RRC INTERNATIONAL

RRC Sample Study Text

NEBOSH

DIPLOMA IN ENVIRONMENTAL MANAGEMENT

Unit ED1
Controlling Environmental Aspects

nebosh

LEARNING PARTNER GOLD 335

The Environment and Key Natural Cycles

IN THIS SECTION...

- Carbon is cycled around the Earth by photosynthesis, respiration, death, consumption, water bodies, fossilisation and release to air.
- The nitrogen cycle consists of nitrogen fixation, extraction, egestion, denitrification and release of nitrogen gas.
- Phosphorus is cycled by weathering, uptake by plants, eating by animals, excretion and decomposition.
- The water cycle operates through precipitation, soil infiltration and seepage through soil, groundwater formation and evaporation.

Meaning of the Environment

The concept of the 'environment' embraces both the physical resources of the Earth (air, water, land and raw materials) and the living resources (animals, plants and humans).

DEFINITION

ENVIRONMENT

"Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelationships ...

Surroundings can extend from within an organisation to the local, regional and global system ... [and] ... can be described in terms of biodiversity, ecosystems, climate or other characteristics."

Source: ISO 14001:2015

Natural Cycles

The various elements of the environment are continually interacting; of particular significance is the way in which important nutrients are exchanged between the physical and living components of the environment.

The Earth is essentially a closed system. Apart from energy from the Sun, all the materials that are needed for life to exist are contained within the Earth. After 3.8 billion years of life on Earth, it might seem surprising that these resources haven't all been consumed. However, the essential elements all form intricate cycles in which they are constantly recycled and re-used by natural processes.

Human activities can have a detrimental effect on these cycles, resulting in problems such as climate change, acid rain and water shortages. Remedying such problems requires an awareness of how these cycles work so measures can be implemented to restore the natural balance.

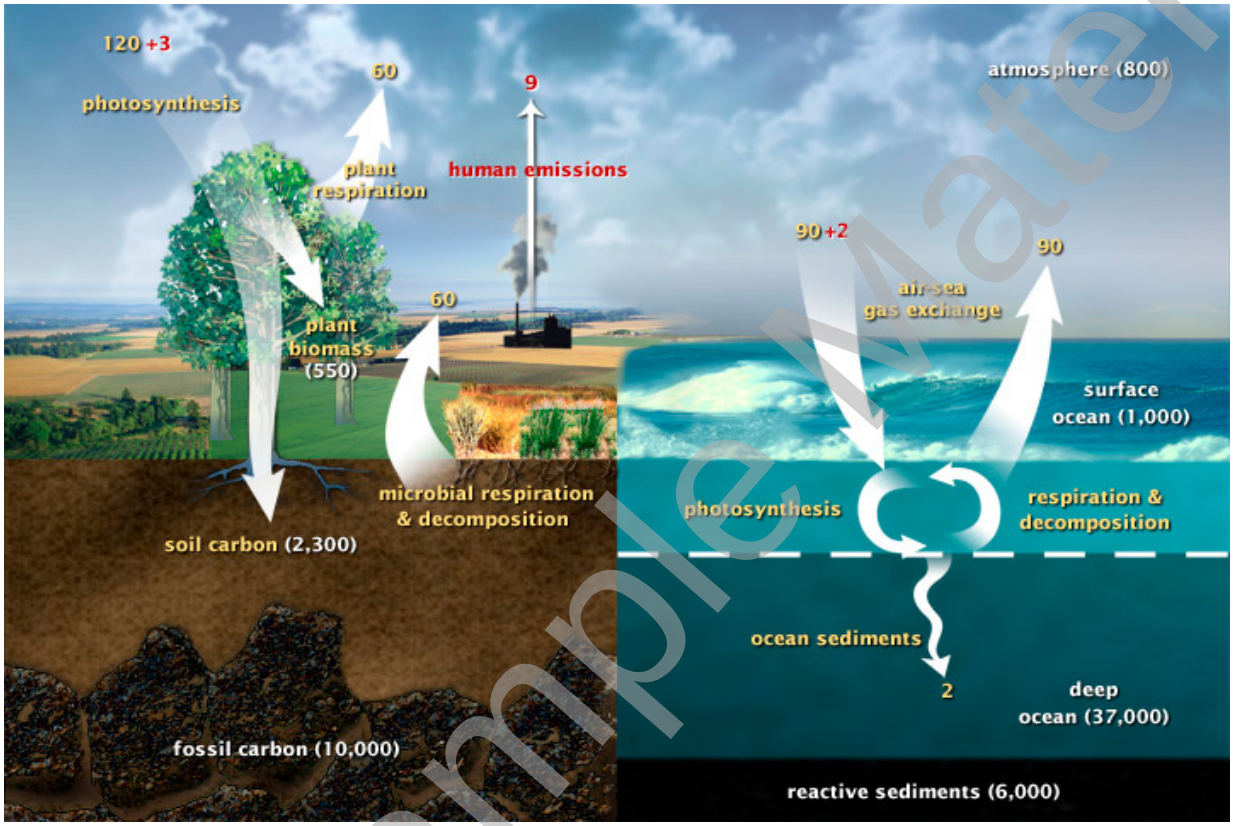
In this section we consider some of the key natural cycles that operate on the Earth - to gain an understanding of these is important as the knowledge will help when we consider global impacts later in the course.

