UNIVERSITY OF SWAZILAND
FACULTY OF EDUCATION
DEPARTMENT OF CURRICULUM AND TEACHING
FINAL EXAMINATION QUESTION PAPER, DECEMBER 2010

TITLE OF PAPER	:	CURRICULUM STUDIES IN BIOLOGY I
COURSE CODE	:	EDC 278
STUDENTS	:	BEd. II, PGCE
TIME ALLOWED	:	THREE (3) HOURS

INSTRUCTIONS:
1. This examination paper has six (6) questions. Question 1 is compulsory. Then answer any three (3) questions.

2. Each question has a total of 25 points.

3. There is an attachment (Biology for IGCSE, Jones, M., 2002, pages 258-277) for some questions

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Question 1 is compulsory.

1. a) Explain the relationship between the following concepts:

i) hypothesis formulating and hypothesis testing
ii) scientific models and scientific theories

[5]

b) Compare the characteristics of a person who has nominal scientific literacy and one who has functional scientific literacy. [5]

c) Discuss the place of behavioural objectives in the science classroom. [5]

d) Explain why individual laboratory activities are preferable to teacher demonstrations. [5]

e) Explain how a test specification grid provides important information about the contents of a test. [5]

Choose any 3 questions below.

2. a) Scientific knowledge, as a product of scientific inquiry, should meet the requirements of description, explanation, prediction and understanding. Discuss any two of these requirements, giving specific examples. **[10]**

b) Peter Medawar, Karl Popper and Thomas Kuhn have distinct views on what the criterion of demarcation is for scientific theories and, therefore, scientific knowledge. Discuss their respective views **[15]**

3. a) In Swaziland science teachers very frequently use demonstration to illustrate scientific phenomena while simultaneously developing inquiry skills in the learners. Explain what the use of *inductive, deductive* and *experimental* demonstrations entails. **[9]**

b) The learning cycle or 5E instructional model (engagement, exploration, explanation, elaboration and evaluation) can be used to actively engage learners in knowledge construction that results in the desired conceptual change. Select a topic(s) from the attachment, *Human Influences on Ecosystems,* and illustrate how you would use this model to foster conceptual change in the learners. **[16]**

4. a) The national science education standards for assessment advocate for *fair* and *accurate* assessment of learner achievement. Provide and explain the forms of assessment that would meet the criteria of fairness and accuracy for achievement in biology. **[15]**

b) Content validity is important in science assessment since it can be determined by teachers. Discuss the validity of this statement. **[5]**

c) Explain the significance of formative assessment in science. **[10]**

5. Questioning, as a teaching strategy, is advantageous because it allows for inquiry and hence can be used in scientific investigations and discussion. You may refer to the attached chapter titled *Human Influences on Ecosystems* to answer the following questions:

a) Select a section(s) and formulate two divergent questions that demand the use of critical thinking. **[5]**

b) If you were to teach a lesson on the selected section(s), explain how the lesson could be taught using discussion method, ensuring that all learners actively participate in the discussion. **[15]**

c) Write 2 objectives in the **affective** domain that you would wish your learners to attain from the above discussion. **[5]**

6. a) It has been observed that the curiosity of learners about the natural world diminishes the longer they study science especially as they progress to higher grade levels. Discuss the strategies you would employ to increase and maintain the curiosity of a Form IV biology class. Use concrete examples to illustrate your strategies. **[18]**

b) Describe the attributes of an effective science teacher **[7]**

Chapter

Human influences on ecosystems

Human activities may have harmful effects on ecosystems, for example by destroying habitats or polluting air, water or soil. Conservation can help to prevent and reverse such damage.

Food production ▶

Modern technology and agriculture

For thousands of years, people have been growing crops and keeping animals for food. At first, such agriculture was performed on a relatively small scale. As the human population has grown, and as the availability of machinery, fertilisers and pesticides continues to increase, people are able to produce more and more food from a given area of land.

This increase in agricultural production has brought great benefits to many people. In the developing countries of the world, general levels of nutrition have improved considerably in the last 40 years or so. For example, in 1961, the average daily energy intake of a person in a developing country was 8000 kJ. By 1983 this had increased to 10 000 kJ.

Nevertheless, the distribution of this improvement in agricultural technology around the world is very uneven. Figure 15.1 shows that although grain production has increased rapidly in Western Europe, it has not done so in Africa. This is partly because of

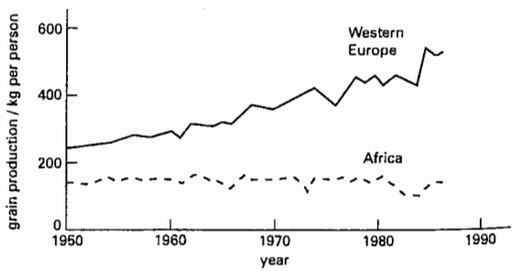
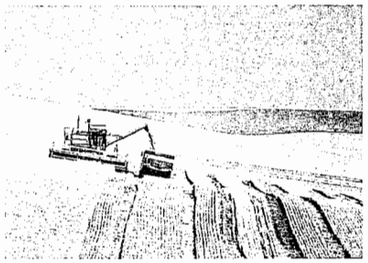


Figure 15.1 ▶
Changes in grain production since 1950 in Western Europe and Africa.



