UNIVERSITY OF SWAZILAND
FACULTY OF EDUCATION
DEPARTMENT OF CURRICULUM AND TEACHING
FINAL EXAMINATION QUESTION PAPER, DECEMBER 2009

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 (IGCSE Biology, Mackean, D. G., 2009, pages 224-228) for one question

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Question 1 is compulsory.

1. a). i) State the views of J. B. Conant on how scientific progress is made. [3]

ii) Explain the relationship between hypothesis formulating and hypothesis testing [4]

b) Two essential features of inquiry teaching and learning, as suggested by the National Science Education Standards, are

i) *learners are engaged by scientifically oriented questions*
ii*) learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions*

Explain how these features can be developed in the classroom using examples from biology. [8]

c) Explain how non-behavioural objectives are advantageous in science teaching. [5]

d) In the IGCSE/SGCSE, criterion referenced decisions are significant whereas in the GCE O'Level, norm referenced decisions are significant. Explain. [5]

Choose any 3 questions below.

2. a) Induction as a way of explaining scientific discoveries is rejected by Peter Medawar and Karl Popper. Explain their justification for this position. [7]

b) Thomas Kuhn states that scientific progress is characterized by a series of scientific revolutions comprising periods of extraordinary science and normal science. Elaborate. [10]

c) Explain, giving examples, the role of scientific models in scientific inquiry. [8]

3. a) You are preparing to teach a Form V inquiry lesson on food chains and/or food webs. You may refer to the attachment (Mackean, D. G., 2009) to answer the following questions.
Explain how the lesson could be taught using the following strategies:
i) Questioning, and
ii) Group work and cooperative learning [9,9]

b) For each technique in a) identify the science process skills you would aim to develop. [7]

4. a) Explain the purpose and function of behavioural objectives in science education. [7]

b) A major aim of science teaching is to produce scientifically and technologically literate individuals.

i) Provide two conceptually different goals of science teaching and explain how they would enable learners to achieve this aim. **[10]**

ii) Write two **general** objectives for each goal from different levels of the cognitive domain. One of the levels should be application or above. **[8]**

5. a) Explain how the following forms of evaluation are used biology education:

    i) Diagnostic evaluation
    ii) Formative evaluation
    iii) Summative evaluation **[12]**

b) Evaluation and assessment are terms that are used interchangeably yet they have distinct meanings. Explain how these terms are different and/or similar to each other. **[6]**

c) Explain the significance of preparing a test specification grid for any test that is to be administered to learners. **[7]**

6. a) A Form 2 science teacher noticed that her class did not show as much enthusiasm in her science class as they did in Form 1. In retrospect, she realised that this had been a gradual trend since Form 1.

i) Discuss three possible causes for the change in the behaviour and responses of the class. **[9]**

ii) Describe the strategies the teacher should employ to motivate her class. **[9]**

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

25 The interdependence of living organisms

Food chains and food webs
Pyramids of numbers and biomass, recycling.
The carbon cycle
The nitrogen cycle
The water cycle
Agriculture
Decay
Energy flow in an ecosystem

'Interdependence' means the way in which living organisms depend on each other in order to remain alive, grow and reproduce. For example, bees depend for their food on pollen and nectar from flowers. Flowers depend on bees for pollination (p. 69). Bees and flowers are, therefore, interdependent.

Food chains and food webs

One important way in which organisms depend on each other is for their food. Many animals, such as rabbits, feed on plants. Such animals are called **herbivores**. Animals called **carnivores** eat other animals. A **predator** is a carnivore which kills and eats other animals. A fox is a predator which preys on rabbits. **Scavengers** are carnivores which eat the dead remains of animals killed by predators. These are not hard and fast definitions. Predators will sometimes scavenge for their food and scavengers may occasionally kill living animals.

Food chains

Basically, all animals depend on plants for their food. Foxes may eat rabbits, but rabbits feed on grass. A hawk eats a lizard, the lizard has just eaten a grasshopper but the grasshopper was feeding on a grass blade. This relationship is called a **food chain** (Figure 25.1).

