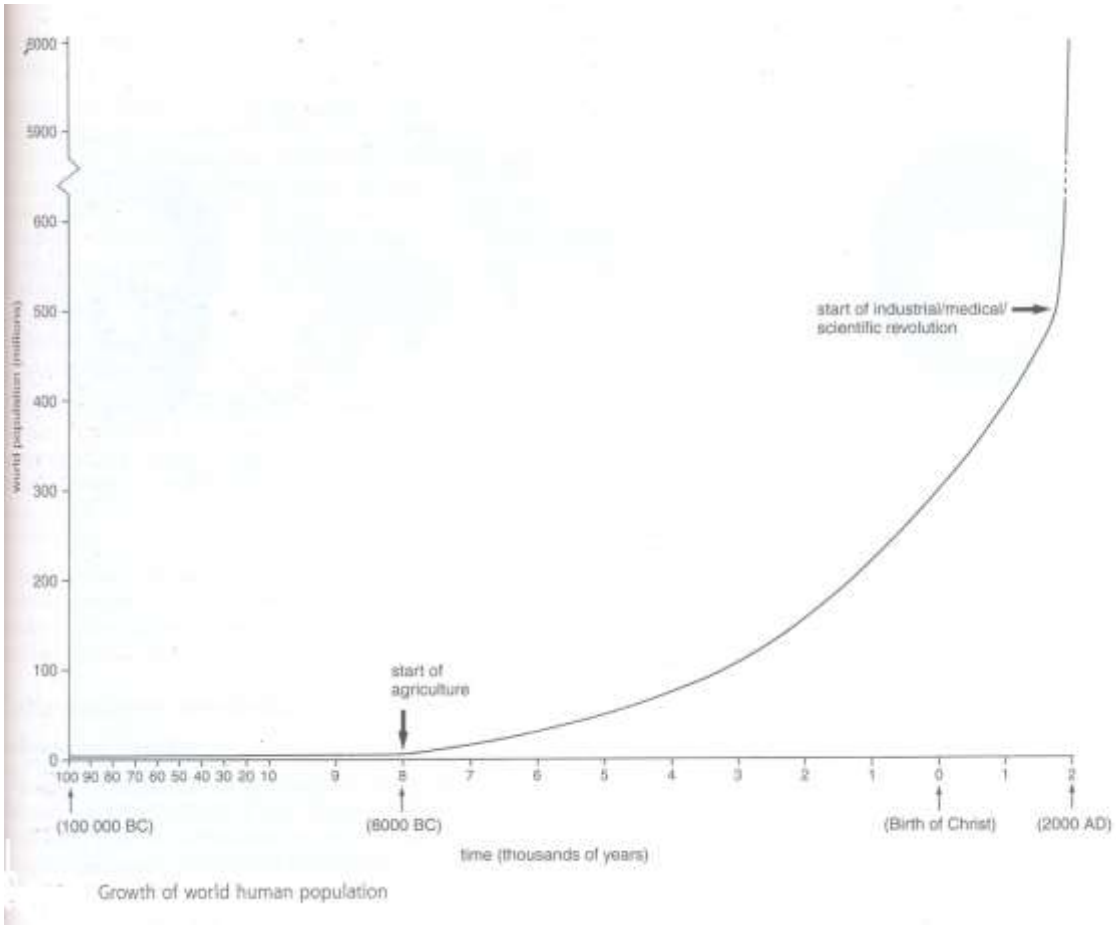
The graph overleaf shows the changes that have occurred in the human population over the last 100 000 years. Fossils and archaeological evidence suggest that the human population was fairly stable at around 5 million individuals until about 10 000 years ago (i.e. 8000 BC). Till this point, humans had to use their intellect to avoid predation. Then the first major **population 'spurt'** took place and resulted in the population reaching an estimated 300 million by the time of Christ and 500 million by 1650 AD. At around this time the second major population 'spurt' began. Both of these dramatic increases in population are attributed to **revolutionary changes** in human culture that took place at the time.

From this time onwards great advances were made in scientific understanding which were soon followed by major **discoveries** and **inventions**. These gradually led to the industrial revolution of the last 200 years which has also been accompanied by significant advances in **medicine**.

Methods of food production have become more efficient. A major assault has been launched on deadly diseases (e.g. smallpox) with

large scale immunisation programmes and significant improvements in childcare.

In many parts of the world, people have benefited from better housing, piped water, modern sanitation and easy access to antibiotics. These advances achieved by the industrial / scientific revolution have contributed to the current human population boom by largely removing the limiting factors the previously regulated the human population.



Growth of world human population

Answer the questions below in your jotter.

1. Give THREE factors that could limit the growth of a population and stop them growing indefinitely.
2. Approximately when did the first major 'spurt' in human population size occur.