▲ Figure 15.2
In the USA, farming is done using sophisticated and powerful machinery. Here, wheat is harvested in California.

▲ Figure 15.3
In many parts of Africa, farmers are not able to use much machinery. This means that more people are needed to work the land, and they often have to work very hard. These farmers are ploughing in Ethiopia.

climatic problems such as lack of water in many parts of Africa, but is also because people do not have enough money to buy the machinery, fertilisers and pesticides which could help them to increase the yields of the crops they grow.

Moreover, although crop production may be increasing, so is the size of the human population. In Africa south of the Sahara, the human population is growing at a faster rate than the crop production. This means that the amount of food produced per person is actually getting less. This problem is not going to be solved simply by improvements in technology. Much of the problem lies in damage being done to the land, which results in soil erosion and loss of fertility.

Country	Soil erosion / metric tonnes per hectare per year
USA	18
Jamaica	36
Nepal	50
Ethiopia	42
India	75

▲ Table 15.1
Rates of soil erosion in five countries.

Soil erosion

Soil is a precious material. A good, deep soil, suitable for growing crops, takes thousands of years to form. If it is lost, it cannot easily be replaced.

When there are plants growing in soil, it is very resistant to erosion. Rain falling onto the ground first hits the plants rather than the soil. The water soaks gently into the soil. A lot of the water is taken up by the plants. However, if all the plant cover has been removed, then the rain drops fall directly on the soil, loosening and moving the soil particles. There are no plants to absorb the water, so a lot of it runs off the land over the surface of the soil, carrying away the soil as it does so.

Question

15.1 Use an atlas to find the five countries listed in Table 15.1. For each country, find out its average rainfall (this information should be in your atlas) and how mountainous it is. Use this information to suggest why some of these countries have higher rates of soil erosion than others.

When people **clear forests** to grow crops, they frequently open up the soil to this kind of erosion. The soil of tropical rainforests is especially thin, and easily eroded. Within a few years of cutting down the trees, the soil will probably be too thin and poor to grow crops.

▲ Figure 15.4
Removing trees can quickly lead to devastating soil erosion. Here you can see that, where the trees are growing, the soil has remained. Where they have been cut down, large amounts of soil have been washed away.

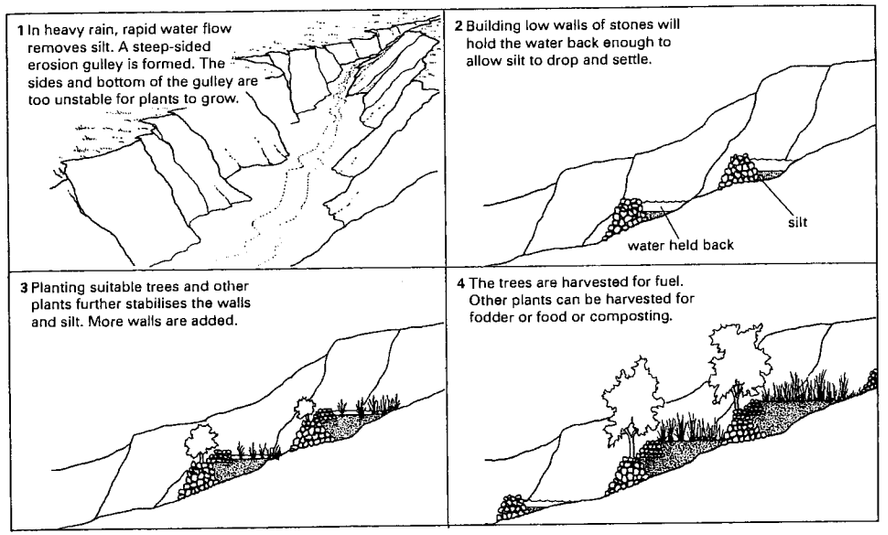
▲ Figure 15.5
Clearing forests on slopes allows more rainwater to run into rivers. This can cause flooding.

Another way plant cover can be removed from soil is by **overgrazing**. Animals such as cattle, sheep and goats may increase soil erosion by eating almost all the plants in an area, and trampling the soil.

Even deep, fertile soils are easily eroded. A farmer may leave his fields empty for part of the year. During this time, rainfall can easily wash away the soil.

As well as losing irreplaceable soil, this can cause damage to waterways. The eroded soil is carried into rivers. The rivers may silt up, reducing their navigability, and making use of the water for irrigation more difficult. When it rains heavily, the silted rivers cannot carry away the excess water, and flooding may result.

Reducing soil erosion



▲ Figure 15.6
Gulley erosion and reclamation. No expensive technology or materials are needed to stop this type of soil erosion – just stones, and people to carry them.