Water - one of Earth's natural resources

The Carbon Cycle

The element carbon is vital for life. It is a primary component of the biological compounds from which all living organisms are made, including proteins, carbohydrates (sugars and starches), lipids (fats and oils), and genetic material (DNA and RNA).

The carbon cycle describes the way in which carbon moves between plants and animals and the physical components of the environment (the atmosphere, ground and water bodies).



The carbon cycle
Source: The Carbon Cycle, NASA's Earth Observatory (http://earthobservatory.nasa.gov/Features/CarbonCycle) adapted from original U.S. DOE. Biological and Environmental Research Information System (http://genomicscience.energy.gov).

The diagram of the carbon cycle shows the movement of carbon between land, atmosphere, and oceans. Yellow numbers are natural fluxes, and red are human contributions in gigatons of carbon per year. White numbers indicate stored carbon.

The carbon cycle consists of four major stores of carbon linked by carbon exchange pathways. The stores are:

- **The atmosphere** - the two main constituents of the Earth's atmosphere are methane (CH_4) and carbon dioxide (CO_2). Carbon dioxide exits the atmosphere via photosynthesis. This is a process undertaken by plants during the day; it involves taking in carbon dioxide from air and using it to form glucose. Carbon dioxide also exits the atmosphere by dissolving into rainwater or directly into water bodies (lakes, oceans, etc.) where it can be absorbed by rocks. Carbon enters the atmosphere through the respiration of plants and animals and volcanic activity.
- **Land biosphere** - this includes carbon stored in plants, animals and other living organisms as well as carbon present in soils. Organic carbon is a major constituent of all living organisms. Carbon leaves this reservoir and is released into the atmosphere by respiration of plants and animals (the opposite of photosynthesis). It may also be passed to oceans by rivers and streams or remain in soils. Animals take in carbon dioxide by eating plants and other animals; when they respire, excrete waste or die, they release carbon to the environment. Waste carbon materials are then digested by microbes or fungi that also respire when breaking down organic matter.

- **Oceans** - carbon enters oceans mainly by dissolution from the atmosphere, but also from rivers. It is converted to organic carbon by photosynthesis, where it can pass through the food chain or accumulate in shells as calcium carbonate.
- **Geological** - most of the Earth's carbon is stored in rocks in the upper mantle. This is formed of around 80% calcium carbonates from shells of marine organisms and 20% kerogens (fossil fuels such as coal, oil and gas). Carbon leaves this reservoir through volcanic activity.