3. Until this time what factor in particular had limited population growth ?
4. Approximately when did the second major 'spurt' in human population size occur ?
5. What name is given to the time in history when humans began to benefit from scientific discoveries and inventions ?

Activity 2 – Increasing Food Demand

period of time	average life expectancy of European male (years)
8000–3000 BC	18.0
800–1600 AD	31.0
1600–1700 AD	33.5
1700–1800 AD	35.3
1800–1900 AD	37.0
around 1910 AD	57.4
around 1950 AD	66.5
around 1990 AD	74.0
2000 AD onwards	?

Average life expectancies

Improved health and standard of living bring about an increase in **life expectancy**. This extends the period during which people can reproduce enabling them to have even more children than the previous generation.

In this growing world much more food will be needed to support the increase in the human population. Strategies must be developed to cope with the extra demand for food.

Methods of Farming

Use the resource sheet to make notes on the following;

- Monoculture
- Intensive farming
- Genetically modified (GM) crops

Resource Sheet: Methods of Farming

Monoculture

There are two distinct definitions of monoculture:

Scientific definition – vegetation composed of a single species

Agricultural definition – a field composed of a single crop rather than multiple crop species

Advantages

- reduced plant competition
- control of pest organisms
- reduction of costs
- greater profit for farmer

Disadvantages

- Limited number of habitats for plants and animals
- Habitats not permanent due to crop being grown changing due to customer demands
- Reduction in the number of many wild animal and plant species

Intensive Farming

Food production in this field has been increased by growing high yield crops, removing other plants and pests and adding fertiliser to the soil. Some other practices include keeping animals indoors, often in restricted spaces. See the table overleaf.

Intensive Farming

Action	Treatment	Explanation	Side Effect
Remove competing plants from the crop growing area	Herbicide spray	Allows more energy to be transferred to the crop	Reduces biodiversity. May have harmful effect on health
Remove animals that feed on the crop	Pesticide spray	Prevents energy being transferred from the crop to consumers	Reduces biodiversity. May poison helpful organisms
Keep animals indoors	'Battery farming'	Reduces energy transferred to environment so more energy available for growth	Increased risk of disease. Lower quality product. Ethical concerns

Examples include:

- Tomatoes in greenhouses
- Fish farms (e.g. salmon)

GM Crops

By far the most genetically modified (GM) organisms are crop plants. For years the human race has methodically improved crop plants through selective breeding, but genetic engineering has accelerated that process. There are many advantages to having GM crops, but not everyone agrees.

Research this theme of GM Crops and present a balanced view of the advantages and disadvantages they bring. Include in your note several examples of crop species being developed and grown in this way.

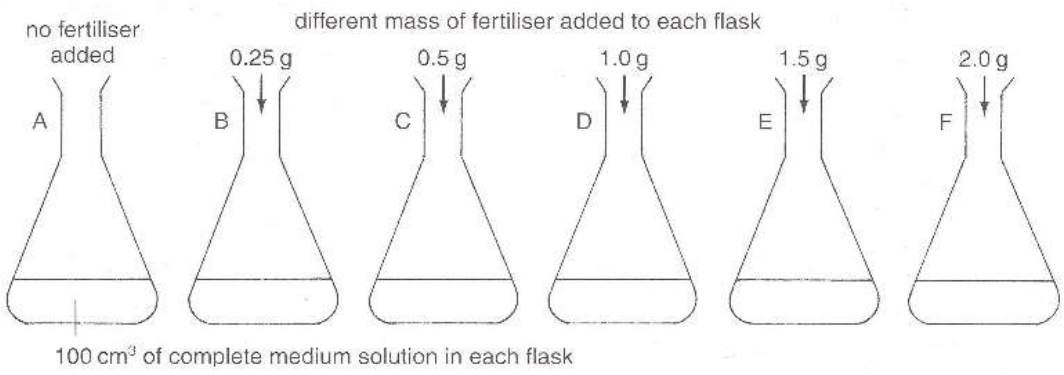
Success Criteria: I can

- **State 3 factors that can limit the growth of a population**
- **Explain the changes in the human population in the last 200 years**
- **Recognise the need for greater food production for humans**
- **Describe methods of farming used to meet these increasing demands**

Learning Outcomes - Algal Blooms

- **To describe the effects leaking of fertilisers can have in fresh water**
- **To explain the importance of minerals for plant growth**

Activity 1 – Effect of Nitrate on Plant Growth



Materials needed;

- 6 conical flasks
- Measuring cylinder
- Balance
- 600cm^3 of complete medium solution
- 6-7g nitrate fertiliser
- Syringe
- Algal suspension
- Filter paper

Method:

1. Add 100cm^3 of complete medium solution to 6 individual flasks.
2. Add the different masses of nitrate fertiliser to each flask (see diagram of experiment).
3. Using a syringe add 3cm^3 of algal suspension to each flask
4. Leave flasks in a warm environment under constant illumination (4 weeks).
5. Add distilled water as required (as water evaporates from flask.
6. Note appearance of plant population.
7. Filter contents.
8. Dry filter paper in oven till constant mass.
9. Record mass of algae.