▲ Figure 15.7
Farmers on these hillsides in the Philippines have built terraces for growing rice. This stops too much soil being washed down the slope.

Figure 15.6 shows how erosion can lead to trenches or **gulleys** being formed in soil, and what can be done about this.

There are many other ways in which people can reduce soil erosion. These include:

- not cutting down trees in areas where the soil is most likely to erode, and planting trees to help to stabilise soil on open land
- not grazing too many animals on land where the soil is vulnerable to erosion
- making terraces where crops are grown on hillsides, so that water cannot wash soil down the slope
- adding humus, such as animal dung and rotted plant material, to the soil, to make it more likely to stick together and less easily washed away
- keeping a cover of plants on the soil, as their roots will help to hold the soil in place.

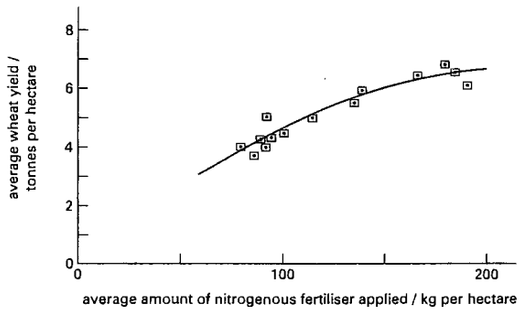
However, for people finding it difficult to get enough to eat, there may be little incentive to do any of these things. If your only concern is how to survive until

tomorrow, or until next year, it is difficult to worry about what may happen to the soil in ten years' time. Problems of soil erosion in poor areas of developing countries can only be solved by improving people's standards of living, so that they do not need to make such heavy demands on the land.

Problems resulting from over-use of fertilisers

One of the main reasons for the increase in crop production in Western Europe shown in Figure 15.1 (page 258) is the increase in use of nitrogenous fertilisers. Adding fertilisers to the soil can greatly increase crop yields (Figure 15.8). Without fertilisers, there would be no hope of feeding the world's population.

Figure 15.8 ▶
Graph to show the relationship between application of nitrogen fertilisers and wheat yields in the UK, 1965–90.



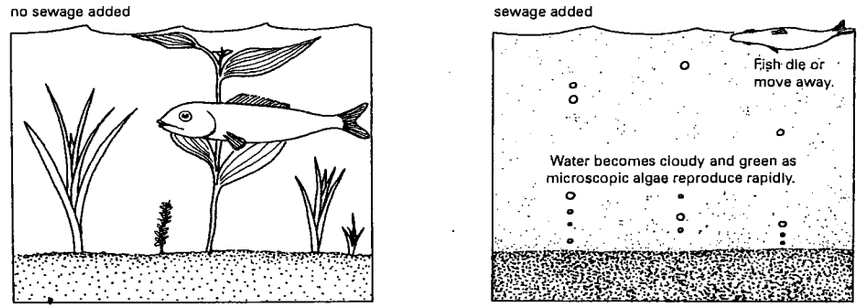
However, careless use of fertilisers can cause great damage to ecosystems. The nitrates contained in fertilisers are very soluble. Any nitrates put onto the soil and not immediately taken up by plants can be washed away when it rains. This is called **leaching**. The leached fertilisers may end up in streams, rivers and lakes.

The fertilisers provide nitrogen for plants and algae, which grow quickly. The algae may grow so much that the water looks thick and green. This blocks out light for the plants growing lower down in the water. These plants, and eventually the algae as well, die. This provides food for bacteria, so the populations of bacteria increase. The bacteria respire, using up oxygen in the water. Animals living in the water cannot breathe, and so they die.

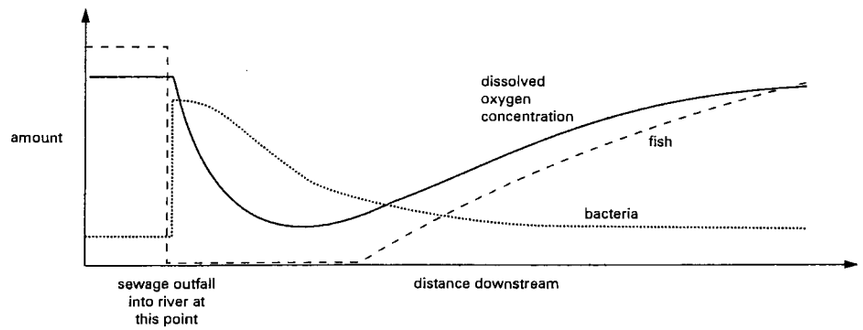
This process is called **eutrophication**. It can happen whenever plant nutrients get into ponds, lakes, rivers or the sea. Fertilisers are not the only cause of eutrophication. Untreated sewage, and waste from factories producing foodstuffs can also cause this problem.

Question

15.2 Figure 15.9(b) shows how the amount of oxygen, numbers of bacteria and numbers of fish change as you go downstream from an outfall of untreated sewage. Suggest explanations for the shapes of each of these three curves.



(a) Eutrophication.