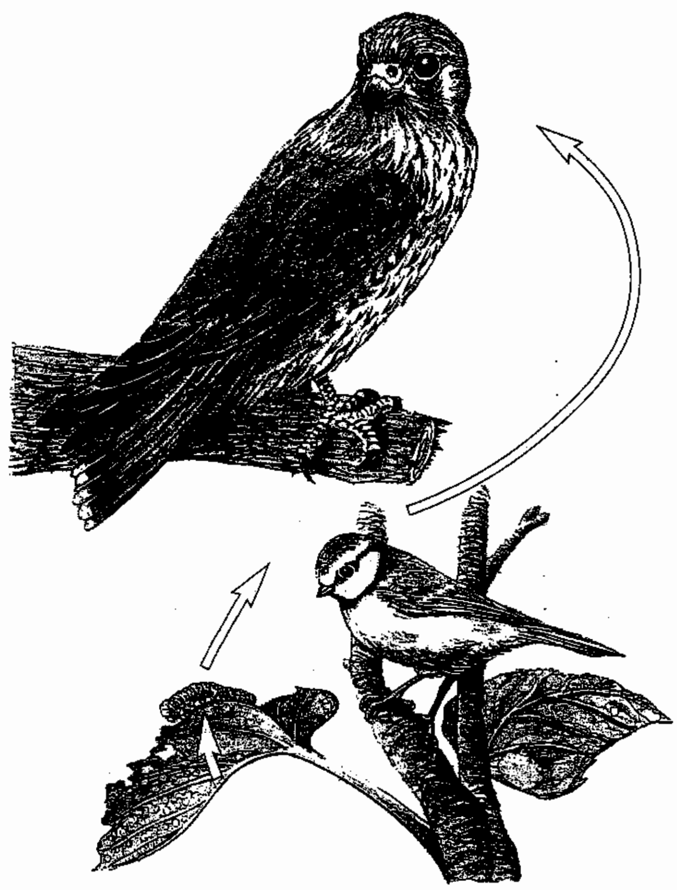


Figure 25.1 A food chain. The caterpillar eats the leaf; the blue tit eats the caterpillar but may fall prey to the kestrel