Results:

Copy table below

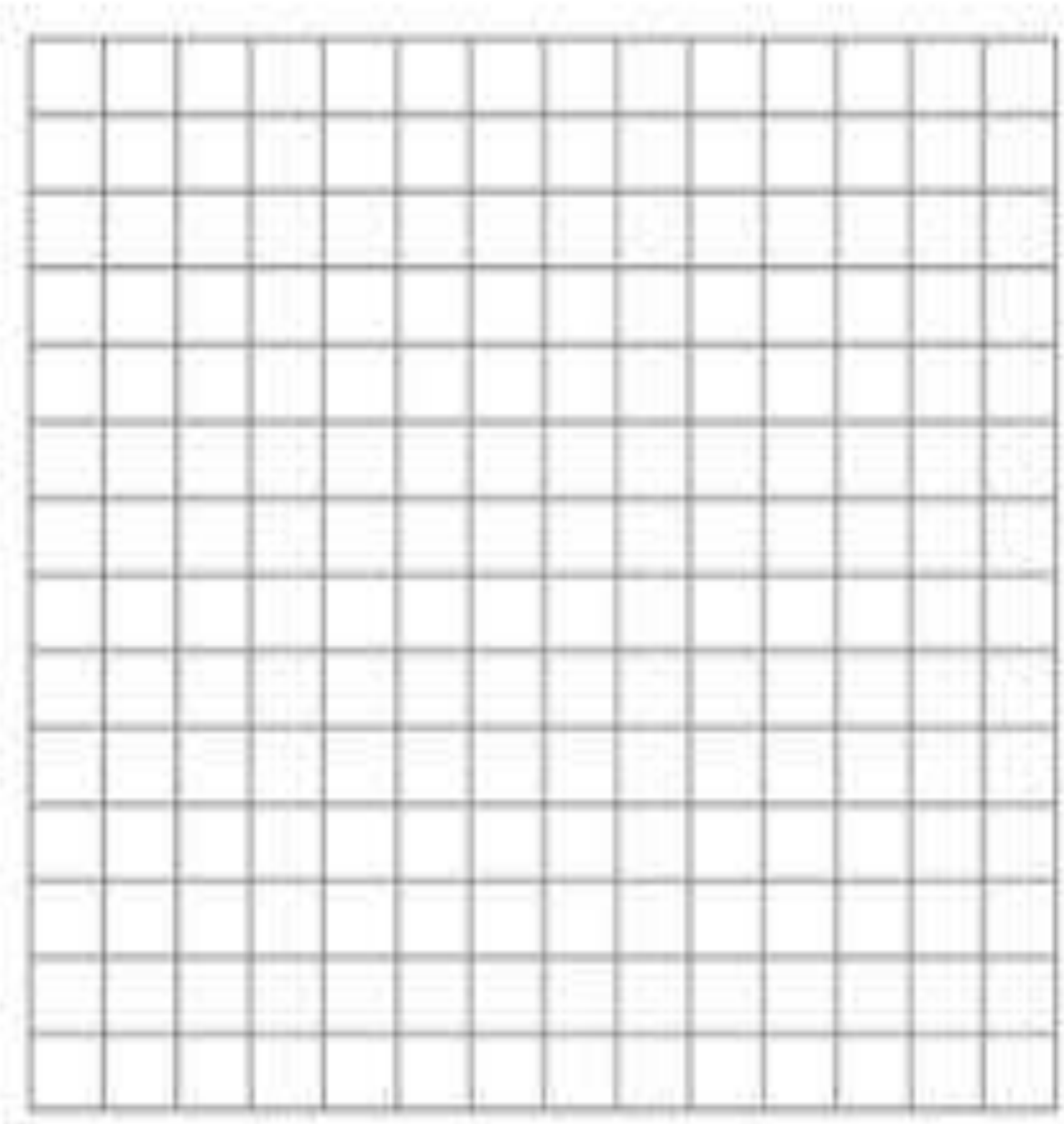
Flask	Mass of nitrate fertiliser added (g)	Colour of solution in flask		Dry mass of algae (g)
		at start	after 4 weeks	
A	0.0	faint green		
B	0.25	faint green		
C	0.5	faint green		
D	1.0	faint green		
E	1.5	faint green		
F	2.0	faint green		

Conclusion:

Comment on the effect that increasing nitrate concentration on algal growth. Make reference also to the colour of the plant material after 4 weeks.

Graph

Copy and complete the graph using results from the experiment.



Evaluation

Copy and complete the table below to summarise the procedures used in the experiment.