(b) Changes in dissolved oxygen, bacteria and fish, upstream and downstream of an outfall of untreated sewage.

▲ Figure 15.9

Preventing problems from over-use of fertilisers

To prevent these problems, people should:

- only apply fertilisers to land when plants are growing, so that they will immediately be taken up
- not apply too much fertiliser, so that it will all be taken up by plants
- not apply fertiliser when it is about to rain
- where possible, use manure or other organic fertilisers instead of fertilisers such as ammonium nitrate – manure is often cheaper, it breaks down slowly and releases the nitrogen to the plants over a long period of time, and adds humus to the soil, which can improve its texture and reduce erosion.

Pollution ▶

Pollution can be defined as *the addition of something to an ecosystem which can damage the living organisms within it.*

Water pollution

The effects of water pollution by **fertilisers** have just been described. Pollution by untreated **sewage** has a similar effect, causing eutrophication.

Pollution by sewage causes another problem, too. Sewage is waste water from houses and industries. It contains human urine and faeces, which may be contaminated with harmful viruses and bacteria. Many diseases, such as cholera, typhoid and poliomyelitis, can be transmitted in untreated sewage. A person may catch these diseases by swimming in or drinking contaminated water, or eating food that has come into contact with it.

Supplement

Sewage treatment

Figure 15.10 outlines how sewage may be treated to make it safe. After treatment, the **effluent** can be allowed to flow into a river, where it will not cause eutrophication, nor carry the risk of disease.

There are many different methods of sewage treatment, but all of them rely on microorganisms, such as

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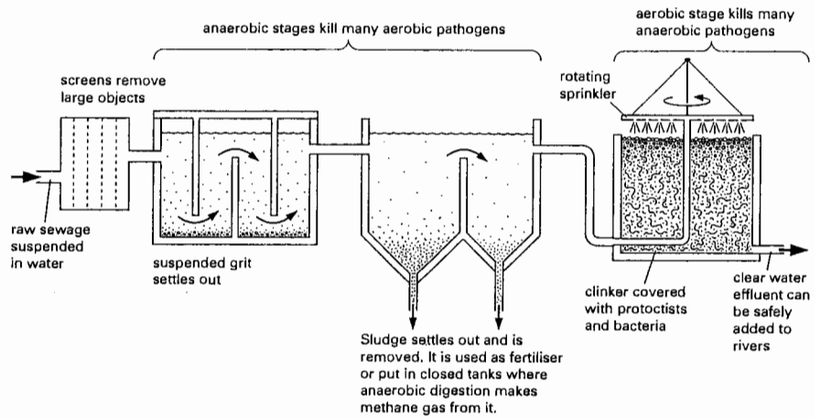

Figure 15.10
One method of sewage treatment.

bacteria and **protoctists**, to feed on the sewage. The microorganisms break down harmful substances in the sewage. In the example shown in Figure 15.10, this is partly done in **anaerobic**, or oxygen-free, conditions. This method has the advantage of producing methane, which can be used as a fuel.

Water pollution by inorganic waste

Inorganic substances are substances that have not been made by living things. They tend not to contain carbon in their molecules. One example is ammonium nitrate, which is widely used as a fertiliser. The effect of pollution by fertilisers has been described in this chapter.

Another important inorganic water pollutant is **mercury**. Mercury may get into water as a waste product from factories. It is highly toxic.

For example, in the 1950s a disease broke out in a Japanese fishing village. Some people died, others suffered from problems with their muscles and nervous systems, and many deformed babies were born. The problem was tracked down to mercury, which had got into the sea near the village from a factory making plastics. The factory was using mercuric sulphate as a catalyst. The mercury was getting into the bodies of

fish, and then into people who ate the fish. Once the factory's discharge of waste into the sea was stopped, the disease disappeared.

Air pollution

We have already described, on page 247, how the burning of fossil fuels releases **carbon dioxide** into the atmosphere. Another gas produced when fossil fuels, especially coal, are burnt is **sulphur dioxide**. Most sulphur dioxide pollution is caused by coal-burning industries, such as power stations.

Sulphur dioxide is a very unpleasant gas. It is an **irritant**, which means that it causes discomfort when you breathe it in. In people who have a tendency towards bronchitis or asthma, it can trigger an attack. Sulphur dioxide gas can also get into plants, through the stomata in their leaves. It can kill cells in the leaf, eventually killing the whole plant if the pollution continues.

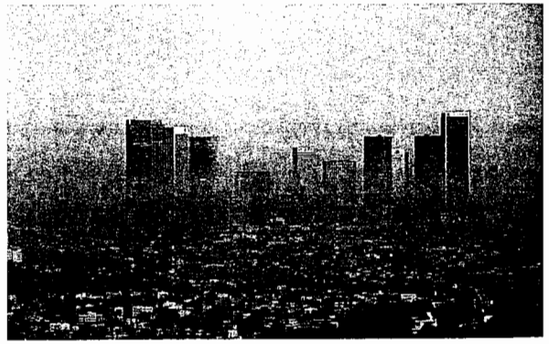

Figure 15.11 ▶
Sulphur dioxide pollution in Los Angeles comes from the huge number of cars which are used in the city.

