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COURSE GUIDE

SED 421
CYCLES IN NATURE BIOLOGICAL CYCLE

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MODULE 1 BIOCHEMICAL, CHEMICAL AND PHYSICAL CYCLES

INTRODUCTION

In this module, you will be exposed to biochemical, chemical and physical cycles.

UNIT 1 FOOD CHAIN AND FOOD WEB

CONTENTS

1.0 INTRODUCTION

Chemicals found in living organisms are derived originally from the abiotic components in the ecosystems, such as soil, water and air, to which they eventually return by way of decomposition of the waste products or dead bodies of organism. Bacteria and fungi bring about decomposition, obtaining energy from the waste products and dead organisms in the process. Since both living and non-living parts of the ecosystem are involved in the chemical cycles, they are called biogeochemical cycles. This unit therefore examines food chains and food webs.

2.0 OBJECTIVES

At the end of the unit, you should be able to:

- Explain the food chains,
- List and discuss each level of the food chain
- Explain the term food web
- Give another name for food web
- Mention the various trophic levels in food web
- Explain how a food chain differs from a food web

3.0 MAIN CONTENT

3.1 The meaning of food chain

A food chain is a linear sequence of links in a food web starting from species that are called producers in the web and ends at species that are called decomposers in the web. A food chain shows how the organisms are related with each other by the food they eat.

3.1.1 How does a food chain differ from a food web?

A food chain differs from a food web, because the complex polyphagous network of feeding relations are aggregated into trophic species and the chain only follows linear monophagous pathways. A common metric used to quantify food web trophic structure is food chain length. In its simplest form, the length of a chain is the number of links between a trophic consumer and the base of the web and the mean chain length of an entire web is the arithmetic average of the lengths of all chains in a food web.

The food chain's length is a continuous variable that provides a measure of the passage of energy and an index of ecological structure that increases in value counting progressively through the linkages in a linear fashion from the lowest to the highest trophic (feeding) levels. Food chains are often used in ecological modeling (such as a three species food chain). They are simplified abstractions of real food webs, but complex in their dynamics and mathematical implications.

3.1.2 Levels in Food Chain

Food chains vary in length from three to six or more levels. A food chain consisting of a flower, a frog, a snake and an owl consists of four levels; whereas a food chain consisting of grass, a grasshopper, a rat, a snake and finally a hawk consists of five levels. Producers, such as plants, are organisms that utilize solar or chemical energy to synthesize starch. All food chains must start with a producer, this is the first trophic level occupied by the autotrophic organisms. In the deep sea, food chains centered around hydrothermal vents and cold seeps exist in the absence of sunlight. Chemosyntheticbacteria and archaea use hydrogen sulfide and methane from hydrothermal vents and cold seeps as an energy source (just as plants use sunlight) to produce carbohydrates; they form the base of the food chain. The primary and secondary consumers are the second and trophic levels that eat other organisms. All organisms in a food chain, except the first organism, are consumers. At every feeding stage some energy is wasted from the chain of animals feeding on each other.

3.2 Meaning of Food web

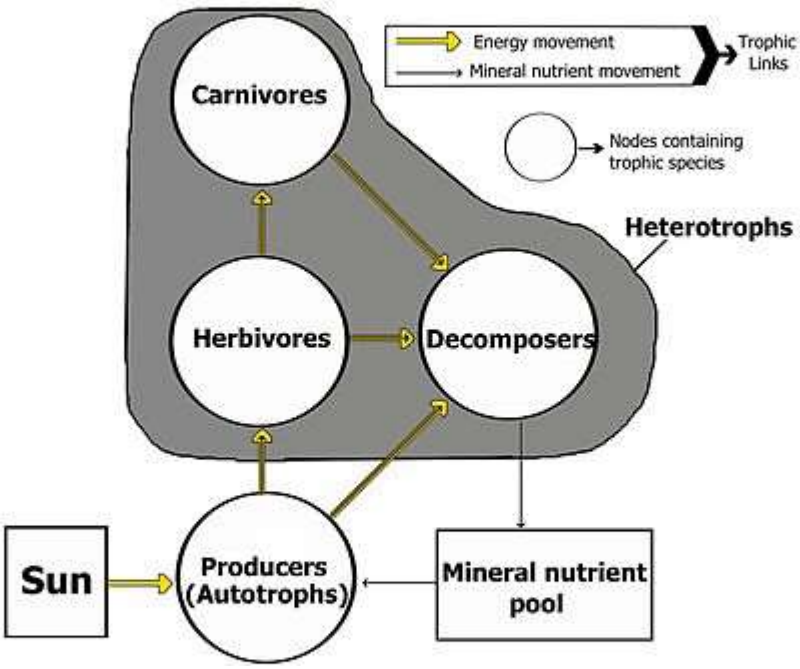
A **food web is** also known as **food** cycle, is the natural interconnection of food chain and generally a graphical representation (usually an image) of what-eats-what (a finella) in an ecological community. Another name for food web is a consumer-resource system. All life forms are broadly lumped into one of two categories called trophic levels namely: 1) the autotrophs, and 2) the heterotrophs. To maintain their bodies, grow, develop, and to reproduce, autotrophs produce organic matter from inorganic substances, including both minerals and gases such as carbon dioxide. These chemical reactions require energy, which mainly comes from the sun and largely by photosynthesis, although a very small amount comes from hydrothermal vents and hot springs. A gradient exists between trophic levels running from complete autotrophs that obtain their sole source of carbon from the atmosphere, to mixotrophs (such as carnivorous plants) that are autotrophic organisms that partially obtain organic matter from sources other than the atmosphere, and complete heterotrophs that must feed to obtain organic matter.

3.2.1 The linkages in a food web

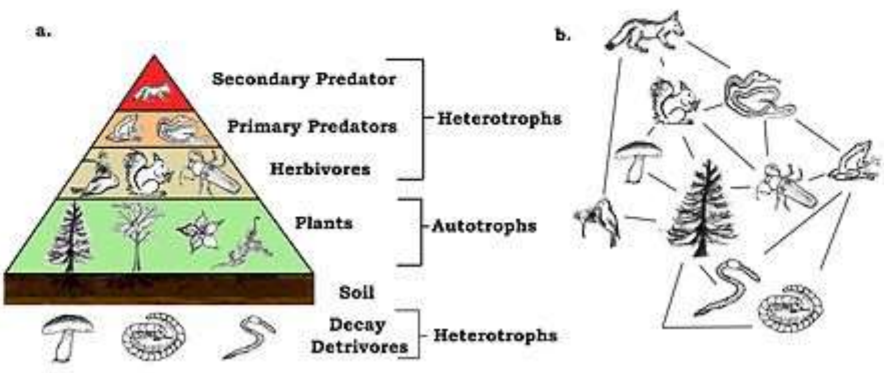
The linkages in a food web illustrate the feeding pathways, such as where heterotrophs obtain organic matter by feeding on autotrophs and other heterotrophs. Autotrophs produce more biomass energy, either chemically without the suns energy or by capturing the suns energy in photosynthesis, than they use during metabolicrespiration. Heterotrophs consume rather than produce biomass energy as they metabolize, grow, and add to levels of secondary production.

The food web is a simplified illustration of the various methods of feeding that links an ecosystem into a unified system of exchange. There are different kinds of feeding relations that briefly divided into herbivory, carnivory, scavenging and parasitism. Autotrophs and heterotrophs come in all sizes, from microscopic to many tonnes.

Food webs are limited representations of real ecosystems as they necessarily aggregate many species into trophic species, which are functional groups of species that have the same predators and prey in a food web.



A simplified food web illustrating a three trophic food chain (*producers-herbivores-carnivores*) linked to decomposers. The movement of mineral nutrients is cyclic, whereas the movement of energy is unidirectional and noncyclic. Trophic species are encircled as nodes and arrows depict the links.



3.2.2 Trophic levels and positions in Food webs

Food webs have trophic levels and positions. Basal species, such as plants, form the first level and are the resource limited species that feed on no other living creature in the web. Basal species can be autotrophs or detritivores, including "decomposing organic material and its associated microorganisms which are defined as detritus, micro-inorganic material and associated microorganisms (MIP), and vascular plant material." Most autotrophs capture the sun's energy in chlorophyll, but some autotrophs (the chemolithotrophs) obtain energy by the chemical oxidation of inorganic compounds and can grow in dark environments, such as the sulfur bacterium Thiobacillus, which lives in hot sulfur springs. The top level has top (or apex) predators which no other species kills directly for its food resource needs. The intermediate levels are filled with omnivores that feed on more than one trophic level and cause energy to flow through a number of food pathways starting from a basal species.

In the simplest scheme, the first trophic level (level 1) is plants, then herbivores (level 2), and then carnivores (level 3). The trophic level is equal to one more than the chain length, which is the number of links connecting to the base. The base of the food chain (primary producers or detritivores) is set at zero.

4.0 CONCLUSION

A food chain shows how the organisms are related with each other by the food they eat. On the other hand food web is the natural interconnection of food chain which is represented generally in a graphical form. Autotrophs and heterotrophs come in all sizes, from microscopic to many tonnes.

5.0 SUMMARY

In this unit, we have learnt that:

- A food chain is a linear sequence of links in a food web.
- Food chains vary in length from three to six or more levels.
- At every feeding stage some energy is wasted from the chain of animals feeding on each other.
- A food web is also known as food cycle.
- A food web is the natural interconnection of food chain and generally a graphical representation of life formsin an ecological community.
- There is simplified illustration of the various methods of feeding that links an ecosystem into a unified system of exchange. A

simplified food web illustrating a three trophic food chain (*producers-herbivores-carnivores*) linked to decomposers.