Effects of Human Activities on the Carbon Cycle

The carbon cycle can be significantly affected by human activities, such as:

- Burning of fossil fuel in energy generation and transportation, which releases large quantities of carbon dioxide into the air contributing to climate change. Normally, this fossilised carbon would be locked away from the carbon cycle.
- Burning of biomass (plants), which releases carbon dioxide to air contributing to climate change.
- Deforestation and other types of land use change, which removes plants that are a key sink for atmospheric carbon through photosynthesis. This increases the amount of carbon dioxide in the atmosphere contributing to climate change.
- Use of carbonate rocks in cement manufacture, which releases carbon dioxide to the air.
- Extraction and transportation of fossil fuels from activities such as coal mining, oil drilling, oil transportation and hydraulic fracturing (commonly known as 'fracking') which also pose a significant risk of water, land and air pollution.

The Nitrogen Cycle

Some biological compounds that are essential for life, most notably proteins and genetic material (DNA and RNA), contain the element nitrogen. All plants and animals therefore require a source of nitrogen and exchange nitrogen with the physical environment. The atmosphere is an enormous reservoir of nitrogen - indeed, 78% of the volume of the atmosphere consists of nitrogen gas - but this is in a form that is unavailable to living things. Nitrogen that is contained in soil and water is more readily available for living organisms:

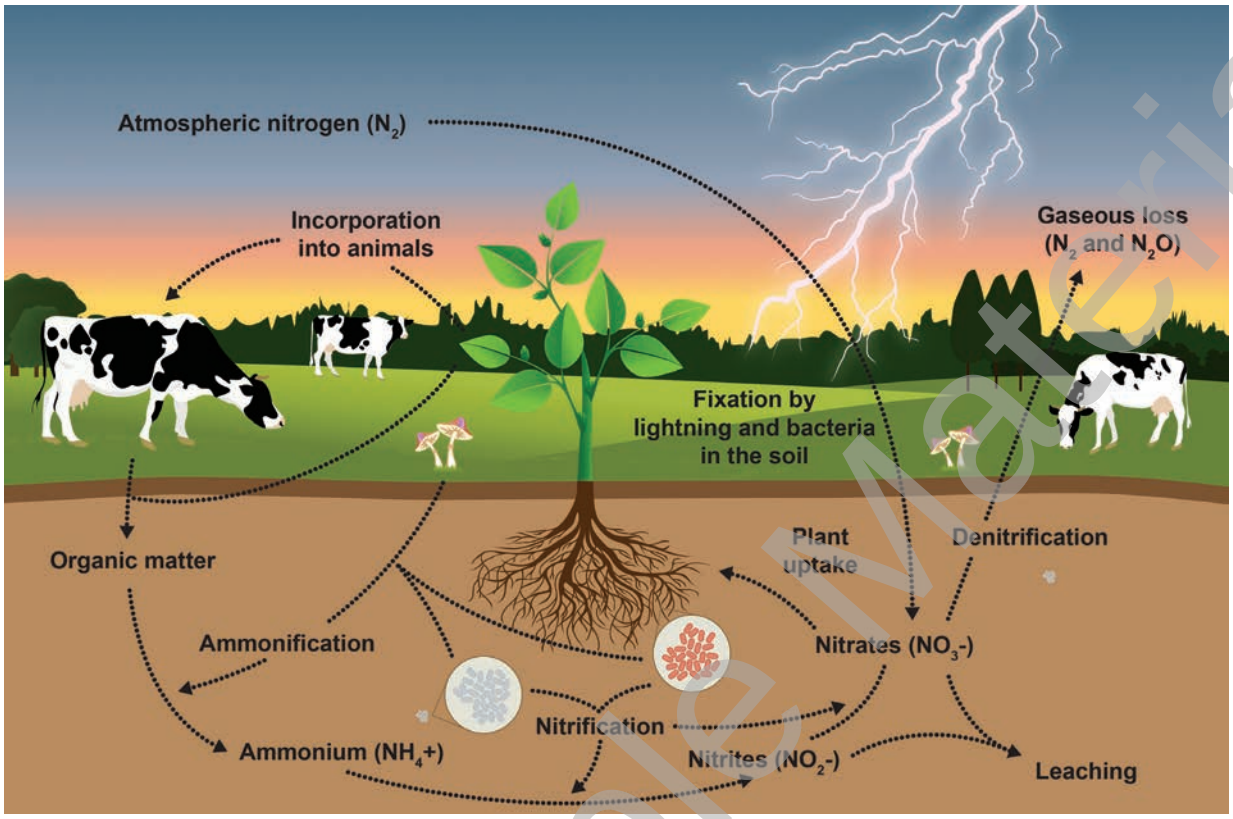
- Plants absorb nitrogen in the form of nitrates or ammonium from soil and water bodies.
- Animals get most of the nitrogen they need by eating and digesting the proteins contained in plants or other animals.
- Animals return nitrogen to the soil and water bodies in their waste products - for example, in urea and ammonia.
- Dead plant and animal remains release nitrogen into soil, water and eventually the atmosphere through the action of decomposer bacteria and fungi.