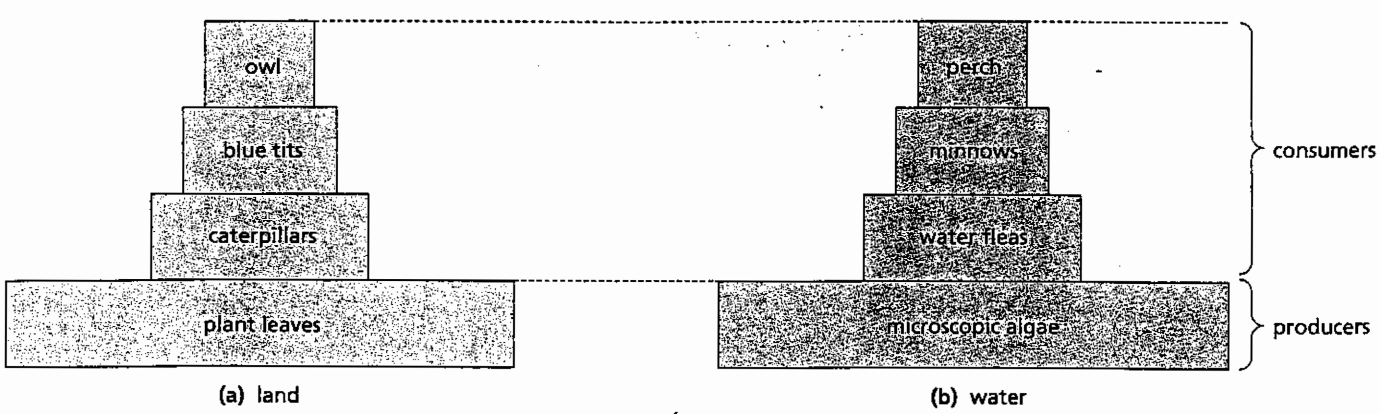
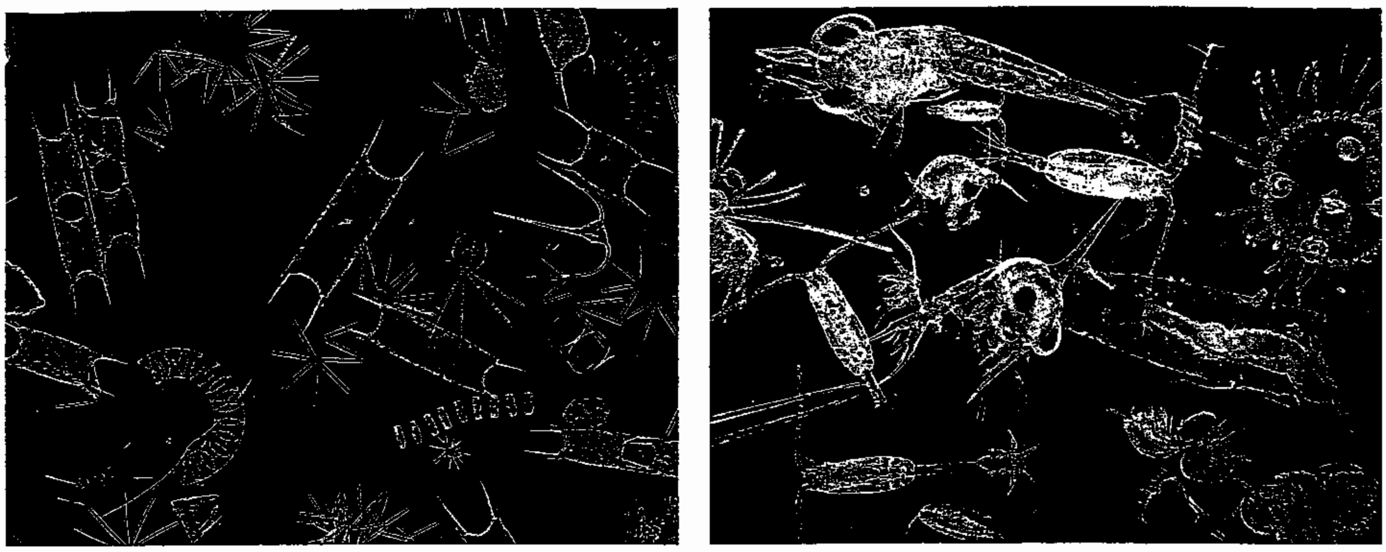


Figure 25.2 Examples of food pyramids (pyramids of numbers)



(a) phytoplankton (× 100) These microscopic algae form the basis of a food pyramid in the water

(b) zooplankton (× 20) These crustacea will eat microscopic algae

Figure 25.3 Plankton. The microscopic organisms which live in the surface waters of the sea or fresh water are called collectively, plankton. The single-celled algae (see p. 279) are the phytoplankton. They are surrounded by water, salts and dissolved carbon dioxide. Their chloroplasts absorb sunlight and use its energy for making food by photosynthesis. The phytoplankton is eaten by small animals in the zooplankton, mainly crustacea (see p. 274). Small fish will eat the crustacea

The organisms at the beginning of a food chain are usually very numerous while the animals at the end of the chain are often large and few in number. The **food pyramids** in Figure 25.2 show this relationship. There will be millions of microscopic, single-celled algae in a pond (Figure 25.3a). These will be eaten by the larger but less numerous water fleas and other crustacea (Figure 25.3b), which in turn will become the food of small fish, like minnow and stickleback. The hundreds of small fish may be able to provide enough food for only four or five large carnivores, like pike or perch.