Design Feature	Reason
use of complete medium solution	
	to check that the one variable factor under investigation is responsible for results
shake each sample vigorously	
light intensity, temperature and volume of liquid kept equal for all flasks	
	to obtain more reliable results

Algal Blooms

Such blooms are a rapid increase in the population of algae. Generally, they are caused by ***eutrophication*** (an increase in nutrients in the water e.g. nitrogen and phosphorous) in rivers and lakes. Human activities are mostly responsible for the raising of nutrient levels in bodies of water. Lawn fertilisers, agricultural manure, sewage output and storm water are potential sources of additional nutrients.

When algal levels are raised there is potential harm for many other organisms. As the algae population increases they cover the surface of the water and block out light to organisms underneath. Much of

the oxygen available to organisms is used up as the algae grow, utilising the extra nutrients available to them.

Sometimes they will produce toxic materials causing fish kills, human illness through shellfish poisoning, and death of marine mammals and shore birds. This population explosion is unsustainable, and eventually dies off, as they block out the light and use up all the oxygen. The algae sink to the bottom, and bacterial decomposition uses the remaining oxygen from the water.

 Answer the questions below in your jotter.

1. Explain what eutrophication is.

2. State the additional nutrients that can cause algal blooms.

3. Describe the potential sources of the additional nutrients.

4. State the two processes that are causing oxygen levels to fall in the water.

Effects of Chemicals on Growth

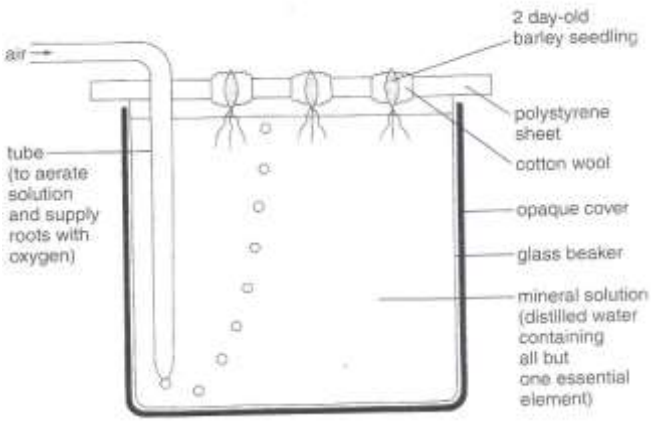
Macro-elements in plants : in addition to the large amounts of carbon (C), hydrogen (H) and oxygen (O) needed for the manufacture of carbohydrate during photosynthesis, a green plant requires small, but appreciable, quantities of other elements for healthy growth.

Four of these macro-elements are **nitrogen** (N), **phosphorous** (P), **potassium** (K) and **magnesium** (Mg). They are present in fertile soil and absorbed by the plant's root hairs. See the table below;

	Percentage of dry weight			
	N	**P**	**K**	**Mg**
Barley	1.94	0.13	4.04	0.29
Sunflower	1.47	0.08	3.47	0.73
Wheat	2.26	0.06	4.16	0.23

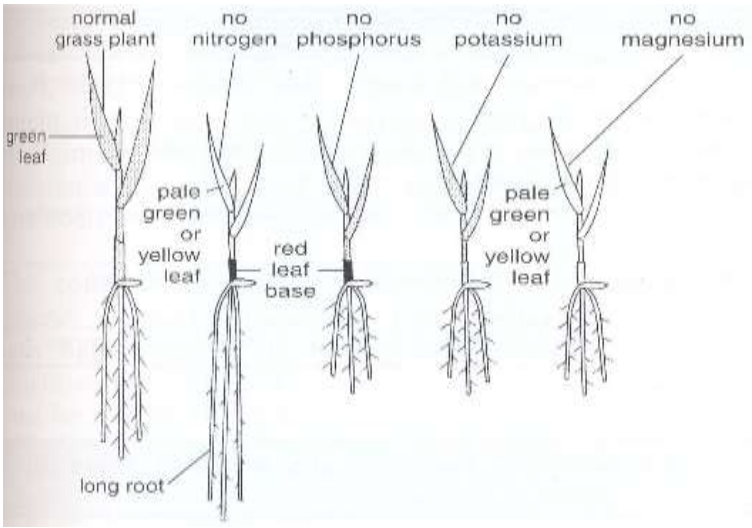
Water culture experiments

The importance of each macro-element to a plant can be shown in these experiments where one element at a time is omitted from a mineral solution. The control contains all the nutrients needed for growth.



The glass beaker used in the experiment is initially rinsed with concentrated nitric acid to remove traces of mineral elements. It has an opaque covering (aluminium foil) to keep out light and prevent

the growth of algae. Several seedlings are used in each beaker to improve the reliability of the results.