6.0 TUTOR-MARKED ASSIGNMENT

i. Explain your understanding of the term food chain.
ii. State the difference between food chain and food web.
iii. What is another name for food web?
iv. Mention one of two categories called trophic levels in which all life forms are broadly lumped into.
v. Mention four different kinds of feeding relations that exist in an ecosystem.
vi. Give a simplified food web illustrating a three trophic food chain starting with the producers-herbivores-carnivores linked to decomposers

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UNIT 2 CARBON/CARBON DIOXIDE AND OXYGEN CYCLES

CONTENTS

1.0 INTRODUCTION

Cycling of elements is a major feature of the ecosystem. A cycle can be drawn which summarizes the movement of an element through the living components of the ecosystem. During the cycle the element can be combined with computer organic molecules in the living components of the ecosystem. These complex components are late broken down to simpler organic and inorganic forms which can be used again to make the living materials of living organics to this unit therefore examines carbon, oxygen and carbon dioxide cycles.

2.0 OBJECTIVES

At the end of the unit, you should be able to

- explain carbon cycle
- explain how photosynthesis is able to help to keep the level of carbon at an appropriate level in the environment
- describe the role of respiration in carbon cycle
- explain how carbon is converted to fossil fuel
- mention human activities that can affect the cycle
- suggest ways of maintaining a healthy carbon environment
- draw carbon, oxygen and carbon dioxide cycles from the explanations given

3.0 MAIN CONTENT

3.1 Carbon/Carbon Dioxide Cycle

The main carbon source for living organism is carbon dioxide which is present in the atmosphere or found dissolved in surface water. During the process of photosynthesis green plaints, algae and blue green bacteria use energy from the sun to combine with carbon dioxide (c02) from the atmosphere with water (H20) to form carbohydrates. These carbohydrates store energy. Oxygen (Or) a byproduct of photosynthesis is released into the atmosphere. The carbohydrate formed because the building block of others organic molecule in the rant. When plant is eaten by animals the carbon sources in form of plant protein and carbohydrates are made available to the animals plants use some of the stored carbohydrate as an energy sources to carry out their life functions. Consumers such as animals, fungi and blue green bacteria get their energy from the plant by taking in oxygen from the atmosphere released by plant cellular respiration which releases energy the animal while carbon dioxide is given off into the atmosphere.

In anaerobic environments such as water logged soil or bottom of still water with poor illustrator decomposition is slow and organic matter, accumulates. This accumulating peat deposits and organic sediments after a very long time may generic new fossil fuel deposits. In this form the carbon is no longer available to living things but remains as reservoir.

In the case of the oceans, carbon dioxide is removed from them through photosynthesis by phytoplankton and also by carbon dioxide dissolving in the surface water. Much of the carbon dioxide is quickly released back into the atmosphere either directly from the water or by respiration. However, some carbon dioxide is backed away for a long time to form carbonate shells in marine organisms and carbonate rocks such as limestone. These is another carbon reservoirs from which carbon can be released through human activities or weathering.

3.2.1 Human and Maintenance of Effective Cycling

Human activities such as deforestation (felling trees) have been implicated to cause accumulation of carbon dioxide in the environment. This has been on the increase as a result of urbanization and industrialization whereby large areas are cleared of trees of economic purpose.

Carbon/carbon dioxide comes from volcames, automobile exhausts, factors power plants and decaying plants and animals. Many animals and plants that lived millions of years ago because buried in swamps before they could decay. Ciradualy they because oil, natural gas and coal when we burn those fuels we rabidly release their carbon as carbon dioxide.

The accumulation of carbon dioxide a green house guse in the atmosphere has been associated with serious climatic abnormally known as global warming. The risk on the environment may because alarming if human activities especially the use of fossil fuel is not cotailed. This threat has lead to efforts by various governments to replace the use of fossil fuel with alternative sources such as solar and wind power.

SELF-ASSESSMENT EXERCISE

1) Explain carbon cycle
2) Explain the role of photosynthesis in carbon cycle
3) Describe the relationship between photosynthesis and respiration in connection with carbon cycle
4) From your reading of carbon cycle a well labeled cycle
5) Suggest tree ways that healthy carbon environment can be maintained.

3.2 Oxygen Cycle

All living things need oxygen. Oxygen is necessary for respiration. We breather oxygen and breather out carbon dioxide living cells need oxygen to create energy. The oxygen cycle helps the movement of oxygen in three main regions of the earth the atmosphere, biosphere and the lithosphere. It is the circulation of oxygen in variousforms of nature oxygen is free in the air and found dissolved in water.

The atmosphere is the region of gasses above the surface of the earth and it is one of the largest reservoirs of free oxygen. Biosphere is the sum of all ecosystems and has some free oxygen which is produced by photosynthesis and other life processes lithosphere is the largest reserve of oxygen. Most oxygen in the lithosphere is free moving and is a part of silicates and oxides of chemical compounds.

The oxygen in the atmosphere is freed by the process of photolysis. The energy in the sunlight breaks the down water to produced free oxygen. Oxygen molecule is broken down by ultra-violet rays from the sun. In the biosphere oxygen undergoes cycles of reparation and photosynthesis. Humans and animals breathe in oxygen. This oxygen is used in metabolic processes and carbon dioxide is given out. Plants and phytoplankton’s undergo process of photosynthesis where carbon dioxide is used in the presence of sunlight to form carbohydrate and oxygen.

In the lithosphere oxygen is fixed in minerals like silicates and oxides oxygen from these minerals is freed by chemical weathering when the mineral bearing oxygen is exposed to chemical reaction. The minerals wears down and free oxygen is produced.

SELF-ASSESSMENT EXERCISE

1) Explain oxygen cycle
2) Draw a well labeled oxygen cycle

4.0 CONCLUSION

In other to have appropriate level of elements in the atmosphere which do not eventually because pollutants which are harmful there has to be a way for such elements to be kept at appropriate levels. Carbon and oxygen are elements found at particular percentages in the atmosphere but through carbon and oxygen cycles their levels in the atmosphere are kept more or less content.

5.0 SUMMARY

In the unit we have learnt

- Carbon cycle
- How photosynthesis utilizes carbon dioxide in the atmosphere to manufacture plant food animal make use of the oxygen produced by plants to release energy and carbon dioxide which are products of cellular respiration
- The activities of man that can pose danger by upsetting the carbon dioxide level in the atmosphere.
- Oxygen cycle and human activities that can reduce the amount of oxygen in the atmosphere.

6.0 TUTOR-MARKED ASSIGNMENT

1) How has human activities have contributed to the building up of carbon dioxide in the atmosphere.
2) Differentiate between photosynthesis and respiration
3) Describe how oxide in the atmosphere, biosphere and lithosphere made available for living organisms?

7.0 REFERENCES/FURTHER READING

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UNIT 3 NITROGEN CYCLE, WATER CYCLE, CANOE, AND ATMOSPHERIC PHOTOCHEMISTRY

CONTENTS

1.0 INTRODUCTION

Nitrogen is one of the primary nutrients important for the survival of all living organisms. Although nitrogen is very abundant in the atmosphere, it is inaccessible in this form to most organisms.

The water cycle describes the continuous movement of water on, above and below the surface of the Earth. The mass of water on Earth remains fairly constant over time but the partitioning of the water into the major reservoirs of ice, fresh water, saline water and atmospheric water is variable depending on a wide range of climatic variables. The water moves from one reservoir to another, such as from river to ocean, or from the ocean to the atmosphere, by the physical processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow. The water goes through different phases: liquid, solid (ice), and gas (vapor).

A canoe is a lightweight narrow boat, pointed at both ends and open on top, propelled by one or more seated or kneeling paddlers facing the direction of travel using a single-bladed paddle.

Atmospheric photochemistry is a branch of atmospheric science that deals with the chemistry of the Earth's atmosphere and that of other planets.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Mention and explain major transformations in the nitrogen cycle
- Explain the oxidation of nitrite to nitrate
- Describe some human activities that may disturb the balance cycle.
- Enumerate Implications of Human Alterations to the Nitrogen Cycle
- Describe the process of water cycle.
- Mention some human activities that alter the water cycle
- State the meaning of canoe
- Explain how canoes operate.
- Give the meaning of atmospheric photochemistry
- Explain the central elements in atmospheric photochemistry

3.0 MAIN CONTENT

3.1 Meaning of Nitrogen Cycle

Nitrogen is a necessary component of many biomolecules, including proteins, DNA, and chlorophyll. It is very abundant in the atmosphere as dinitrogen gas (N2), but largely inaccessible in this form to most organisms, making nitrogen a scarce resource and often limiting primary productivity in many ecosystems. It becomes available to primary producers, such as plants, only when nitrogen is converted from dinitrogen gas into ammonia (NH3)

In addition to N2 and NH3, nitrogen exists in many different forms, including both inorganic (e.g., ammonia, nitrate) and organic (e.g., amino and nucleic acids) forms. Thus, nitrogen undergoes many different transformations in the ecosystem, changing from one form to another as organisms use it for growth and for energy.

The major transformations of nitrogen are nitrogen fixation, nitrification, denitrification, and ammonification .

The transformation of nitrogen into its many oxidation states is key to productivity in the biosphere and is highly dependent on the activities of microorganisms, such as bacteria and fungi.

3.1.1 Major transformations in the nitrogen cycle

Human activities, such as making fertilizers and burning fossil fuels, have significantly altered the amount of fixed nitrogen in the Earth's ecosystems. Increase in available nitrogen can alter ecosystems by increasing primary productivity and impacting carbon storage

3.1.2 Nitrogen Fixation

Nitrogen gas (N2) makes up nearly 78% of the Earth's atmosphere, nitrogen is often the nutrient that limits primary production in many ecosystems simply because plants and animals are not able to use nitrogen gas in its present form. For nitrogen to be available to make proteins, DNA, and other biologically important compounds, it must first be converted into a different chemical form. The process of converting N2 into biologically available nitrogen is called nitrogen fixation. N2 gas is a very stable compound due to the strength of the triple bond between the nitrogen atoms, and it requires a large amount of energy to break this bond. The whole process requires eight electrons and at least sixteen ATP molecules. Some nitrogen can be fixed abiotically by lightning or by certain industrial processes, which includes the combustion of fossil fuels.