The organisms at the base of the food pyramids in Figure 25.2 are plants. Plants produce food from carbon dioxide, water and salts (see 'Photosynthesis', p. 35), and are, therefore, called **producers**. The animals which eat the plants are called **primary consumers**, e.g. grasshoppers. Animals which prey on the plant-eaters are called **secondary consumers**, e.g. shrews, and these may be eaten by **tertiary consumers**, e.g. weasels or kestrels (Figure 25.4).

Figure 25.4 The kestrel, a secondary or tertiary consumer

The position of an organism in a food pyramid is sometimes called its **trophic level**.

Pyramids of numbers and biomass

The width of the bands in Figure 25.2 is meant to represent the relative number of organisms at each trophic level. So, the diagrams are sometimes called **pyramids of numbers**.

However, you can probably think of situations where a pyramid of numbers would not show the same effect. For example, a single sycamore tree may provide food for thousands of greenfly. One oak tree may feed hundreds of caterpillars. In these cases the pyramid of numbers is upside-down.

The way round this problem is to consider not the single tree, but the mass of the leaves that it produces in the growing season, and the mass of the insects which can live on them. **Biomass** is the term used when the mass of living organisms is being considered, and pyramids of biomass can be constructed as in Figure 25.16, p. 233.

An alternative is to calculate the energy available in a year's supply of leaves and compare this with the energy needed to maintain the population of insects which feed on the leaves. This would produce a **pyramid of energy**, with the producers at the bottom having the greatest amount of energy. Each successive trophic level would show a reduced amount of energy.

Later in the chapter, the recycling of matter is discussed. The elements which make up living organisms are recycled, i.e. they are used over and over again. This is not the case with energy, which flows from producers to consumers and is eventually lost to the atmosphere as heat. (See 'Energy flow', p. 231.)

Food webs

Food chains are not really as straightforward as described above, because most animals eat more than one type of food. A fox, for example, does not feed entirely on rabbits but takes beetles, rats and voles in its diet. To show these relationships more accurately, a **food web** can be drawn up (Figure 25.5).

The food webs for land, sea and fresh water, or for ponds, rivers and streams, will all be different. Food webs will also change with the seasons when the food supply changes.

If some event interferes with a food web, all the organisms in it are affected in some way. For example, if the rabbits in Figure 25.5 were to die out, the foxes, owls and stoats would eat more beetles and rats. Something like this happened in 1954 when the disease myxomatosis wiped out nearly all the rabbits in England. Foxes ate more voles, beetles and blackberries, and attacks on lambs and chickens increased. Even the vegetation was affected because the tree seedlings which the rabbits used to nibble off were able to grow. As a result, woody scrubland started to develop on what had been grassy downs. A similar effect is shown in Figure 25.6.

Dependence on sunlight

If you take the idea of food chains one step further you will see that all living organisms depend on sunlight and photosynthesis (p. 35). Green plants make their food by photosynthesis, which needs sunlight. Since all animals depend, in the end, on plants for their food, they therefore depend indirectly on sunlight. A few examples of our own dependence on photosynthesis are given below.

sunlight

↓	↓	↓
photosynthesis in wheat	photosynthesis in grass	photosynthesis in flowering plants
↓	↓	↓
wheat grains	cow	nectar
↓	↓	↓
flour	milk	bees
↓	↓	↓
bread	cheese	honey