Supplement

Acid rain

Sulphur dioxide, SO_2, in the atmosphere may be oxidised to sulphur trioxide, SO_3. The sulphur trioxide dissolves in water in the atmosphere to form sulphuric acid, which falls as acid rain or acid snow.

Sulphur dioxide is not the only gas that causes acid rain. **Nitrogen oxides** also do this. The major source of nitrogen oxides is car exhaust fumes. Figure 15.12 shows the formation and effects of acid rain.

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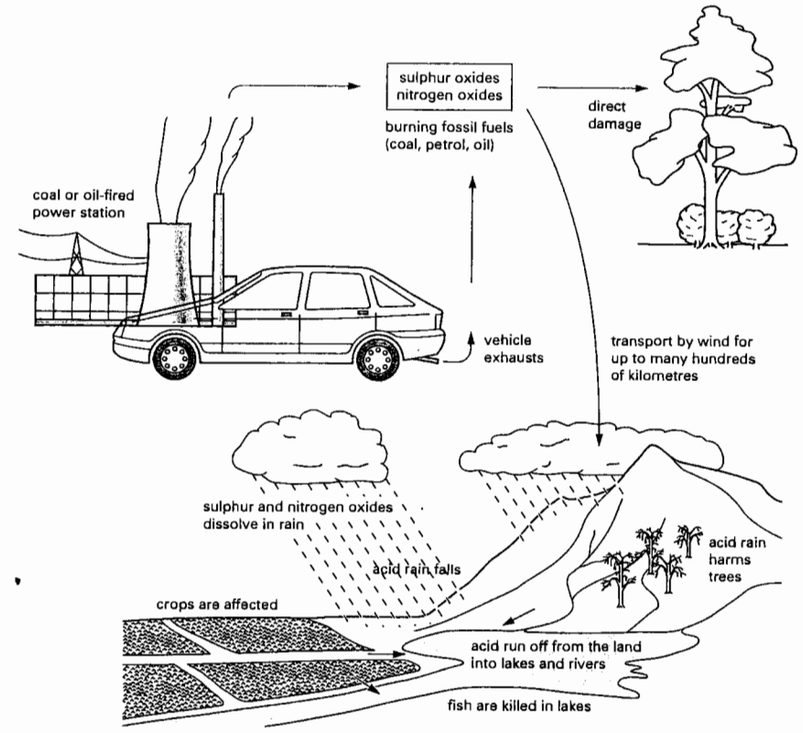


Figure 15.12
Acid rain.

Acid rain may damage the leaves of trees directly, but these effects are relatively small. More importantly, it can dissolve and wash away important minerals, such as calcium and magnesium, as it soaks through the soil. On thin soils, such as those on mountainous areas of some parts of Europe (Figure 15.13 overpage), this can make the soil so poor that whole forests die.

The acid rain also washes out aluminium ions from the soil. The aluminium accumulates in rivers and lakes. Aluminium ions are toxic to fish, especially young ones, as they can stop the gills functioning properly. The fish in badly acidified lakes are often killed.

Supplement

Figure 15.13
Areas of Western Europe most affected by acid rain.

Acid rain can damage buildings. Some buildings are made of stone containing carbonates, such as calcium carbonate (limestone). The acid dissolves the carbonate, causing the stone to crumble away.

Reducing pollution from acid rain

Several steps are being taken in developed countries to reduce pollution by sulphur dioxide and nitrogen oxides. These include:

- Installing 'scrubbers' which remove almost all of the sulphur dioxide from the waste gases at coal-burning power stations. However, this is expensive, and means that the electricity produced by these power stations costs more.
- Using catalytic converters on car exhausts. These convert the nitrogen oxides into nitrogen. (However, although catalytic converters help reduce acid rain, they do nothing to reduce the amount of carbon dioxide emitted in the exhaust fumes.)

Pollution by pesticides and herbicides

Pesticides are chemicals used to kill pests, such as insects that eat crop plants. Herbicides are chemicals used to kill weeds.

Benefits of using pesticides Pesticides are used to reduce crop losses, and also to control the spread of diseases like malaria, which are spread by insect vectors.

Pesticides have been immensely valuable in increasing food production. In developing countries, it is estimated that at least a third of the crops grown are lost to pests. For cotton production, the figures are even worse – it has been calculated that, without the use of pesticides, almost half of the cotton produced in developing countries would be destroyed.

Pesticides also help to control diseases. Malaria is a devastating disease, which causes repeated and debilitating illness, and may kill. Without pesticides to control mosquitoes, many more people worldwide would suffer from malaria. A campaign run by the World Health Organisation since 1955, using pesticides and other methods to control mosquitoes and hence malaria, is estimated to have saved 15 million lives.

Problems with using pesticides Despite their benefits, pesticides must be used with great care. In the past, before the problems associated with pesticides were understood, a lot of damage was done to the environment.