3.1.3 Nitrification

Nitrification is the process that converts ammonia to nitrite and then to nitrate. Most nitrification occurs aerobically and is carried out exclusively by prokaryotes. There are two distinct steps of nitrification that are carried out by distinct types of microorganisms. The first step is the oxidation of ammonia to nitrite, which is carried out by microbes known as ammonia-oxidizers. Aerobic ammonia oxidizers convert ammonia to nitrite via the intermediate hydroxylamine, a process that requires two different enzymes, ammonia monooxygenase and hydroxylamine oxidoreductase . The process generates a very small amount of energy relative to many other types of metabolism; as a result, nitrosofiers are notoriously very slow growers. Additionally, aerobic ammonia oxidizers are also autotrophs, fixing carbon dioxide to produce organic carbon, much like photosynthetic organisms, but using ammonia as the energy source instead of light.

The second step in nitrification is the oxidation of nitrite (NO_2^-) to nitrate (NO_3^-). This step is carried out by a completely separate group of prokaryotes, known as nitrite-oxidizing Bacteria. Some of the genera involved in nitrite oxidation include Nitrospira, Nitrobacter, Nitrococcus, and Nitrospina. Similar to ammonia oxidizers, the energy generated from the oxidation of nitrite to nitrate is very small, and thus growth yields are very low. In fact, ammonia- and nitrite-oxidizers must oxidize many molecules of ammonia or nitrite in order to fix a single molecule of CO_2.

3.1.4 Denitrification

Denitrification is the process that converts nitrate to nitrogen gas, thus removing bioavailable nitrogen and returning it to the atmosphere. Dinitrogen gas (N_2) is the ultimate end product of denitrification, but other intermediate gaseous forms of nitrogen exist. Some of these gases, such as nitrous oxide (N_2O), are considered greenhouse gasses, reacting with ozone and contributing to air pollution.

Unlike nitrification, denitrification is an anaerobic process, occurring mostly in soils and sediments and anoxic zones in lakes and oceans. Some denitrifying bacteria include species in the genera Bacillus, Paracoccus, and Pseudomonas. Denitrifiers are chemoorganotrophs and thus must also be supplied with some form of organic carbon.

Denitrification is important in that it removes fixed nitrogen (i.e., nitrate) from the ecosystem and returns it to the atmosphere in a biologically inert form (N_2). This is particularly important in agriculture where the loss of nitrates in fertilizer is detrimental and costly. However, denitrification in wastewater treatment plays a very beneficial role by removing unwanted nitrates from the wastewater effluent, thereby reducing the chances that the water discharged from the treatment plants will cause undesirable consequences (e.g., algal blooms).

3.1.5 Ammonification

When an organism excretes waste or dies, the nitrogen in its tissues is in the form of organic nitrogen (e.g. amino acids, DNA). Various fungi and prokaryotes then decompose the tissue and release inorganic nitrogen back into the ecosystem as ammonia in the process known as ammonification. The ammonia then becomes available for uptake by plants and other microorganisms for growth.

3.1.6 Implications of Human Alterations to the Nitrogen Cycle

Many human activities have a significant impact on the nitrogen cycle.

- Burning fossil fuels,
- Application of nitrogen-based fertilizers and other activities have increased the amount of biologically available nitrogen in an ecosystem. Nitrogen availability often limits the primary productivity of many ecosystems, large changes in the availability of nitrogen can lead to severe alterations of the nitrogen cycle in both aquatic and terrestrial ecosystems.

3.2 Meaning of Water Cycle

The water cycle involves the exchange of energy, which leads to temperature changes. For instance, when water evaporates, it takes up energy from its surroundings and cools the environment. When it condenses, it releases energy and warms the environment. These heat exchanges influence the climate.

The evaporative phase of the cycle purifies water which then replenishes the land with freshwater. The flow of liquid water and ice transports minerals across the globe. It is also involved in the reshaping of the geological features of the Earth, through processes which includes erosion and sedimentation. The water cycle is also essential for the maintenance of most life and ecosystems on the planet.

3.2.1 Description

The Sun, which drives the water cycle, heats water in oceans and seas. Water evaporates as water vapour into the air. Ice,rain and snow sublimates directly into water vapour. Evapotranspiration is water transpired from plants and evaporated from the soil. Rising air currents take the vapour up into the atmosphere where cooler temperatures cause it to condense into clouds. Air currents move water vapour around the globe, cloud particles collide, grow, and fall out of the upper atmospheric layers as precipitation.

Some precipitation falls as snow or hail, sleet, and this accumulate as ice caps and glaciers, which can store frozen water for thousands of years. Most water falls back into the oceans or onto the land as rain, where the water flows over the ground as surface runoff. A portion of runoff enters rivers in valleys in the landscape, with stream flow moving water towards the oceans. Runoff and water emerging from the ground (groundwater) may be stored as freshwater in lakes. Not all runoff flows into rivers, much of it soaks into the ground as infiltration. Some water infiltrates deep into the ground and replenishes aquifers, which can store freshwater for long periods of time.

Some infiltration stays close to the land surface and can seep back into surface-water bodies (and the ocean) as groundwater discharge. Some groundwater finds openings in the land surface and comes out as freshwater springs. In river valleys and flood-plains there is often continuous water exchange between surface water and ground water in the hyporheic zone. Over time, the water returns to the ocean, to continue the water cycle.

3.2.2 Processes

Many different processes lead to movements and phase changes in water:

- **Precipitation:** This is condensed water vapor that falls to the Earth's surface. Most precipitation occurs as rain, or also as snow, hail, fog drip, and sleet. 78% of global precipitation occurs over the ocean. The precipitation that is intercepted by plant foliage, eventually evaporates back to the atmosphere rather than falling to the ground
- **Runoff:** This is the variety of ways by which water moves across the land. This includes both surface runoff and channel runoff. As it flows, the water may seep into the ground, evaporate into the air, become stored in lakes or reservoirs, or be extracted for agricultural or other human uses.
- **Infiltration:** This is the flow of water from the ground surface into the ground. Once infiltrated, the water becomes soil moisture or groundwater.
- **Subsurface flow:** This is the flow of water underground. Subsurface water may return to the surface, this is usually as a spring or by being pumped or eventually seep into the oceans. Water returns to the land surface at lower elevation than where it infiltrated, under the force of gravity or gravity induced pressures. Groundwater moves slowly and is also replenished slowly.
- **Evaporation:** This is the transformation of water from liquid to gas phases as it moves from the ground or bodies of water into the overlying atmosphere. The source of energy for evaporation is primarily solar radiation. Evaporation includes transpiration from plants and together, they are referred to as evapotranspiration.
- **Sublimation:** This state changes directly from solid water (snow or ice) to water vapor.
- **Condensation:** This is the transformation of water vapor to liquid water droplets in the air, creating clouds and fog.

- **Transpiration:** This involves the release of water vapor from plants and soil into the air. Water vapor is a gas that cannot be seen.
- **Percolation:** This involves the flow of water vertically through the soil and rock under the influence of gravity.

Old groundwater is called fossil water. Water stored in the soil remains there very briefly, because it is spread thinly across the Earth, and is readily lost by evaporation, transpiration, stream flow, or groundwater recharge. After evaporating, the residence time in the atmosphere is about 9 days before condensing and falling to the Earth as precipitation.

Surface Waters

Rainwater takes the quickest route to the sea and flows into rivers, streams, lakes and aquifers. The water in the surface waters is clean enough to support a variety of wildlife, but it is not safe to drink and needs to be treated in a water treatment works to remove any harmful substances.

- Water is abstracted from underground sources via boreholes or alternatively is pumped from rivers and stored in reservoirs before being passed through sand filter beds which trap any dirt and organisms. It is then treated using the most up to date advanced water treatment (AWT) technology such as ozonation and carbon filtration (granular activated carbon) which remove the substances that we cannot see.

3.2.3 Water Distribution

Clean, fresh drinking water is usually pumped into an underground network of pipes and storage reservoirs. The pipes are not seen again until they reach the tap, this guarantees that the water been drank remains clean and fresh.

Water Use

On average, in European countries, each person uses around 150 litres (33 gallons) of water every day. A large amount of water is also used for bathing, showers, washing up, washing clothes and toilet flushing. These activities transform clean tap water into dirty wastewater. The water utility not only supplies clean drinking water but also collects, transports and disposes dirty water after it has been used.

Sewerage
Dirty water or sewage is collected firstly in drains and then in underground sewers and is transported via a sewerage system (a network of pipes and tunnels) to a sewage treatment works.

Sewage Treatment Works
During treatment use of natural micro-organisms is involved in removing harmful substances from dirty water. The solid material (sludge) is separated from the liquid (effluent) and both are treated to produce clean effluent that can be released back to the river and bio-solids that can be used in agriculture as a fertilizer or incinerated to produce energy.

3.2.4 Human activities that alter the water cycle

These activities include:

- agriculture
- industry
- alteration of the chemical composition of the atmosphere
- construction of dams
- deforestation and afforestation
- removal of groundwater from wells
- water abstraction from rivers
- urbanization

3.3 Meaning of Canoe

A canoe is a lightweight narrow boat which points at both ends and open on top, it is propelled by one or more seated or kneeling paddlers facing the direction of travel using a single-bladed paddle.