Deficiency Symptoms

Copy table into your jotter

Element omitted	Symptoms of deficiency	Reason for deficiency symptom (role of element)
nitrogen	overall growth reduced, leaves chlorotic (pale green or yellow), leaf bases red, roots long and thin	required for formation of amino acids, proteins and nucleic acids
phosphorous	overall growth reduced, leaf bases red	required for formation of ATP and nucleic acids
potassium	overall growth reduced, early death of older leaves	required for important role in transport of molecules across membranes
magnesium	overall growth reduced, leaves chlorotic	required for chlorophyll formation

Answer the questions below;

1. State the variables controlled in this experiment.
2. What was the purpose of the control experiment ?
3. What precautions were taken to ensure no contaminants, or other organisms interfered with results ?
4. Other than nitrogen, name an element that if deficient, results in chlorosis.
5. Apart from Carbon, Hydrogen and Oxygen name TWO elements needed by a plant to make DNA.
6. Give a reason why a plant needs potassium.

Success Criteria: I can

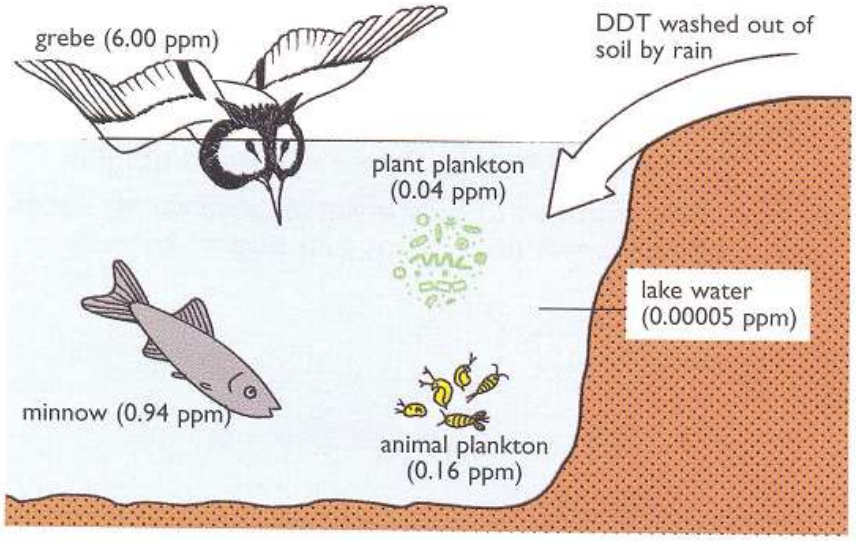
- **State what eutrophication is**
- **Identify causes of algal blooms**
- **Describe the effect increasing fertiliser concentration can have on plant species**
- **Identify macro-elements needed by plants**
- **State the purpose of macro-element use in plants**
- **State the effect of macro-element deficiency in plants**

Learning Outcomes – Pesticide Accumulation in Food Chains

- **To describe the effects pesticides have on organisms in food chains**
- **To describe how their toxicity changes**

Pesticides - DDT

DDT is a poisonous chemical that used to be sprayed on crops to kill insect pests. The molecules of DDT are non-biodegradable (i.e. are not broken down by decay microbes into harmless substances). They therefore gathered in the soil and were washed by rain into lakes near farmland.



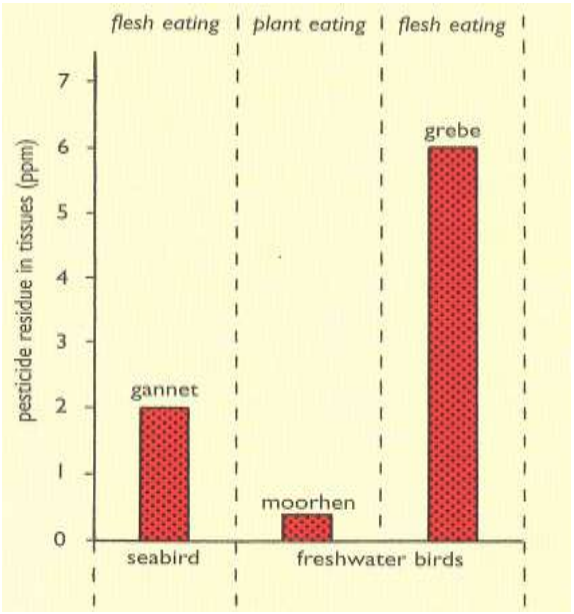
The diagram above shows the concentration of DDT in parts per million (ppm) found in the cells of the members of a lake community.

Answer the questions below in your jotter.

1. Construct a food chain which includes the four types of organism shown in the diagram.
2. Draw up a table to show the concentration of DDT found in the cells of each type of organism and arrange the information in increasing order.
3. a) What relationship exists between the food chain and the concentration of DDT in the cells of its members ?

b) Which animal do you think was found to suffer most and often die as a result of DDT poisoning ?
Explain your choice of answer.