Nitrogen gas from the atmosphere can also be converted into a form that plants can use, through a process of nitrogen fixation:

- Biological nitrogen fixation can be achieved through the action of special nitrogen-fixing bacteria that live in soil and the root nodules of leguminous plants (e.g. clover, beans).

Nitrogen fixation can also occur via physical processes:

- Lightning - the power in lightning can cause nitrogen gas in the atmosphere to be converted into nitrites and nitrates, which are carried into the soil by rain.
- The Haber process - an important industrial process that converts nitrogen gas from the atmosphere into ammonia and, subsequently, nitrate fertilisers.



The nitrogen cycle

Effects of Human Activities on the Nitrogen Cycle

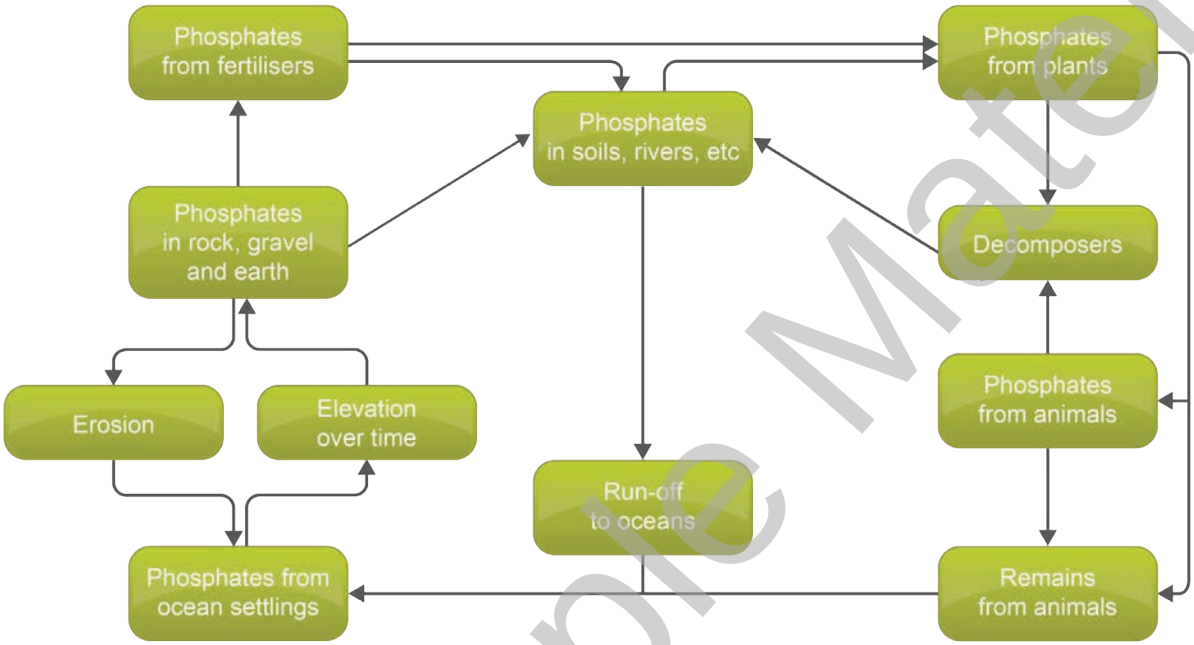
Ways in which humans can interact with the nitrogen cycle include:

- Run-off into water of nitrogen-based fertilisers, both natural and synthetic, causing nutrient enrichment (eutrophication) leading to excessive growth in plants, causing oxygen depletion, blockage of light and nuisance.
- Combustion of fossil fuels, leading to release of nitrogen into the atmosphere, which causes acidification of ecosystems (e.g. damage to forests and lakes).
- Discharge of sewage containing nitrogen compounds into rivers, lakes and streams, which causes nutrient enrichment.
- Emissions of nitrogen (mainly ammonia compounds) from manure to air from intensive rearing of pigs and chickens.

The Phosphorus Cycle

The primary biological importance of phosphorus is as a component of special energy-rich compounds (ATP) that living cells use to transfer energy. Phosphorus is also found in biological membranes (phospholipids) and animal bones (calcium phosphate).

Key steps in the phosphorus cycle are:



The phosphorus cycle

- Geological weathering releases soluble forms of phosphorus (phosphates) into rivers, lakes and oceans.
- Plants absorb phosphates from the soil and incorporate them into useful compounds.
- Animals obtain the phosphorus they need by eating plants and other animals.
- Animals return phosphorus compounds to soil and water via excreta.
- Decomposer bacteria and fungi act on dead plant and animal remains and phosphorus is returned to soil and water, usually in the form of phosphates.

Effects of Human Activities on the Phosphorus Cycle

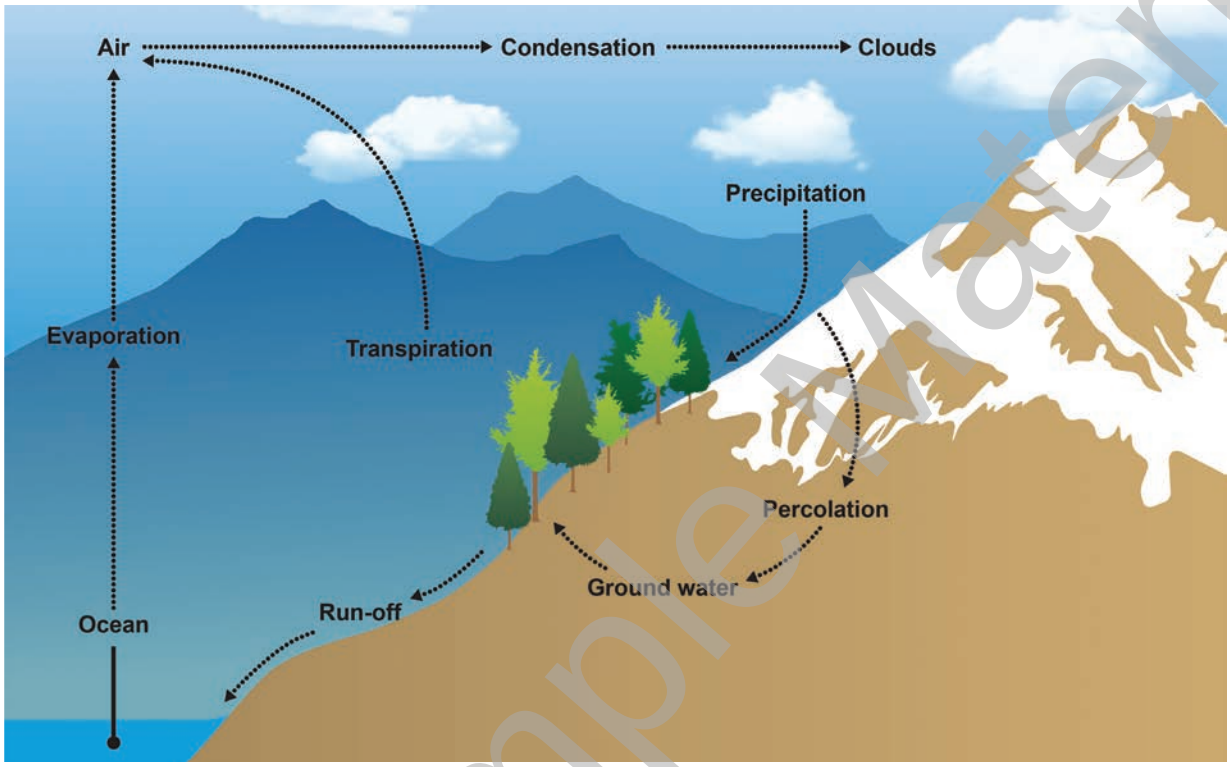
Ways in which humans can interact with the phosphorus cycle include:

- Phosphorus-containing fertilisers can run off into rivers and cause nutrient enrichment (eutrophication), leading to depleted levels of oxygen and subsequent damage to aquatic life.
- Increased erosion due to deforestation can lead to greater concentration of phosphorus-containing particles in rivers, causing nutrient enrichment.
- Discharges of phosphorus to surface water may also arise from sewage treatment, as not all phosphorus will be removed during the treatment process.

Hydrological Cycle

Water moves around the Earth through a system known as the hydrological cycle. For water to complete the full cycle it can take thousands of years.

The hydrological cycle is illustrated below.



The hydrological cycle

- The initial input of water in the system is in the form of **precipitation**, which either seeps into the land surface (soil), or runs over the surface.
- The amount of water that will run off will depend on the **permeability** of the ground and the **catchment area**. If conditions are dry, more water will seep in, but after heavy rain the ground can become saturated, resulting in more run-off. Run-off may be greatly increased in urban areas, which can lead to flooding if the drainage systems do not have sufficient capacity.
- **Plant roots** can take up water that has seeped into the soil. If the water contains pollutants, they can be drawn up into the plant and possibly transferred to another natural cycle, i.e. if eaten by animals or humans.
- The water can continue to seep through the soil horizons to reach **aquifers** (water-bearing rocks) and form part of the groundwater supply, i.e. chalk aquifer in southern UK, limestone and sandstone aquifers in northern UK. There is continuity between surface water and groundwater, both of which can be adversely affected by domestic, industrial and commercial activities.
- As both of these processes are happening, the power of the Sun is driving this cycle by causing **evaporation**. This is the change of liquid water to a vapour. Sunlight aids this process, as it raises the temperature of liquid water in oceans and lakes. As the liquid heats, molecules are released and change into a gas. Warm air rises up into the atmosphere and becomes the vapour involved in condensation.

Because of this cycle, there can be an accumulation of pollutants through water catchments, making prevention of pollution particularly important.

Effects of Human Activities on the Hydrological Cycle

Ways in which humans can interact with the water cycle include:

- Depletion of aquifers, with the water in aquifers being used at a faster rate than it can be replenished. Underground water sources provide drinking water and supply water for rivers, streams and other types of surface water.
- Damming of rivers, which can lead to water being impeded, which will harm fish and other aquatic organisms.
- Deforestation, which means that more water will end up in rivers, which may cause flooding.
- Climate change, which is altering the location and amount of water around the planet.
- Changes in land use will increase or decrease the flow of water in a catchment.

STUDY QUESTIONS

1. Explain what is meant by the term 'environment'.
2. Describe the water cycle.
3. Outline how human activities can impact on the nitrogen cycle.

(Suggested Answers are at the end.)

General Effects of Human Activity on the Environment

IN THIS SECTION...