3.3.1 Uses of Canoe

Canoes are used for racing, whitewater canoeing, touring and camping, freestyle, and general recreation. The intended use of the canoe dictates its hull shape and construction material.

When a canoe is paddled through water, it takes an effort to push all of the displaced water out of the way. Canoes are displacement hulls: the longer the waterline relative to its displacement, the faster it can be paddled. Among general canoeists, 5.2 m (17 ft) is the most popular length, providing a good compromise between maneuverability and speed.

Historically, canoes were dugouts or made of bark on a wood frame, but construction materials evolved to canvas on a wood frame, then to aluminum. Most modern canoes are made of molded plastic or composites such as fiberglass. Until the mid-1800s the canoe was an important means of transport for exploration and trade, but then transitioned to recreational or sporting use. Canoeing has been part of the Olympics since 1936. In places where the canoe played a key role in history, such as the northern United States, Canada, and New Zealand, the canoe remains an important theme in popular culture.

Canoes adapted to many purposes, for example with the addition of sails, outboard motors, and outriggers.

3.3.2 History of Canoe

The word canoe comes from the Carib kenu (dugout), via the Spanish canoa.

Australian Aboriginal people made canoes using a variety of materials, including bark and hollowed out tree trunks. The indigenous people of the Amazon commonly used Hymenaea trees. Many indigenous peoples of the Americas built bark canoes. They were usually skinned with birch bark over a light wooden frame, but other types could be used if birch was scarce. At a typical length of 4.3 m (14 ft) and weight of 23 kg (50 lb), the canoes were light enough to be portaged, yet could carry a lot of cargo, even in shallow water. Although susceptible to damage from rocks, they are easily repaired. Their performance qualities were soon recognized by early European immigrants, and canoes played a key role in the exploration of North America.

Native American groups of the north Pacific coast made dugout canoes in a number of styles for different purposes, from western red-cedar or yellow-cedar, depending on availability. Different styles were required for ocean-going vessels versus river boats, and for whale-hunting versus seal-hunting versus salmon-fishing.

The canot du nord is a craft specially made and adapted for speedy travel, was the workhorse of the fur trade transportation system. About one-half the size of the Montreal canoe, it could carry about 35 packs weighing 41 kg (90 lb) and was manned by four to eight men. It could be carried by two men and was portaged in the upright position.

There was the canoe called express canoe or canot léger, it was about 4.6 m (15 ft) long and was used in carrying people, reports, and news.

The birch bark canoe was used in a 6,500 kilometres (4,000 mi) supply route from Montreal to the Pacific Ocean and the Mackenzie River, and continued to be used up to the end of the 19th century.

Canoes were once primarily a means of transport, but with industrialization they have become popular as recreational or sporting watercraft.

Materials used for manufacturing canoes

- **Plastic**: Royalex is a composite material, which comprises of an outer layer of vinyl and hard acrylonitrile butadiene styrene plastic (ABS) and an inner layer of ABS foam; it is bonded by heat treatment. As a canoe material, Royalex is lighter, more resistant to UV damage, is more rigid, and has greater structural memory than non-composite plastics such as polyethylene. Royalex canoes are more expensive than aluminium canoes or canoes made from traditionally molded or roto-molded polyethylene hulls. It is heavier, and less suited for high-performance paddling than fiber-reinforced composites, such as fiberglass, kevlar, or graphite. Roto-molded polyethylene is a cheaper alternative to Royalex.
- **Fiber reinforced composites**: Fiberglass is the most common material used in manufacturing canoes. Fiberglass is not expensive and can be molded to any shape, more so, it is easy to repair. Kevlar is popular with paddlers looking for a light boat that will not be taken in whitewater. Fiberglass and Kevlar are strong but lack rigidity. Boats are built by draping the cloth on a mold, then impregnating it with a liquid resin. A gel coat on the outside gives a smoother appearance.
- **Polycarbonate**: Lexan is used in transparent canoes.
- **Aluminum**: Before the invention of fiberglass, this was the standard choice for whitewater canoeing. It is good value and very strong by weight. This material was once more popular but is being replaced by modern lighter materials. "It is tough and durable; it has no gel or polymer outer coating which would make it subject to abrasion. The hull does not degrade from long term exposure to sunlight, and "extremes of hot and cold do not affect the material". It can dent, is difficult to repair, is noisy, can get stuck on underwater objects, and requires buoyancy chambers to assist in keeping the canoe afloat in a capsize. Folding canoes usually consist of a PVC skin around an aluminum frame.
- **Inflatable**: These contain no rigid frame members and can be deflated, folded and stored in a bag. The more durable types consist of an abrasion-resistant nylon or rubber outer shell, with separate PVC air chambers for the two side tubes and the floor.

3.3.3 Types of canoe

Modern canoe types are usually categorized by the intended use. Many modern canoe designs are hybrids this is, a combination of two or more designs, meant for multiple uses. The purpose of the canoe determines the materials that will be used. Most canoes are designed for either one person referred to as solo or two people refer to as tandem, while some are designed for more than two people.

3.3.4 General recreation

A square-stern canoe is an asymmetrical canoe meant for lake travel or fishing. In practice, use of a side bracket on a double-ended canoe often is more comfortable for the operator, with little or no loss of performance. Since mounting a rudder on the square stern is very easy, such canoes often are adapted for sailing.

Touring canoe

In North America, a "touring canoe" is a good-tracking boat, good for wind-blown lakes and large rivers. A "tripping canoe" is a touring canoe with larger capacity for wilderness travel and is often designed with more rockers for better maneuverability on Whitewater Rivers but requires some skills on the part of the canoeist in open windy waters when lightly loaded. Touring canoes are often made of lighter materials and built for comfort and cargo space. Commercially built canoes are commonly built of fiberglass.

A touring canoe is sometimes covered with a greatly extended deck, forming a "cockpit" for the paddlers. A cockpit has the advantage that the gunwales can be made lower and narrower so the paddler can reach the water more easily, and the sides of the boat can be higher, keeping the boat dryer.

3.4 Atmospheric Photochemistry

Atmospheric chemistry is a branch of atmospheric science that deals with the chemistry of the Earth's atmosphere and that of other planets. It is also a multidisciplinary field of research which draws on environmental chemistry, physics, meteorology, computer modeling, oceanography, geology, volcanology and other areas of study such as climatology.

The composition and chemistry of the atmosphere is of importance primarily because of the interactions between the atmosphere and living organisms. The composition of the Earth's atmosphere changes as result of natural processes such as volcano emissions, lightning and bombardment by solar particles from corona. It has also been changed by human activity and some of these changes are harmful to human health, crops and ecosystems. Problems addressed by atmospheric chemistry include acid rain, ozone depletion, photochemical smog, greenhouse gases and global warming. Atmospheric chemists seek to understand the causes of these problems, and it is only when a theoretical understanding of these are obtained, that possible solutions can be tested and the effects of changes in government policy could be evaluated.

Atmospheric composition

Composition by volume of the Earth's atmosphere. Water vapour is highly variable, it is therefore not included. Schematic of chemical and transport processes related to atmospheric composition.

Average composition of dry atmosphere (mole fractions)

Gas	per NASA
Nitrogen, N_2	78.084%
Oxygen, O_2[1]	20.946%
Argon, Ar	0.934%
Minor constituents (mole fractions in ppm)	
Carbon Dioxide, CO_2	400
Neon, Ne	18.18
Helium, He	5.24
Methane, CH_4	1.7
Krypton, Kr	1.14
Hydrogen, H_2	0.55
Water vapour	Highly variable; typically makes up about 1%

History

The ancient Greeks regarded air as one of the four elements, but the first scientific studies of atmospheric composition began in the 18th century. The following chemists such as Joseph Priestley, Antoine Lavoisier and Henry Cavendish made the first measurements of the composition of the atmosphere.

There was a shift in interest towards trace constituents with very small concentrations in the late 19th and early 20th century'. One particularly important discovery for atmospheric chemistry was the discovery of ozone by Christian Friedrich Schönbein in 1840.

In the 20th century atmospheric science moved on from study of the composition of air to considering how the concentrations of trace gases in the atmosphere changed over time and the chemical processes which create and destroy compounds in the air. Two very important examples were the explanation given by Sydney Chapman and Gordon Dobson of how the ozone layer is created and maintained, and the explanation of photochemical smog by Arie Jan Haagen-Smit.

In the 21st century Atmospheric chemistry is increasingly studied as one part of the Earth system. Instead of concentrating on atmospheric chemistry in isolation the focus is now on seeing it as one part of a single system with the rest of the atmosphere, biosphere and geosphere. An especially important driver for this is the links between chemistry and climate such as the effects of changing climate on the recovery of the ozone hole and vice versa but also interaction of the composition of the atmosphere with the oceans and terrestrial ecosystems.

Methodology

The three central elements in atmospheric chemistryare Observations, lab measurements and modeling. The progress in atmospheric chemistry is driven by the interactions between these components and they form an integrated whole. For instance, observations indicates that more of a chemical compound may exist than previously thought possible. This will stimulate new modeling and laboratory studies which will increase our scientific understanding to a point where the observations can be explained.

Observation

Observations of the atmospheric chemistry are essential to our understanding. Routine observations of chemical composition tell us about changes in atmospheric composition over time. One important example of this is the Keeling Curve - a series of measurements from 1958 to today which show a steady rise in of the concentration of carbon dioxide. Observations of atmospheric chemistry are made in observatories such as that on Mauna Loa and on mobile platforms such as aircraft. Observations of atmospheric composition are increasingly made by satellites giving a global picture of air pollution and chemistry.