4. Suggest why the use of DDT has now been banned in Britain.
5. Explain the relationship that you gave as your answer to question 3a using the terms non-biodegradable, accumulation and pyramid of numbers in your answer.
6. The bar graph shows the concentrations of pesticide residue found in the muscle tissues of three different water birds.
   a) Account for the difference in concentration found between grebe and moorhen.
   b) Suggest why gannets are less severely affected than grebes.



Success Criteria: I can

- **Construct a food chain**
- **State the relationship between the organisms in a food chain and the concentration of DDT**
- **Explain the relationship between organisms in a food chain and the concentration of DDT**

Learning Outcomes – Indicator Species

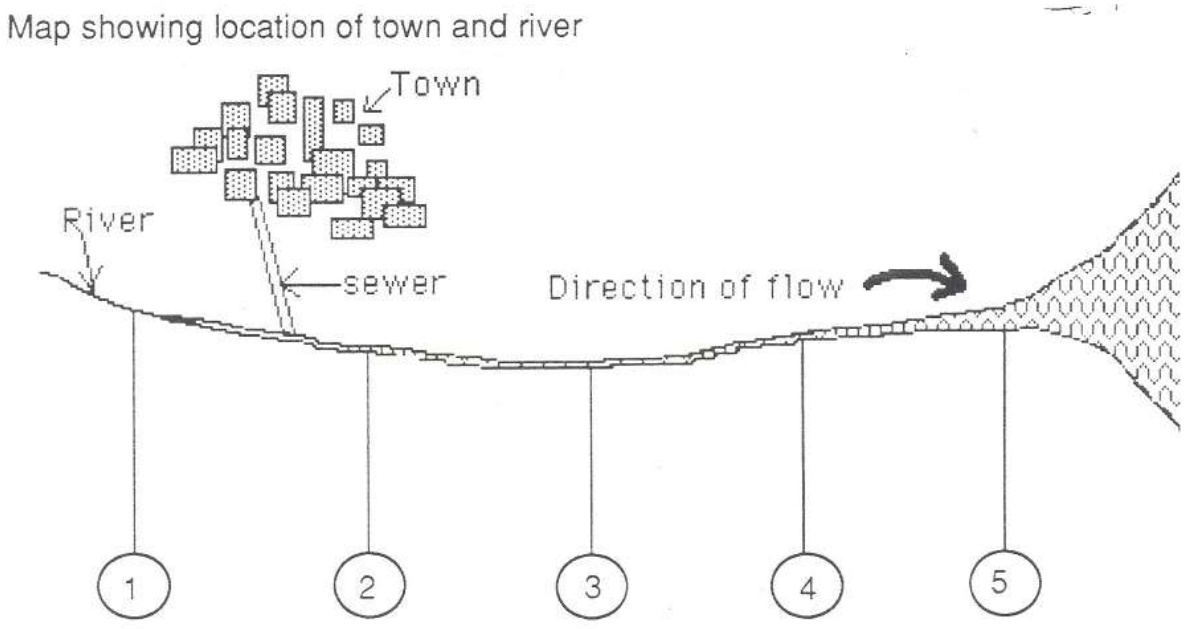
- **Describe the effects of sewage in water**
- **Explain how organisms can describe conditions in our surroundings**

Polluted Water

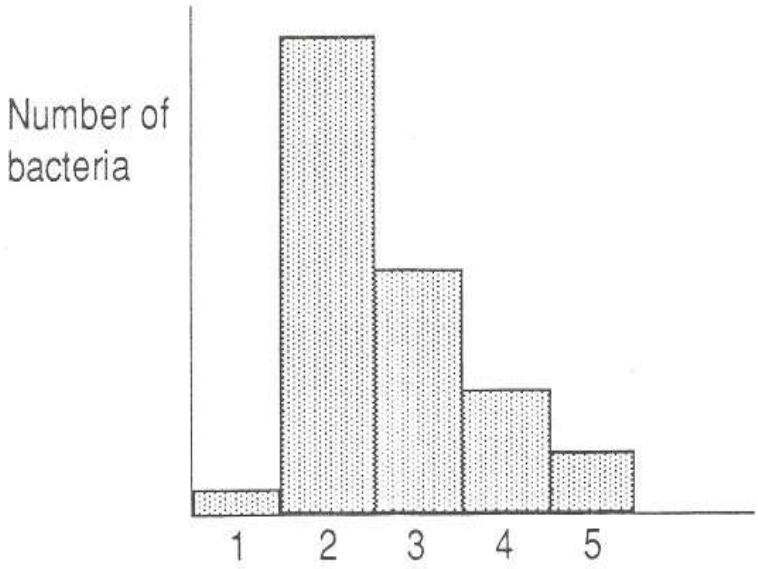
Copy the note below.