For example, one of the first insecticides to be used was **DDT**. This was widely used in the 1950s and 1960s. However, it was discovered that DDT used to kill insects could enter food chains. It is a **persistent** pesticide – it does not break down, but remains in the environment. As it was passed along a food chain, it became more and concentrated in each successive organism. Carnivores ended up with so much DDT in their bodies that they died. DDT has now been banned in most countries.

Persistent pesticides may end up in food intended for humans, as **pesticide residues**. This is particularly likely if food is harvested soon after it has been sprayed with pesticides. In most developed countries, there are strict regulations about how long food must be left between spraying and harvesting, but some developing countries do not follow these rules. Thus, people could be poisoned by eating food containing pesticide residues.

People using the pesticides can also be poisoned if they do not wear proper protective clothing. Many pesticides can be absorbed through the skin. In Britain, some farmers have become ill after using pesticides called organophosphates, to kill parasites on sheep.

Another problem is that insects and weeds may develop **resistance** to pesticides. This happens in a similar way to the development of resistance to antibiotics by bacteria, described on pages 229–230. This has happened, for example, with mosquitoes, which have built up resistance to the pesticides used to kill them. Mosquitoes, and the malaria they carry, are beginning to spread back into areas where they had been eradicated.

Insecticides (pesticides used to kill insects) often kill not only harmful insects, but also helpful ones. Such insecticides are said to be **non-specific**. Thus, a farmer spraying a crop with a pesticide to kill a pest may also kill all the natural predators, such as spiders, of that pest. In future, if he does not keep on spraying with the

▲ Figure 15.14
The amount of care taken over the use of pesticides in developed and some developing countries differs greatly. The first picture shows wheat being sprayed near Oxford, England, while in the second one a farmer sprays cotton plants with DDT in Nicaragua. What differences can you see in the way the pesticide is being used? What problems might the Nicaraguan farmer be causing?

pesticide, he will have an even worse problem with the pests than before.

How can all these problems be solved? Much more care is now taken when new pesticides are developed, to make sure that they are not persistent. However, it is now realised that it is in everyone's interest to find other ways of controlling pests. This may involve **biological control**, in which a natural predator of a pest is used to keep the pest's population low. This has the advantages that it is often cheaper, does not cause pollution, and only kills the pest and not other living organisms.

Question

15.3 The table shows the increase in use of pesticides on cotton crops in an area of Sudan between 1959 and 1979.

Year	Average number of times pesticide was sprayed in one year
1959	1.0
1964	2.5
1969	4.9
1974	6.0
1976	6.5
1977	8.1
1978	9.3

a Plot a graph to show these data. Take care with the *x*-axis!

b Describe what happened to the use of pesticides between 1959 and 1978.

c Suggest reasons for the changes you have described.

d Suggest what the cotton farmers of Sudan might have done to allow them to decrease their use of pesticides.

Pollution by nuclear fallout

Ionising radiation, such as alpha, beta and gamma radiation, damages DNA. This can lead to cancer or birth defects. Exposure to large amounts of radiation can also cause radiation sickness, when so many cells are damaged that the person becomes very ill, and may die.

There is ionising radiation all around, all the time. This is called **background radiation**, and it comes from rocks in the Earth, and from cosmic rays from the Sun. However, in most parts of the world, this background radiation is not great enough to cause any harm.

Nuclear reactions can produce large amounts of radiation. Nuclear reactions take place in nuclear power stations. If these are well designed, well built and well maintained, little or no radiation leaks from them. However, when accidents occur, such as at Chernobyl, large amounts of radioactive substances, emitting ionising radiation, can be released into the air. This is sometimes called nuclear fallout. Nuclear bombs also produce enormous quantities of nuclear fallout.

Some of the radioactive substances produced last for a very long time, and may be carried in the air over very large distances. In the Chernobyl accident, a radioactive form of iodine was produced, which fell to the ground in many countries, including Wales. The radioactive iodine was absorbed by grass, and eaten by sheep. Many years after the accident, it is still not safe to eat sheep which have grazed in some of these areas, because levels of radiation are still high.

Supplement

Pollution by non-biodegradable plastics

Substances such as sewage are **biodegradable**. Given time, bacteria and other microorganisms will break them down. Biodegradable substances cause only short-term pollution problems.

In the past, most of the waste substances produced by humans were biodegradable. However, many substances used in the manufacturing industry, such as metals, glass and plastics, are not biodegradable. If these materials are thrown away, they remain in the environment virtually for ever. They are an eyesore, and can be dangerous to small animals which may get trapped in them.

Disposal of non-biodegradable plastics is a problem. They can be buried, but they then remain in the soil for years. They can be burnt, but many of them release toxic gases.

Supplement

Some plastics can be **recycled**. The plastic called PET, which is used for making bottles for soft drinks, can be reused. People save their empty PET bottles and take them to a collection point, from where they are taken to a recycling plant to be made into new plastic articles. This reduces plastic pollution. It would be better still if the bottles were cleaned and reused as they are, but this is expensive and difficult to do.