Lab Measurements

Measurements conducted in the laboratory aids our understanding of the sources and sinks of pollutants and naturally occurring compounds. Lab studies indicate which gases react with each other and how fast they react. Measurements of interest include reactions in the gas phase, on surfaces and in water. Also of high importance is photochemistry which quantifies how quickly molecules are split apart by sunlight and what the products are plus thermodynamic data such as Henry's law coefficients.

Modeling

Computer models such as chemical transport models are used in synthesizing and testing theoretical understanding of atmospheric chemistry. Numerical models solve the differential equations governing the concentrations of chemicals in the atmosphere. They are very simple. One common trade off in numerical models is between the number of chemical compounds and chemical reactions modeled versus the representation of transport and mixing in the atmosphere. For example, a box model might include hundreds or even thousands of chemical reactions but will only have a very crude representation of mixing in the atmosphere. Models are used in interpreting observations, test understanding of chemical reactions and predicting future concentrations of chemical compounds in the atmosphere. One important current trend is for atmospheric chemistry modules to become one part of earth system models in which the links between climate, atmospheric composition and the biosphere can be studied.

Construction of Models

Some models are constructed by automatic code generators (e.g. Autochem or KPP). In this approach a set of constituents are chosen and the automatic code generator selects the reactions which involve those constituents from a set of reaction databases. The ordinary differential equations (ODE) that describe their time evolution is automatically constructed once the reactions have been chosen.

4.0 CONCLUSION

Nitrogen is said to be the most important nutrient in regulating primary productivity and species diversity in both aquatic and terrestrial ecosystems. The bulk of nitrogen transformations, such as nitrogen fixation, nitrification, and denitrification, play a critical role in the fate of nitrogen in the Earth's ecosystems. However, as human populations continue to increase, the consequences of human activities continue to threaten our resources and have already significantly altered the global nitrogen cycle. The meaning of water cycle, processes water treatment have been discussed. The meaning of Canoes and materials used for manufacturing canoes has been examined. Atmospheric photochemistry as a branch of atmospheric science has also been discussed in unit.

5.0 SUMMARY

In this unit, we have learnt that:

- Nitrogen inaccessible in its present form to most organisms, making nitrogen a scarce resource and often limiting primary productivity in many ecosystems.

- It available to primary producers, such as plants, only when nitrogen is converted from dinitrogen gas into ammonia (NH3).
- Nitrogen undergoes many different transformations in the ecosystem, changing from one form to another as organisms use it for growth and for energy.
- The major transformations of nitrogen are nitrogen fixation, nitrification, denitrification, and ammonification .
- There are Implications of Human Alterations to the Nitrogen Cycle.
- The water cycle involves the exchange of energy, which leads to temperature changes.
- The evaporative phase of the water cycle purifies water which then replenishes the land with freshwater.
- The water cycle is essential for the maintenance of most life and ecosystems on the planet.
- Many different processes lead to movements and phase changes in water.
- The flow of water vertically through the soil and rocks under the influence of gravity is percolation.
- Old groundwater is called fossil water.
- There are some human activities that alter the water cycle.
- A canoe is a lightweight narrow boat which points at both ends and open on top propelled by one or more seated or kneeling paddlers facing the direction of travel using a single-bladed paddle.
- Canoes are used for racing, whitewater canoeing, touring and camping, freestyle, and general recreation.
- Historically, canoes were dugouts or made of bark on a wood frame, but construction materials evolved to canvas on a wood frame, then to aluminum.
- Most modern canoes are made of molded plastic or composites such as fiberglass.
- Materials used for manufacturing canoes
- A touring canoe is sometimes covered with a greatly extended deck, forming a "cockpit"
- Problems addressed by atmospheric chemistry include acid rain, ozone depletion, photochemical smog, greenhouse gases and global warming.
- The three central elements in atmospheric chemistry are Observations, lab measurements and modeling.

6.0 TUTOR-MARKED ASSIGNMENT

i. Mention and explain five major transformations in the nitrogen cycle.
ii. Explain the oxidation of nitrite to nitrate.
iii. Write explanatory note on the following:
   a. Nitrification process
   b. Denitrification
   c. Positive implication of Nitrogen Cycle on man
iv. Enumerate five implications of Human Alterations to the Nitrogen Cycle
v. Describe the processes involved in the water cycle.
vi. Describe five (5) different processes that leads to movements and phase changes in water.
vii. Mention five human activities that alter the water cycle.
viii. State the meaning of canoe.
ix. List four materials used for manufacturing canoes.
x. Give a brief history of the canoe
xi. Explain how canoes operate.
xii. What are those problems addressed by atmospheric photochemistry?
xiii. What are those three central elements in atmospheric photochemistry?

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UNIT 4 PHYSICAL CYCLES ENTROPY AND CARNOT CYCLE

CONTENTS

1.0 INTRODUCTION

In the unit Physical cycles also known as biorhythm, entropy and Carnot cycles were discussed. The meaning and the various steps involved in the cycles and their implications were highlighted.

2.0 OBJECTIVES

At the end of this unit you should be able to

- Describe the different steps involved in biorhythm cycles.
- Explain how you can plan from your knowledge of biorhythm cycle.
- Give examples of the effect of entropy on natural phenomena.
- Describe the steps involved in the Carnot cycle.
- Explain the implication of entropy and Carnot cycle.

3.0 MAIN CONTENT

3.1 Physical Cycles/Biorhythm

The human body undergoes fluctuations in strength, endurance, energy and physical well-being. Our energy levels vary. This type of feeling is classified under Biorhythms or Physical cycles that affect humans physically, emotionally and intellectually. They regulate metabolism, coordinate emotion, memory, sexuality creativity and more. Biorhythms occurs in cycles, and as each cycle rise and fall so does our ability to perform certain tasks, physical activities, deal with stress and make sound decisions. There are days that we find it difficult to get out of bed while in another day we feel on top of the world. Everyone has gone from having a great day to having a bad day one time or the other. These are not collective experiences they are personal. Biorhythms are cycles that attempt to describe energy levels or capacities for performance in various areas.

1) Physical Biorhythm cycle. This has 23 days. It describes your physical energy reflexes, strength and stamina. The physical cycle is said to be the dominant cycle in men. It regulates hand-eye coordination, strength, endurance, sex drive, initiative, metabolic rate, resistance to and recovery from illness. Surgery should be avoided on physical transition days and during negative physical cycle.

   Emotional Biorhythm cycle. This cycle takes 28 days. The emotional cycle is said to be the dominant cycle in women. It regulates emotions, feelings mood, sensitivity, sensation, sexuality, fantasy, temperament, nerves, reactions, affections and creativity. It describes your emotional stability and empathy.
   Intellectual Biorhythm cycle: - This cycle takes 33 days. The intellectual cycle regulates intelligence, logic, mental reaction, alertness, and sense of direction, decision-making, judgment, power of deduction, memory and ambition. It describes your mental aptitude, creativity and problem-solving capabilities.

Transition Days

- For all these cycles transition days exist when biorhythm cycles change polarity. At mid point and end point in each biorhythm cycle, the cycle sharply moves back to zero and changes polarity. This is called transition day (or caution, or critical day). As the cycle constantly changes polarity, we experience life's ups and downs.
- A double transition day is when 2 of your cycles change polarity on the same day. This day may be difficult especially if both cycles are changing polarity in their tandem (going in the same direction.
- A triple transition day is when 3 of your cycles change polarity on the same day. A triple transition day occurs once every 7-8 years.
- The toughest days are multiple transition days closely following each other. These are days when transition days of each of the cycles follow each other closely. Each of us experience these tough days several times in a year.

- During the first half of each of the cycles, one's physical, emotional and intellectual capacity and well-being increases. During this first half of the cycles a person is at the top for each.
- During the second half of each of the cycles, there is reduction in physical capability, emotional feeling and intellectual capability. This are periods when the individual needs to slow down because the internal drive/push is reduced gradually tending to Zero level.

Implication of Biorhythm

The fact that the cycles have both positive and negative sides does not mean that experiencing the negative aspect of each cycle has a negative effect on our lives. When the cycle is at its low point the body tends to relax to a point where you realize that you need rest. Intellectually it is a time of self-reflection and intuition is at its peak. Emotionally you are not driven by aesthesis but a time of sober reflection.

- Understanding your positive biorhythm cycles will assist you in planning physical activities intellectual endeavours and emotional reactions. Understanding your negative biorhythm cycles will help you avoid accidents, hurtful situations, grief and misfortune.
- Knowing our biorhythm cycles helps us in decision making intellectual pursuits and when to engage in creative activities.
- It enables us to know our off days so that we don't exert ourselves.

SELF-ASSESSMENT EXERCISE

1) What do you understand by biorhythms
2) Explain what one should expect during the positive and the negative aspects of each of the cycles.
3) Give three reasons why knowing our biorhythm cycles are important.

3.2 Entropy

Entropy is measure of randomness/order/disorder. Entropy is also defined as a thermodynamic state quantity that is a measure of randomness or disorder of the molecules of the system.

Entropy is the amount of energy that is not available for work during certain processes and in other words the energy form of a system that relates to its internal state of disorder. High entropy levels are disordered states while low entropy levels are characteristics of ordered states.

Entropy in general is based on the second law of thermodynamics which states that “whenever a spontaneous process takes place, it is accompanied by an increase in the total energy of the universe. The second law as stated above tells us that when an irreversible spontaneous process occurs, the entropy of the system and that of the surrounding increases. When a reversible process occurs, the entropy of the system remains constant meaning that there is no randomness. The universe as we know is undergoing spontaneous change the entropy of the system can be said to be constantly increasing.