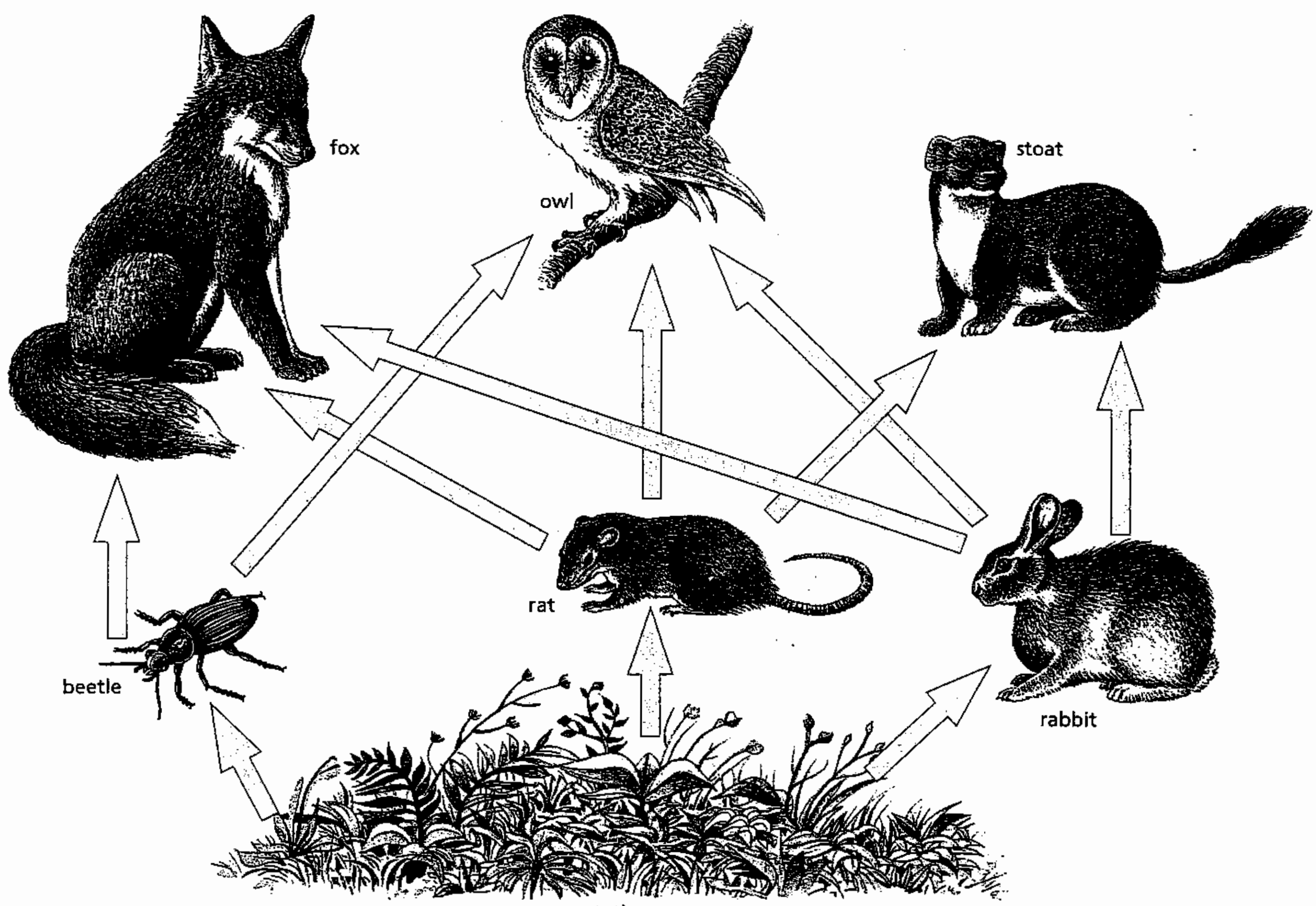


Figure 25.5 A food web

(a) Sheep have eaten any seedlings which grew under the trees

(b) Ten years later, the fence has kept the sheep off and the tree seedlings have grown

Figure 25.6 Effect of grazing

Nearly all the energy released on the Earth can be traced back to sunlight. Coal comes from tree-like plants, buried millions of years ago. These plants absorbed sunlight for their photosynthesis when they were alive. Petroleum was formed, also millions of years ago, probably from the partly decayed bodies of microscopic algae which lived in the sea. These, too, had absorbed sunlight for photosynthesis.

Today it is possible to use mirrors and solar panels to collect energy from the sun directly, but the best way, so far, of trapping and storing energy from sunlight is to grow plants and make use of their products, such as starch, sugar, oil, alcohol and wood, for food or as energy sources. For example, sugar from sugar-cane can be fermented (p. 20) to alcohol, and used as a motor fuel instead of petrol.