Question

15.4 One way of disposing of non-biodegradable plastics is to burn them in order to produce energy. The table shows the amount of energy released when 1 kg of different kinds of plastics are burnt.

Plastic	Energy released on combustion / kJ per kg
Polystyrene	38 000
Polyethylene	43 000
PVC	22 000
PET	22 000
Mixed plastic	37 000

a State one problem encountered when burning plastics.

b Suggest a use that could be made of the energy released from burning plastic waste.

c Suggest why sorting plastic waste before burning it could be useful.

d Assuming that all of these plastics could be recycled, and using only the information in the table, suggest which plastics would be better recycled than used as a fuel.

Conserving natural resources

Humans take and use a great many materials from the Earth. These are called **resources**. We shall consider just three examples – fossil fuels, water and trees used for paper.

Fossil fuels were produced millions of years ago. They are only forming very slowly, in just a few tiny areas, now. As we use up the fossil fuels in the Earth, they are not renewed. They are ***non-renewable resources***.

Huge amounts of fossil fuels are being used all over the world, especially in developed countries, to provide energy. This causes several problems. Two such problems are:

- Burning fossil fuels causes pollution by carbon dioxide, sulphur dioxide and nitrogen oxides.
- Our supply of fossil fuels will soon run out.

Although some attempts have been made by some countries to cut down their energy consumption, and hence their rate of use of fossil fuels, there has been little success in this. Instead, we are beginning to turn to using **renewable resources** for energy production. These include solar power, wave and tidal power, hydroelectric power and wind power. By using these resources for generating electricity, we can not only reduce our rate of use of fossil fuels and ensure that we have energy supplies in the future, but can also reduce pollution.

Water is a vital substance which is in short supply in many countries. Although there is plenty of water on Earth to provide every person with more than enough for their needs, the distribution of water is very uneven. Thus, in parts of the world where population is very dense, or where rainfall is very low, water may be a resource that needs to be **conserved**.

Trees are used for many purposes, and the problems caused by deforestation have been described earlier. Many trees are cut down to produce **paper**.

Conservation of species and their environments

The impact of human activities on the environment, such as deforestation, farming and pollution, has caused

▲ Figure 15.15
When old forest trees are cut down, lasting damage is done, because it takes so long for such trees to be replaced. The environment is likely to be permanently damaged, destroying habitats for many different species of living organisms.

tremendous changes to the habitats of many organisms. This can destroy some species completely, making them extinct. Figure 15.16 shows some causes of threats to mammals and birds.

For example, the cutting down of tropical rainforest puts large numbers of species in danger of extinction. One hectare of tropical rainforest may contain 200 different species of trees, and thousands of species of other plants and animals. Many of these species have very small ranges, so that cutting down quite a small piece of forest may remove almost all of their habitat. It is very easy to make such a species extinct.

This is not a problem that has just begun to happen. Humans have been causing extinctions for a very long time. For example, it is thought that the first humans settled on the Pacific islands of Fiji, Tonga and Samoa about 3000 years ago. Their coming caused mass extinctions of animals living on the islands. Of the 25 species of flightless birds that lived there, only 8 survive today.

Similarly, Hawaii has suffered great losses of bird species. When European settlers first arrived there in 1778, there were 50 species of birds living there. Now there are only 34.

Why does it matter if a species becomes extinct? For many people, there is no question about this – it is obvious that the loss of a species is a loss to the whole

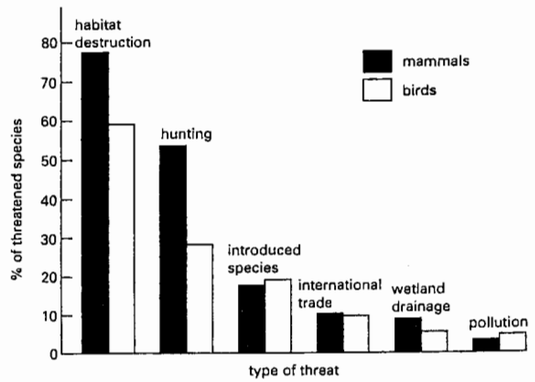


Figure 15.16 ▶
The relative importance of six types of environmental threat to mammals and birds.

world. The fewer species there are on Earth, the less diverse and rich is our environment.

There are other arguments, too, directly related to the potential benefits to humans of conserving as many species as possible. The more different species there are in an ecosystem, the more stable the ecosystem is. This means that any changes which take place – such as a new disease evolving, or a climatic disaster – have less chance of causing lasting damage to the ecosystem than if only a few species live in it. Complex, rich ecosystems, with many different species living in them, help to stabilise the environment, making it more able to support not only the species that live in it but also humans as well. Rich ecosystems mean a healthy Earth.

You may be surprised to know that large numbers of new species are discovered each year. We still do not know all the different kinds of living things on the Earth. In 1993, the number of known species was about 1.4 million. Some biologists estimate that this is only one tenth of the number of species which live on Earth! Of course, these as yet undiscovered species will not be large animals, but mostly small ones such as insects (especially beetles), and small plants. When we destroy part of a tropical rainforest, we may be destroying many totally unknown species, for ever.