Implication of Entropy

In the universe there are a lot of things that undergo sponteous changes that do not remain constantly in an orderly manner. The water molecules in ice are arranged in a highly organized crystal pattern which permits little movement. As the ice melts, the water molecules become disorganized and can move more freely at random. Evaporation of water occurs in water bodies. The movement of the molecules of water become free in the gaseous state and is able to evaporate into space since they can roam about throughout the entire atmosphere. In both cases, we can say that the randomness of water molecules increase as ice melts into water and water evaporates into space. It can therefore be said that increase in entropy occurs with increase in disorderliness while entropy tends to zero in an orderly system

SELF-ASSESSMENT EXERCISE

1) How would you define entropy to your classmates who has difficulty in understanding the concept entropy?
2) On which law is entropy based? State the law.
3) Describe/explain the level of entropy in an orderly and a disordered system.

3.3 Carnot Cycle

Carnot cycle is a theoretical thermodynamic cycle by Nicolas Leonard Sai Carnot in 1824 and expanded by others in the 1830s and 19840s. It is said to be the most efficient cycle for converting a given amount of thermal energy into work or conversely creating a temperature difference (e.g. refrigeration) by doing a given amount of work.

Every thermodynamic system exists in a particular state. A thermodynamic cycle occurs when a system is taken through a series of different states and finally returned to its initial state. In the process of going through this cycle, the system may perform work on its surrounding, thereby acting as a heat engine.

The Carnot cycle when acting as a heat engine consists of the following steps:

1. **Reversible isothermal expansion of the gas at the "hot" temperature Ti (isothermal heat addition or absorption) Isothermal means constant temperature.**
   - During this step the gas is allowed to expand and it does work on the surroundings.
   - The temperature of the gas does not change during the process therefore the expansion is isothermal.
   - The gas expansion is propelled by absorption of heat energy Q1a and of entropy $\Delta S = Q / TH$ from the high temperature reservoir.

2. **Isentropic (reversible adiabatic) expansion of gas (isentropic work output)**
   - For this step the piston and cylinder are assumed to be thermally insulated, therefore they neither rain nor lose heat.
   - The gas continues to expand, doing work on the surrounds, and losing an equivalent amount of internal energy.
   - The gas expansion causes it to cool to the "cold" temperature.

   The entropy remains unchanged.

3. **Reversible isothermal compression of the gas at the "cold" temperature Tc. (Isothermal heat rejection).**
   - The surroundings do work on the gas, causing an amount of heat energy Q2 and of entropy $\Delta 2$

   $= Q2/Tc$ to flow out of the gas to the low temperature reservoir. (This is the same amount of entropy absorbed in step 1.

4. **Isentropic compression of gas (isentropic work input).**
   - Once again the piston and cylinder are assumed to be thermally insulated.
   - During this step, the surroundings do work on the gas, increasing its internal energy and compressing it, causing the temperature to rise to TH
   - The entropy remains unchanged.
   - At this point the gas is in the same state as at the start of step 1

Implication of Carnot cycle

The Carnot engine is able to produce both hot and cold as a result of expansion and compression of the gas molecules in the engine which depends on the entropy of the gas. The Carnot engine can theoretically be used to produce both hot and cold temperatures as in the case of heaters and refrigerators.

SELF-ASSESSMENT EXERCISE

1) Who designed the Carnot cycle
2) What was the reason given for its efficiency
3) Describe how the Carnot cycle is able to produce both hot and cold temperature.

4.0 CONCLUSION

Entropy and Carnot cycle both took their root from the law of thermodynamic. Increase in entropy or disorderliness of molecules or gases bring about expansion and random movement of molecules which can bring about increase in temperature conversely zero entropy brings about cooling of the system as can be seen in Carnot cycle.

5.0 SUMMARY

6.0 TUTOR-MARKED ASSIGNMENT

i. Describe the practical application of entropy as can be observed naturally around us.
ii. Explain how entropy can bring about change of state.
iii. Explain in details the steps involved in Carnot cycle.
iv. What are biorhythms? Explain how different transition days can affect you.
v. Explain how our knowledge of our positive and negative cycles can be used for our benefit.

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UNIT 5 DIESEL CYCLE, MAGNETIC FIELDAND LORENTZ FORCE

CONTENTS

1.0 INTRODUCTION

Diesel cycle is a gas power cycle developed in the year 1897 by Rudolph Diesel. It is used in diesel engines. In this unit, magnetic field and Lorentz force will be examined.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain Diesel cycle.
- state the four distinct processes exhibited by Diesel cycle.
- explain the Magnetic field.
- give a brief history of the Magnetic field.
- explain the production of Magnetic field.
- state the significance of the Lorentz force.
- explain Lorentz force law as the definition of E and B

3.0 MAIN CONTENT

3.1 Meaning of Diesel cycle

Diesel cycle is a gas power cycle invented by Rudolph Diesel in the year 1897. It is widely used in diesel engines.

Diesel cycle is similar to Otto cycle except that it has one constant pressure process instead of a constant volume process.

The **Diesel cycle** is the thermodynamic cycle which approximates the pressure and volume of the combustion chamber of the Diesel engine.

The ideal Diesel cycle follows the following four distinct processes:

Process 1 to 2 is isentropic compression (blue)
Process 2 to 3 is reversible constant pressure heating (red)
Process 3 to 4 is isentropic expansion (yellow)
Process 4 to 1 is reversible constant volume cooling (green)

The Diesel is a heat engine which converts heat into work. The isentropic processes are impermeable to heat: that is heat flows into the loop through the left expanding isobaric process and some of it flows back out through the right depressurizing process, and the heat that remains does the work.

Work in (W_{in}) is done by the piston compressing the working fluid
Heat in (Q_{in}) is done by the combustion of the fuel
Work out (W_{out}) is done by the working fluid expanding on to the piston (this produces usable torque)
Heat out (Q_{out}) is done by venting the air

3.1.1 Maximum Thermal Efficiency

The maximum thermal efficiency of a Diesel cycle is dependent on the compression ratio and the cut-off ratio.

3.2 Meaning of Magnetic Field

Magnetic field is the magnetic influence of electric currents and magnetic materials. The magnetic field at any given point is specified by both a direction and a magnitude referred to as strength; as such it is a vector field. The term is used for two distinct but closely related fields denoted by the symbols B and H, where H is measured in units of amperes per meter (symbol: A·m−1 or A/m) in the SI. B is measured in teslas (symbol: T) and Newtons per meter per ampere (symbol: N·m−1·A−1 or N/(m·A)) in the SI. B is most commonly defined in terms of the Lorentz force it exerts on moving electric charges.

3.2.1 Production of Magnetic fields

Magnetic fields are produced by moving electric charges and the intrinsic magnetic moments of elementary particles associated with a fundamental quantum property, their spin. In special relativity, electric and magnetic fields are two interrelated aspects of a single object, called the electromagnetic tensor; the split of this tensor into electric and magnetic fields depends on the relative velocity of the observer and charge. In quantum physics, the electromagnetic field is quantized and electromagnetic interactions result from the exchange of photons.

Magnetic fields are most often encountered as a force created by permanent magnets, which pull on ferromagnetic materials such as iron, cobalt, or nickel and attract or repel other magnets. Magnetic fields are used in modern technology, particularly in electrical engineering and electromechanics. The Earth produces its own magnetic field, which is important in navigation, and this guards the Earth's atmosphere from solar wind.

3.2.2 History of Magnetic Fields

A French scholar named Petrus Peregrinus de Maricourt mapped out the magnetic field on the surface of a spherical magnet using iron needles during his study of magnetic fields in 1269. He noted that the resulting field lines crossed at two points, he named those points 'poles' in analogy to Earth's poles. He further articulated the principle that magnets always have both a north and South Pole, no matter how finely one slices them.

It was three centuries later, that William of Colchester replicated Petrus Peregrinus' work and from his findings, he stated that the Earth is a magnet. Published in 1600, Gilbert's work, De Magnete, established magnetism as a science.

In 1750, John Michell stated that magnetic poles attract and repel in accordance with an inverse square law. In 1785 Charles-Augustin de Coulomb experimentally verified this and stated clearly that the north and south poles cannot be separated. Siméon Denis Poisson (1781–1840) building on this force between poles, created the first successful model of the magnetic field, which he presented in 1824. In this model, a magnetic **H**-field is produced by 'magnetic poles' and magnetism is due to small pairs of north/south magnetic poles

Three discoveries were reported to challenge this foundation of magnetism. First, in 1819, Hans Christian Oersted discovered that an electric current generates a magnetic field encircling it. Second in 1820, André-Marie Ampère showed that parallel wires having currents in the same direction attract one another. Finally, Jean-Baptiste Biot and Félix Savart discovered the Biot–Savart law in 1820, which correctly predicts the magnetic field around any current-carrying wire.

Ampère in 1825extending these experiments published his own successful model of magnetism. He showed the equivalence of electrical currents to magnets and proposed that magnetism is due to perpetually flowing loops of current instead of the dipoles of magnetic charge in Poisson's model. This has the additional benefit of explaining why magnetic charge cannot be isolated. Further, Ampère derived both Ampère's force law describing the force between two currents and Ampère's law, which, like the Biot–Savart law, correctly described the magnetic field generated by a steady current. AlsoAmpère introduced the term electrodynamics to describe the relationship between electricity and magnetism.

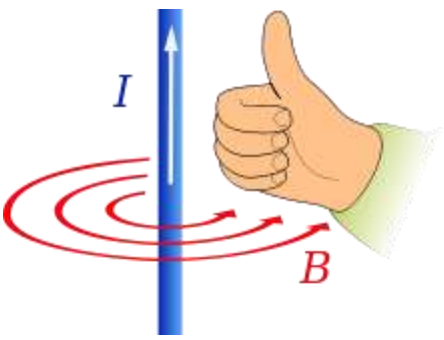
Michael Faradayin 1831 discovered the electromagnetic induction when he found that a changing magnetic field generates an encircling electric field. This phenomenon is described and known as Faraday's law of induction. Franz Ernst Neumann later proved that, for a moving conductor in a magnetic field, induction is a consequence of Ampère's force law. In the process he introduced the magnetic vector potential, which was later shown to be equivalent to the underlying mechanism proposed by Faraday.