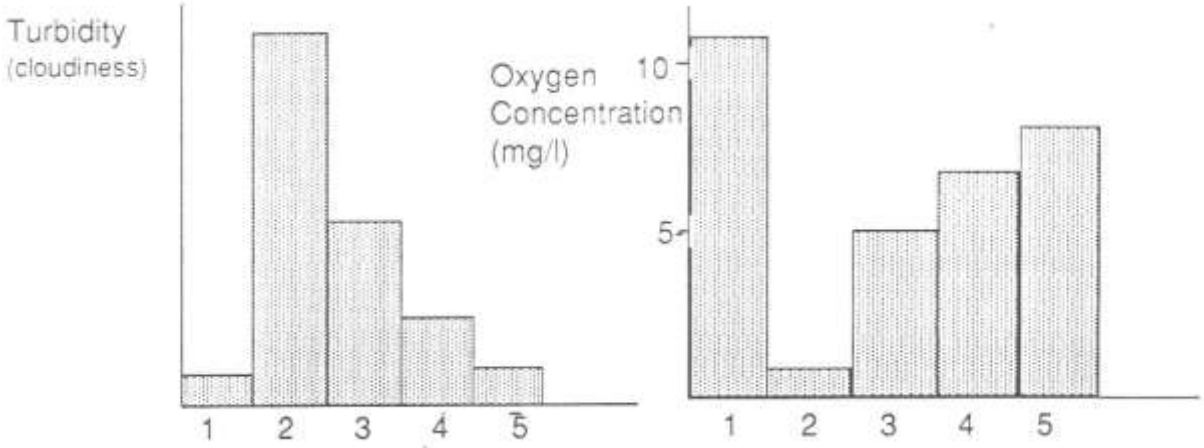
Sewage, which is a rich source of organic waste, is a common pollutant of rivers. Organic wastes can result in considerable changes to the water, and the number and kinds of organisms present. Organic waste provides food for micro-organisms (bacteria).

If water is polluted by organic waste, such as sewage or paper fibres, bacteria will feed on the organic material, grow and multiply. Like most organisms, bacteria require oxygen which they absorb from the surrounding water. This can cause the death of other aquatic (water living) organisms which require oxygen to survive.



At five places along the river samples of water were taken and tested for turbidity, oxygen concentration and numbers of bacteria. In addition, aquatic invertebrates were collected at each site. The results of this survey of organisms can be seen on the page overleaf.



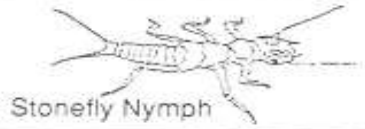
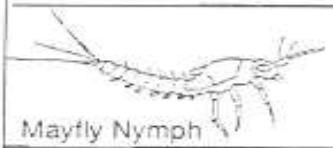
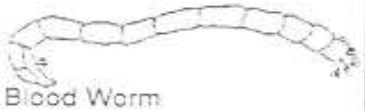
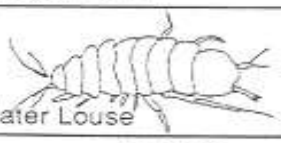
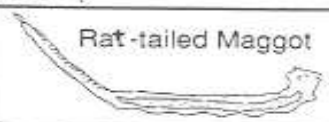


Answer the questions below.

1. In which part of the river is the turbidity the greatest ?
2. Why is there a large number of bacteria at sample site 2 ?
3. Why is there a low concentration of oxygen at sample site 2 ?
4. Why do the numbers of bacteria decrease as you go downstream of sample site 2 ?
5. Give two reasons why the oxygen level increases as you go downstream of sample site 2.

Pollution Indicators – Results

Some animals are only able to live in water which contains a lot of oxygen. Others can survive in water which contains little or no oxygen. ***Indicator organisms*** are organisms that tell us about environmental conditions.

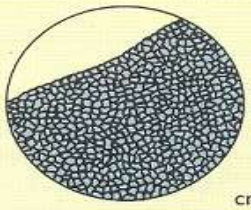
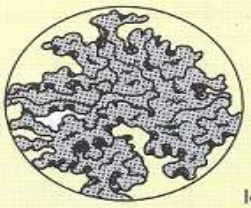
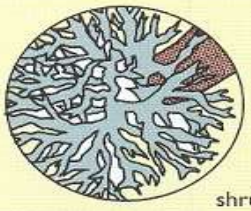
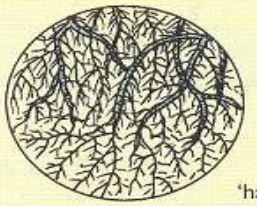
	SAMPLE SITE				
WATER ANIMALS	1	2	3	4	5
 Stonefly Nymph	55	0	0	0	40
 Mayfly Nymph	14	0	0	0	13
 Caddisfly Larva	3	0	0	1	1
 Blood Worm	0	0	10	5	0
 Sludge Worm	0	59	32	0	0
 Water Louse	1	0	21	20	0
 Shrimp	2	0	0	1	1
 Rat-tailed Maggot	0	38	4	0	0