Some of these species may be directly useful to humans. For example, one small plant that comes from Madagascar, called the rosy periwinkle, was recently discovered to contain a chemical which can help to cure cancer. The use of this plant has saved the lives of hundreds of children suffering from leukemia. How many other useful, unknown, species exist?

Much can be done to reduce the likelihood of extinctions. The main focus must be on conservation of whole ecosystems. This means reducing the impact humans have on areas which are especially important for wildlife, such as tropical forests. However, this is not easy. Many of the countries in which tropical rainforests still grow are relatively poor. By cutting down their forests, people can temporarily increase their standard of living, by selling timber from the forest, or by increasing the amount of agricultural land. Such countries need help from richer ones, in order to be able to afford conservation measures. The developed

countries must not forget that they have already destroyed many of their natural habitats.

Question

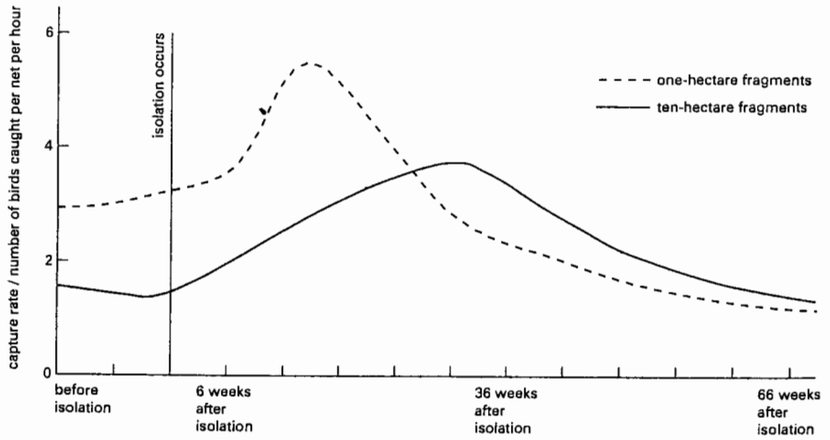
15.5 One strategy used to attempt to conserve species is to preserve areas of their habitat.

For example, as rainforest in one part of the Amazon basin was destroyed, areas of different sizes were left as undisturbed habitat. Biologists counted the number of species of birds in these areas before and after the removal of the rainforest around them. They did this in areas of two different sizes, one hectare and ten hectares. The results are shown in Figure 15.17.

a Suggest why the number of bird species caught in the area increased in the few weeks after the surrounding forest was cut down compared with before.

b Suggest why the number of bird species caught in the area gradually decreased to below the original levels.

c What do these results suggest about the usefulness of such isolated patches of undisturbed habitat as wildlife reserves?



▲ Figure 15.17
The numbers of birds caught before and after isolation of fragments of forest.

Supplement

Recycling

One way of conserving water is to reuse or recycle it. Water that has been used for washing, or in industry, or for any other purpose, can be treated to make it suitable for reuse. This can also apply to water that has been drunk! It is excreted from the body in urine, which can be treated in sewage plants to destroy any harmful organisms and produce a harmless effluent. The water will need further treatment before it is pure enough to drink.

We can reduce the number of trees that are cut down by recycling paper. Newspapers, magazines and cardboard wrapping can be collected and taken to recycling plants. Here, the print on the paper is removed using chemicals, and the paper mixed with water to make a slurry before being re-rolled into sheets. Recycled paper is not as pure white as 'first-time round' paper, nor can it be of such a fine texture. However, it is very suitable for making paper towels, paper bags, writing paper and packaging.

It should be realised, however, that in many parts of the world the trees cut down to make paper have been specially planted just for this purpose. When they are harvested, new trees are planted to take their place. Paper-making does most harm to the environment when the trees used are taken from mature forests, such as tropical rainforests, which are irreplaceable.

- Modern technology has greatly increased the output from farming. However, this technology is not always available to farmers in developing countries.
- Deforestation and overgrazing can cause soil erosion, which in turn can lead to flooding.
- Water pollution by fertilisers or untreated sewage can cause bacterial populations to increase rapidly. The bacteria use up oxygen in the water, so that animals such as fish cannot live there. This is called eutrophication.
- Sulphur dioxide is produced when coal or oil are burned. It combines with oxygen and water in the air to form acids, which fall as acid rain. This can damage trees and aquatic organisms.
- Nuclear fallout of radioactive substances can increase the likelihood of mutations occurring.
- Non-biodegradable substances, such as plastics, can cause pollution and may harm animals.
- Pesticides and herbicides that are not biodegradable can build up as they pass along a food chain, so that animals feeding at the end of the chain absorb large amounts of them and may be harmed.
- Conservation aims to maintain biodiversity and conserve natural resources. Recyling, for example of paper or water (sewage treatment) can reduce our use of natural resources and reduce pollution.