The magnetic field is defined in several equivalent ways based on the effects it has on its environment.

The magnetic field is often defined by the force it exerts on a moving charged particle. It is known from experiments in electrostatics that a particle of charge q in an electric field $\mathbf{E}$ experiences a force $\mathbf{F} = q\mathbf{E}$. In other situations, when a charged particle moves in the vicinity of a current-carrying wire, the force also depends on the velocity of that particle. Fortunately, the velocity dependent portion can be separated out such that the force on the particle satisfies the Lorentz force law,

$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B}).$$

Magnetic field due to moving charges and electric currents



Right hand grip rule: a current flowing in the direction of the white arrow produces a magnetic field shown by the red arrows.

All moving charged particles produce magnetic fields. Moving point charges, such as electrons, produce complicated but well known magnetic fields that depend on the charge, velocity, and acceleration of the particles.

Magnetic field lines form in concentric circles around a cylindrical current-carrying conductor, such as a length of wire. The direction of such a magnetic field can be determined by using the "right hand grip rule". The strength of the magnetic field decreases with distance from the wire.

3.3 The Term Lorentz Force

The Lorentz force in physics, particularly electromagnetism, is the combination of electric and magnetic force on a point charge due to electromagnetic fields. If a particle of charge *q* moves with velocity **v** in the presence of an electric field **E** and a magnetic field **B**, then a force will be experienced. For any produced force there will be an opposite reactive force. In the case of the magnetic field, the reactive force may be obscure, but it must be accounted for.

$$\mathbf{F} = q\left(\mathbf{E} + \mathbf{v} \times \mathbf{B}\right)$$

Variations on this basic formula describe the magnetic force on a current-carrying wire sometimes called Laplace force, the electromotive force in a wire loop moving through a magnetic field. This is an aspect of Faraday's law of induction, and the force on a charged particle which might be traveling near the speed of lightthat is relativistic form of the Lorentz force.

3.3.1 Significance of the Lorentz force

The modern Maxwell's equations describe how electrically charged particles and currents or moving charged particles give rise to electric and magnetic fields, while the Lorentz force law describes the force acting on a moving point charge *q* in the presence of electromagnetic fields. The Lorentz force law therefore describes the effect of **E** and **B** upon a point charge, but such electromagnetic forces are not the entire picture. Charged particles are coupled to gravity and nuclear forces. Maxwell's equations do not stand separate from other physical laws, but are coupled to them via the charge and current densities. The response of a point charge to the Lorentz law is one aspect; the generation of **E** and **B** by currents and charges is another.

In real materials the Lorentz force is inadequate to describe the behavior of charged particles, both in principle and as a matter of computation.

The charged particles in a material medium both respond to the **E** and **B** fields and generate these fields.

3.3.2 Lorentz Force Law as the Definition of E and B

The Lorentz force is understood to be the following empirical statement: *The electromagnetic force **F** on a test charge at a given point and time is a certain function of its charge* q *and velocity **v**, which can be parameterized by exactly two vectors **E** and **B**, in the functional form*:

$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

This *is* valid as several experiments have shown that it is, even for particles approaching the speed of light. The two vector fields E and **B** defined through space and time are called the "electric field" and "magnetic field". The fields are defined everywhere in space and time with respect to what force a test charge would receive regardless of whether a charge is present to experience the force.

Concerning the definition of **E** and **B**, the Lorentz force is only a definition in principle because a real particle as opposed to the hypothetical "test charge" of infinitesimally-small mass and charge would generate its own finite **E** and **B** fields, which would alter the electromagnetic force that it experiences.

When a wire carrying an electrical current is placed in a magnetic field, each of the moving charges, which comprise the current, experiences the Lorentz force, and together they can create a macroscopic force on the wire (sometimes called the **Laplace force**). By combining the Lorentz force law with the definition of electrical current, the following equation willresult in the case of a straight stationary wire:

$$\mathbf{F} = I\boldsymbol{\ell} \times \mathbf{B}$$

where $\boldsymbol{\ell}$ is a vector whose magnitude is the length of wire, and whose direction is along the wire, aligned with the direction of conventional current flow *I*.

If the wire is not straight but curved, the force on it can be computed by applying this formula to each infinitesimal segment of wire $d\ell$, then adding up all these forces by integration. Formally, the net force on a stationary, rigid wire carrying a steady current *I* is therefore

$$\mathbf{F} = I \int \mathrm{d}\boldsymbol{\ell} \times \mathbf{B}$$

This is the net force. In addition, there will usually be torque, plus other effects if the wire is not perfectly rigid.

4.0 CONCLUSION

Diesel cycle is a gas power cycle developed in the year 1897 and is widely used in diesel engines. It has one constant pressure process instead of a constant volume process and approximates the pressure and volume of the combustion chamber of the engine. The ideal Diesel cycle follows four distinct processes. Meaning of Magnetic field and Lorentz forces has also been examined.

5.0 SUMMARY

In this unit, we have learnt that:

- Diesel cycle is a gas power cycle invented by Rudolph Diesel in 1897 and mainly used in diesel engines.
- Diesel cycle is similar to Otto cycle except that it has one constant pressure process instead of a constant volume process.
- The Diesel cycle is the thermodynamic cycle which approximates the pressure and volume of the combustion chamber of the Diesel engine.
- The ideal Diesel cycle has four distinct processes.
- Magnetic field is the magnetic influence of electric currents and magnetic materials.
- The Lorentz force is the combination of electric and magnetic force on a point charge due to electromagnetic fields.
- The Lorentz force law describes the force acting on a moving point charge q in the presence of electromagnetic fields.

6.0 TUTOR-MARKED ASSIGNMENT

i. Briefly explain the following:
ii. a.Diesel cycle b.Magnetic field c.Lorentz force
iii. State the four distinct processes exhibited by Diesel cycle.
iv. Explain the production of the Magnetic fields.
v. Give a brief history of the Magnetic field.

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MODULE 2 GEOLOGICAL CYCLES

INTRODUCTION

In this module, you will be exposed to geochemical cycle, tectonic cycle, major tectonic episodes and plate tectonic.

UNIT 1 GEOCHEMICAL CYCLE

CONTENTS

1.0 INTRODUCTION

In this unit the path followed by elements found in the earth crust and earth's surface is discussed.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- define geochemical cycle
- explain geochemical cycle
- draw geochemical cycle

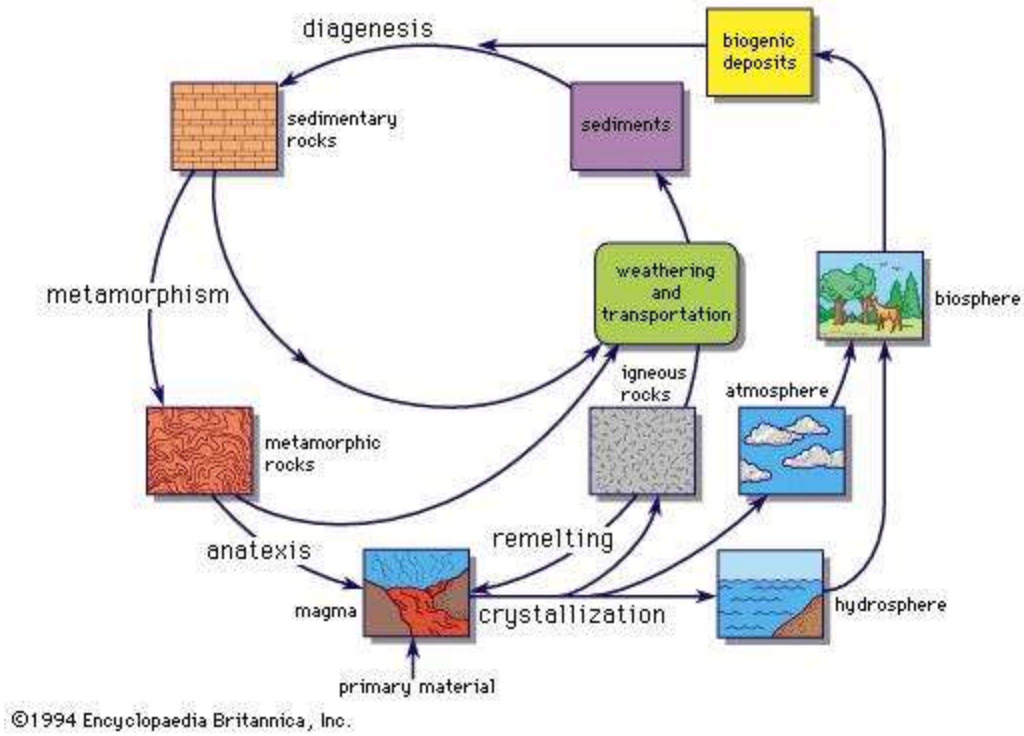
3.0 MAIN CONTENT

3.1 Geochemical Cycle

Geological cycle is thedevelopmental path followed by individual elements or groups of elements in the crustal and subcrustal zones of the **Earth** and on its surface. The concept of a geochemical cycle encompasses geochemical differentiation (*i.e.,* the natural separation and concentration of elements by Earth processes) and heat-assisted, elemental recombination processes.

The **earth is a system** containing a **fixed amount** of each stable atom or element. Each element can exist in several different **chemical reservoirs**. Each element on earth moves among **reservoirs** in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles.
* **Movement of matter** between reservoirs is driven by the earth's internal and external sources of energy.