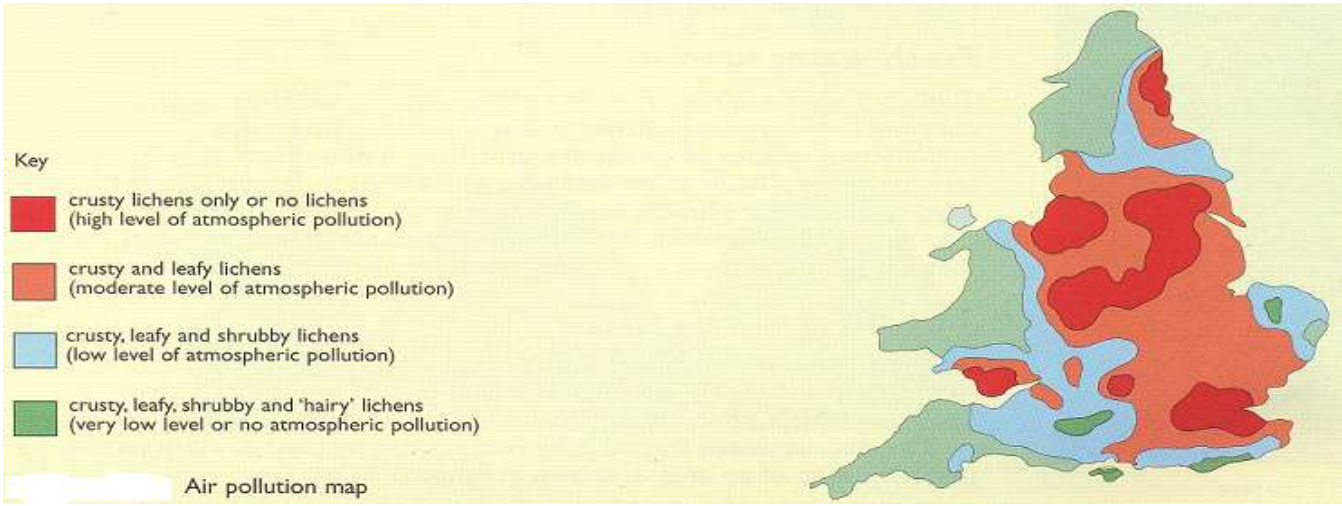
Complete the questions on "***Polluted water***".

6. Identify THREE organisms found in water with low levels of pollution.
7. Identify THREE organisms found in water with high levels of pollution.
8. For sample site 2 explain in detail the reason for each of the following;
   a) The increased level of organic pollution
   b) The increased number of bacteria
   c) The reduced level of oxygen
   d) The reduction in the number of species
9. Describe the trend, from sample site 1 to site 5, as raw sewage is dumped in the river, for;
   Turbidity
   Oxygen concentration
   Number of bacteria

Pollution Indicators – Lichen

Lichen are simple plants composed of algae and fungi that act as indicator species for different concentrations of ***sulphur dioxide*** (pollutant gas from combustion of fossil fuels) in the air. The diagram to the right shows how lichen indicate the degree to which an ecosystem's atmosphere is polluted by this harmful gas.

indicator species present	appearance of lichen	SO_2 concentration (and level of pollution) of atmosphere
crusty lichens only	 crusty	high
crusty and leafy	 leafy	medium
crusty, leafy and some shrubby	 shrubby	low
crusty, leafy, shrubby and 'hairy'	 'hairy'	very low/zero



Air pollution map

Data from a survey was used to complete and air pollution map of an area.

Answer the questions below in your jotter.

1. What is an indicator organism ?

2. Where are the pollutant gases coming from ?

3. Using the map, can you explain why crusty lichen are found concentrated in particular areas.

Success Criteria: I can

- **State that sewage is a source of organic material**
- **Describe the levels of oxygen lowering, bacteria rising and organism numbers falling in a water supply when sewage is emptied in.**
- **Explain the changes**
- **State that indicator organisms tell us about environmental conditions**
- **Identify organisms that indicate low and high levels of pollution.**

Learning Outcomes – Biological Control

- **To describe the use of one species to control the numbers of a pest species**
- **To describe how biological control and GM crops can reduce the negative effects intensive farming have on the environment**

Using as many resources as possible, produce an investigation into ***Biological control.*** Your report should detail;

- The pest species
- Negative impact pest has on the environment
- Control species and why it was chosen
- Potential drawbacks of control species
- Negative aspects of intensive farming
- Advantages to be gained from Biological control and potentially GM crops

Success Criteria: I can

- **Produce a report detailing how Biological control and GM crops could reduce the effects of intensive farming on the environment**