Recycling

There are a number of organisms which have not been fitted into the food webs or food chains described so far. Among these are the **saprotrophs**. Saprotrophs do not obtain their food by photosynthesis, nor do they kill and eat living animals or plants. Instead they feed on dead and decaying matter such as dead leaves in the soil or rotting tree-trunks (Figure 25.7). The most numerous examples are the fungi, such as mushrooms, toadstools or moulds, and the bacteria, particularly those which live in the soil. They produce extracellular enzymes (p. 15) which digest the decaying matter and then they absorb the soluble products back into their cells. In so doing, they remove the dead remains of plants and animals which would otherwise collect on the Earth's surface. They also break these remains down into substances which can be used by other organisms. Some bacteria, for example, break down the protein of dead plants and animals and release nitrates which are taken up by plant roots and there built into new amino acids and proteins (p. 11). This use and re-use of materials in the living world is called **recycling**.

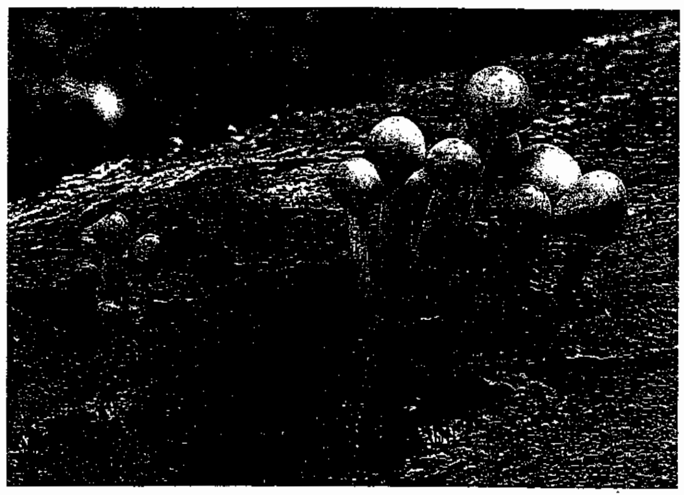


Figure 25.7 Saprotrophs. These toadstools are getting their food from the rotting tree stump

The general idea of recycling is illustrated in Figure 25.8. The green plants are the producers, and the animals which eat the plants and each other are the consumers. The bacteria and fungi, especially those in the soil, are called the **decomposers** because they break down the dead remains and release the chemicals for the plants to use again. Two examples of recycling, one for carbon and one for nitrogen, are described next.

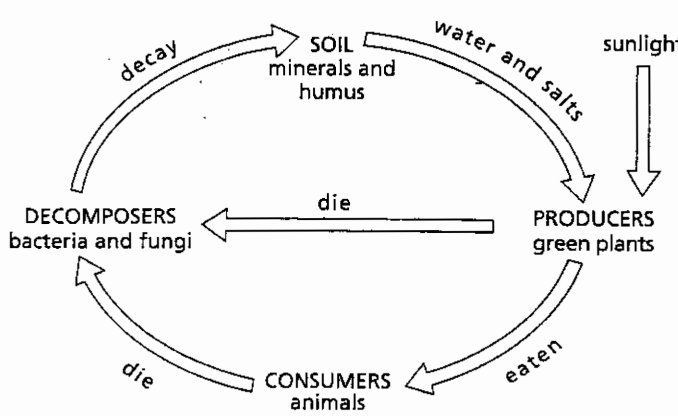


Figure 25.8 Recycling in an ecosystem

Questions

1 Try to construct a simple food web using the following: sparrow, fox, wheat seeds, cat, kestrel, mouse.

2 Describe briefly all the possible ways in which the following might depend on each other: grass, earthworm, blackbird, oak tree, soil.

3 Explain how the following foodstuffs are produced as a result of photosynthesis: wine, butter, eggs, beans.

4 An electric motor, a car engine and a race horse can all produce energy. Show how this energy could come, originally, from sunlight. What forms of energy on the Earth are *not* derived from sunlight?