- Biodiversity is the variety of plants, animals and other living things in an area or region. There are many benefits of biodiversity (e.g. ecological, economic, cultural, tourism).
- Ecosystems work on the principle of food chains. A combination of food chains is known as a food web.
- Humans benefit from numerous services that are provided by natural ecosystems.
- Deforestation can lead to numerous environmental problems such as contributing to climate change, soil erosion and reduction in biodiversity.
- Desertification describes the deterioration of land in arid and sub-humid areas as a result of loss of soil moisture and vegetation.
- Destruction of habitats may occur from single events or through cumulative impacts.
- Certain non-native (invasive) species cause significant impacts affecting the economy and important native species.
- Protected species are often listed in law. It is an offence to kill, disturb or harm such species.

Meaning of Ecology, Ecosystems and Biodiversity

DEFINITIONS

BIODIVERSITY

Is simply diversity, or variety, of plants, animals and other living things in a particular area or region. Diversity within the natural environment is important.

ECOLOGY

The study of the relationship between and interactions of living things to one another and their physical surroundings.

ECOSYSTEM

A community of living things in addition to non-living parts of their environment (such as air, water and soil).

We have seen that living things interact with each other and with the physical environment. Ecosystems define the inter-dependency of different plants and animals and the flow of energy and materials between living and non- living components. They are found in:

- Rivers and lakes.
- Estuaries.
- Forests.
- Wetlands.
- Arctic tundra.
- Coral reefs.

Ecology is the science of these interactions.

Forests are an example of an ecosystem

Some regions and areas of the world support a wider range of plants and animals than others. Tropical ecosystems such as coral reefs and rainforests, for example, support far greater numbers of different species than Arctic areas. These ecosystems are said to have high biodiversity.

The Earth's biological resources are vital to economic and social development because they:

- Provide us with sustainable materials.
- Maintain the quality of our air, soils, waters and climate.
- Contribute to our health and enjoyment of life.

Estimates of global species diversity vary enormously, as it is difficult to estimate how many species there may be in less well-explored habitats, such as untouched rainforests. Rainforest areas that have been sampled have shown a very high level of biodiversity.

Extinction is a fact of life. However, species are now becoming extinct at an alarming rate, almost entirely as a direct result of human activities. Previous mass extinctions evident in the geological record are thought to have been brought about mainly by massive climatic or environmental shifts. Predictions and estimates of future species losses abound. One such estimate calculates that a quarter of all species on Earth are likely to be extinct, or on the way to extinction, within 30 years.

Biodiversity has many benefits, including:

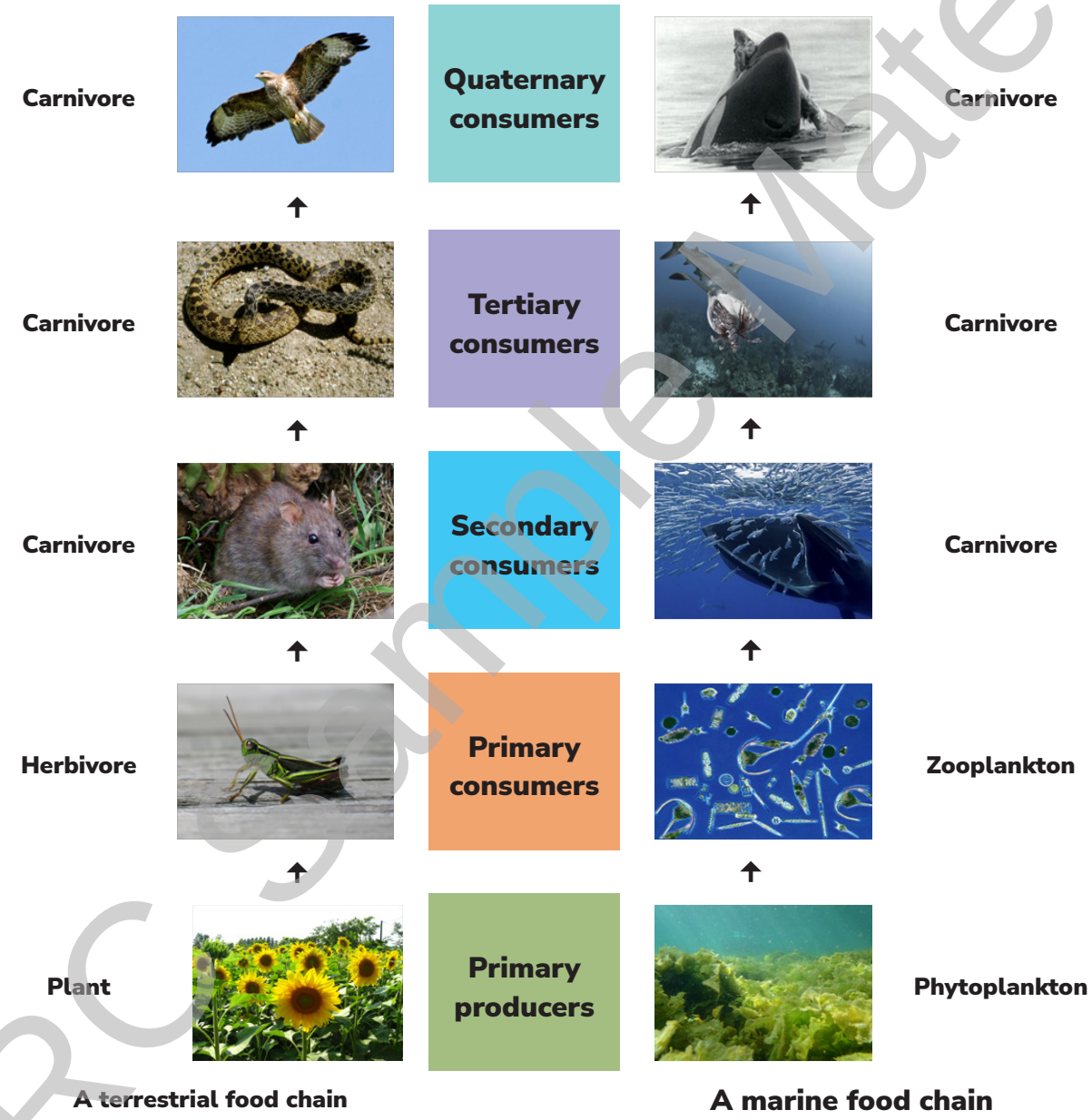
- **Ecological** - individual species and ecosystems have evolved over millions of years into a complex interdependence. If key pieces on which the framework is based are removed, then the whole picture may be in danger of collapsing. The ecological arguments for conserving biodiversity are therefore based on the premise that we need to preserve biodiversity in order to maintain our own life-support systems.
- **Economic** - maintaining and enjoying a high-quality natural environment and the regenerative effects of an improved environment can bring substantial financial benefits to an area. Resources can also be taken from nature for consumption.
- **Cultural/spiritual/aesthetic** - the beauty of nature is something many people are captivated by. The natural environment is something to which many people really connect, and it gives them an immense sense of satisfaction when they experience nature. For some, there are also cultural or spiritual meanings attached to the landscape.
- **Recreation/tourism** - many people take day trips and holidays to areas because of the quality of the natural environment, as well as to visit wildlife.
- **Education/information** - unique natural spaces have an important function in enabling society to improve its knowledge of the natural world. Scientists can use these areas to gather data and conduct research, which can materially benefit society.

In most countries there will be numerous legal requirements for the protection of biodiversity. These largely surround compliance with the Convention on Biological Diversity which we will cover in more detail in Element 6.

Effects of Human Activity on Flora, Fauna and Natural Systems

Composition and Dynamics of Communities and Ecosystems

Ecosystems work on the principle of food chains (examples of which are shown below). Energy from the Sun is cycled through the system through photosynthesis, ingestion (eating) or decomposition. This generally covers energy, plants, herbivores, carnivores and decomposers.



Examples of food chains

A combination of food chains is known as a food web. It is often the case that one animal does not solely feed on another animal, e.g. a fox may prey upon rabbits, rats, birds, etc.