5 How do you think evidence is obtained in order to place animals such as a fox and a pigeon in a food web?

6 When humans colonized islands they often introduced their domestic animals such as goats or cats. This usually had a devastating effect on the natural food webs. Suggest reasons for this.

The carbon cycle

Carbon is an element which occurs in all the compounds which make up living organisms. Plants get their carbon from carbon dioxide in the atmosphere and animals get their carbon from plants. The carbon cycle, therefore, is mainly concerned with what happens to carbon dioxide (Figure 25.9).

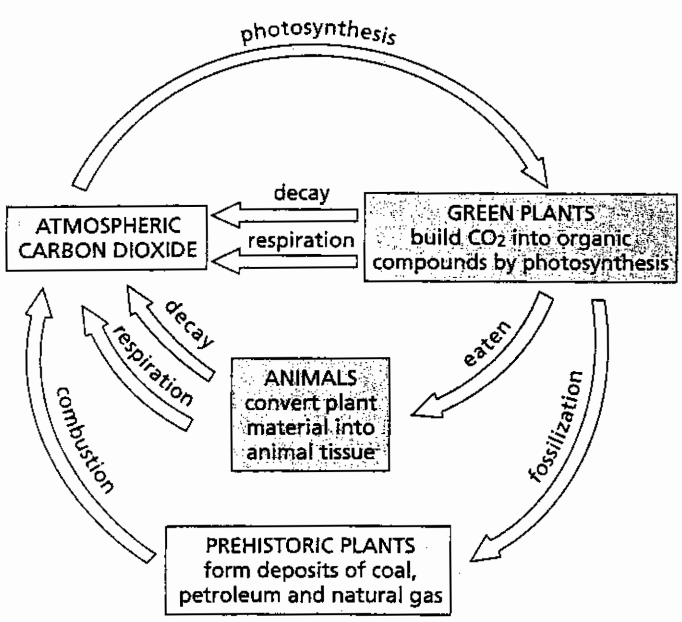


Figure 25.9 The carbon cycle

Removal of carbon dioxide from the atmosphere

Photosynthesis

Green plants remove carbon dioxide from the atmosphere as a result of their photosynthesis. The carbon of the carbon dioxide is built first into a carbohydrate such as sugar. Some of this is changed into starch or the cellulose of cell walls, and the proteins, pigments and other compounds of a plant. When the plants are eaten by animals, the organic plant material is digested, absorbed and built into the compounds making up the animals' tissues. Thus the carbon atoms from the plant become part of the animal.

Addition of carbon dioxide to the atmosphere

Respiration

Plants and animals obtain energy by oxidizing carbohydrates in their cells to carbon dioxide and water (p. 19). The carbon dioxide and water are excreted and so the carbon dioxide returns once again to the atmosphere.

Decay

The organic matter of dead animals and plants is used by saprotrophs, especially bacteria and fungi, as a source of energy. These micro-organisms decompose the plant and animal remains and turn the carbon compounds into carbon dioxide.

Combustion (burning)

When carbon-containing fuels such as wood, coal, petroleum and natural gas are burned, the carbon is oxidized to carbon dioxide ($C + O_2 \rightarrow CO_2$). The hydrocarbon fuels, such as coal and petroleum, come from ancient plants which have only partly decomposed over the millions of years since they were buried.

So, an atom of carbon which today is in a molecule of carbon dioxide in the air may tomorrow be in a molecule of cellulose in the cell wall of a blade of grass. When the grass is eaten by a cow, the carbon atom may become part of a glucose molecule in the cow's bloodstream. When the glucose molecule is used for respiration, the carbon atom will be breathed out into the air once again as carbon dioxide.

The same kind of cycling applies to nearly all the elements of the Earth. No new matter is created, but it is repeatedly rearranged. A great proportion of the atoms of which you are composed will, at one time, have been part of other organisms.