For the **lithosphere** (*i.e.*, the crust and upper mantle), the geochemical cycle begins with the crystallization of a **magma** at the surface or at depth. In turn, surface alteration and weathering break down the **igneous rock**, a process that is followed by the transportation and deposition of the resulting material as **sediment**. This sediment becomes lithified and eventually metamorphosed until melting occurs and new magma is generated. This ideal cycle can be interrupted at any point. Each element may be affected differently as the cycle progresses. During the weathering of an igneous rock, for example, minerals containing iron, magnesium, and calcium break down and are carried in solution, but silicon-rich quartz and feldspar are mainly transported as sediment. The resultant sedimentary rocks are dominated by quartz and feldspar, whereas others are dominated by calcium and magnesium owing to the precipitation of calcium or magnesium carbonates. Such elements as sodium remain in solution until precipitated under extreme conditions. As partial melting of sedimentary rocks begins, elements become separated according to melting properties; volatiles are released to the **atmosphere**. These elements in the atmosphere utilized by plants and animals. Physical movement of chemically separated bodies also occurs. While the geochemical cycle over a short term appears to be in a seemingly steady state, long-term changes also occurs which can result in the evolution of continents and oceans over geologic **time**.



GEOCHEMICAL CYCLE

SELF-ASSESSMENT EXERCISE

1. What happens to magma igneous rock?
2. What factor determines the separation of elements during geochemical cycle?
3. Where are volatile elements released into ?

4.0 CONCLUSION

Elements which are locked up deep in the earth crust are made available in the atmosphere or dissolved in water through such physical processes as crystallization, melting weathering and sedimentation.

5.0 SUMMARY

In this unit we have learnt

- The developmental part followed by element in the earth crust and the earth surface.
- Geochemical cycles starts with Crystallization of magma.
- Igneous rock is broken down through weathering.
- The weathers particles of the rock form sediments.
- The elements released do not follow similar cycle.

- Minerals containing iron, magnesium and calcium break down and are carried in solution.
- Silicon –rich quartz are transported as sediment.
- The elements released in the air and those that dissolved in water are made available for plant and animals.
- Long-term changes that occur as a result of geochemical cycles can result in the formation of oceans and continents.

6.0 TUTOR-MARKED ASSIGNMENT

i. Describe the processes involved in geochemical cycle.
ii. Of what importance is the cycle to the following’
    a. Plants
    b. Animals
    c. Mineral production

7.0 REFERENCES/FURTHER READING

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Wikipedia,thefreeencyclopaediaGeochemicalcyclehttp://en.wikipedia.org/wiki/Geochemical_cycle

UNIT 2 TECTONIC CYCLE

CONTENTS

1.0 INTRODUCTION

The first to recognize how plate tectonics applied to the geological record was J. Tuzo Wilson and the Tectonic Cycle is also called the Wilson Cycle.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the meaning of tectonic cycle.
- describe the rifting and the development of ocean basins.
- explain the stages recognized in the tectonic development
- state how rifting is initiated.
- explain some Rift Terminologies.

3.0 MAIN CONTENT

3.1 Meaning of Tectonic Cycle/Rifting and the Development of Ocean basins

J. Tuzo Wilson was one of the first to recognize how plate tectonics could be applied to the geological record. If continents rift apart to form ocean basins, other oceans must close. This may be repeated throughout Earth history. Example: the IAPETUS Ocean between England & Scotland in the Lower Palaeozoic, closed in the Caledonian; later opening of the Atlantic, almost in the same place. The Tectonic Cycle is known as the Wilson Cycle.

The Tectonic Cycle involves

(1) Rifting of continents by mantle diapirism
(2) Continental drift, seafloor spreading & formation of ocean basins
(3) Progressive closure of ocean basins by subduction of ocean lithosphere
(4) Continental collision and final closure of ocean basin

Uprising plume causes doming of crust with magma chamber developing underneath. As extension continues, an ocean basin forms, and thick sedimentary sequences develop at continental margins as rivers dump sediments in deep water.

Continental Rifting: triple junctions

Stages recognized in the tectonic development
Four main stages are recognized in the tectonic development of a typical rifted passive margin and these include:

1) The RIFT VALLEY stage which involves early graben formation prior to continental splitting. This stage may be associated with domal uplift caused by uprise of hot upper mantle material and is connected with underlying mantle hotspots. Example: African Rift Valley.
2) The YOUTHFUL stage, lasting about 50 my after the onset of seafloor spreading, while the thermal effects are still dominant. This stage is characterized by rapid regional subsidence of the outer shelf and slope, but some graben formation may persist. Example: Red Sea.
3) The MATURE stage during which more subdued regional subsidence may continue. Example: most of the present Atlantic continental margins.
4) The FRACTURE stage when subduction starts and terminates the history of the continental margin.

The continent of Africa is thought to have been split by a series of rift valleys in various states of development. Those in East Africa are still in thick crust. Those in West Africa are associated with thick oil-bearing sediments. In the Red Sea area the rifting has gone so far as to form a narrow ocean. In the south-east Madagascar has been completely separated from Africa by rifting.

3.2 What Initiates Rifting?

Some have ascribed rifting to up-doming of the crust over a hot-spot; though parts of the E African rift system are very elevated, compared with other sectors, which suggest that the doming reflects an underlying hot low-density mantle plume. In other cases, geophysical models suggest the asthenospheric mantle is rising to high levels beneath the rift. However it is also apparent that rifting can take place without extensive uplift; it could be that the convective processes in the underlying asthenosphere are causing the extension. To rift a continent apart it needs the rifts associated with various possible thermal domes to link together. Morgan (1981, 1983) suggested that as continents drift slowly over hotspots the hotspots weaken the plate - like a blowtorch impinging on the base - and these weakened zones become the sites of continental rifting.

Burke & Whiteman (1973), following the doming hypothesis, suggested that in these domal regions, three rifts would develop, forming an 'rrr' triple junction. It is possible that all three rifts might develop into an ocean ('RRR'), it is more likely that two of these rifts would develop into an ocean ('RRr'), leaving the third rift as a 'failed arm'. They indicated that on many continents it was possible to recognise these RRr junctions. The 'failed arm' rift would eventually subside as the thermal anomaly decayed and become the site of a major depositional basin, or a major river channel and delta. The Benue Trough in Nigeria is regarded as an example of such a failed arm following the opening of the S. Atlantic. When oceans eventually close it is possible to recognise these failed arms as depositional basins oriented perpendicular to the collision mountain belt (most basins tend to be aligned parallel to mountain belts). These are termed 'aulacogens'.

3.3 Development of Continental Rifts

Early ideas on the development of rifts are conceptualized in the diagram shown in Fig. 5. This is based on the African rift system, where there is significant rift magmatism. There is notable extension, shown by the widening of the diagram block by at least 50 km. At the same time there is uplift or ascent of the more ductile mantle, especially the asthenosphere. The crust, and particularly the upper crust, is assumed to act in a brittle fashion.

Uprise and decompression of the underlying asthenosphere results in magma formation. The crust responds by brittle fracture. Early rift sediments are downfaulted into the developing rift (graben). Erosion takes place on the sides of the rift valley.

The first stage assumes that graben-like faults begin to form in the brittle crust.

The second stage shows simultaneous necking of the lithosphere with uprise of an asthenosphere diapir. The decompression associated with the latter causes melting of the mantle to give alkaline basaltic magmas. Pre-existing sediments are downfaulted into the graben.

The third stage is accompanied by significant extension and by more uprise of the asthenosphere. The latter causes doming of the crust (which is evident along the E. African rift system, but is variably developed. New sediments are deposited within the graben as a result of erosion of the uplifting sides of the graben. So there are both pre-rift and syn-rift sediments within the developing rift valley, but sediments on the flanks are progressively eroded away.

The fourth stage shows the actually rifting-apart of the continent, so the asthenosphere rises towards the surface, causing decompression and extensice melting. New basaltic oceanic crust is formed.

Finally, sea-floor spreading takes over as the ocean basin widens. The rift sedimentary sequence is buried beneath younger marine sediments.

3.4 Continental Shelf Sediments

The real situation at passive continental margins is shown in Fig. 6 (below). This is typical of a number of crustal cross-sections across the continental shelf of the eastern Atlantic seaboard of North America, projected down to 30 km -- based largely on gravity and magnetic evidence, plus some seismic profiles -- and some extrapolation from land geology based on deep drill holes.

In many sections of the continental shelf off this eastern seaboard of the USA there is a major coast-parallel magnetic structure, possibly a major intrusion. But its age is unknown.

Some Rift Terminologies

Continental Rift: elongate tectonic depression with which the entire lithosphere has been modified in extension

Rift System: Tectonically interconnected series of rifts
Modern Rift: A rift that is teconically or magmatically active
Paleorift: A dead or dormant rift
Failed Arm: Branch of a triple junction not developed into an ocean basin
Aulacogen: Paleorift in ancient platform that has been reactivated by compressional deformation
Active Rifting: Rifting in response to thermal upwelling of the asthenosphere

Passive Rifting: Rifting in response to remote stress field

Rifts and Mineralisation
Rifting structures are often good sites for mineralisation. This arises for three reasons:

1) They are sites of thick clastic sedimentation. These sediments hold vast amounts of inter-granular salt water (brines).
2) Rift structures are also thermally anomalous hot zones. This is because they are frequently underlain by igneous intrusions -- granite (or perhaps in some cases gabbro) plutons.
3) The rift zones may be the sites of diverse rocks, such as basaltic lavas, which release their metals on hydrothermal alteration.

4.0 CONCLUSION

Continents rift apart to form ocean basins, other oceans do close and this is repeated throughout Earth history. Geophysical models have indicated that the asthenospheric mantle rises to high levels beneath the rift. However it is also apparent that rifting can take place without extensive uplift;

5.0 SUMMARY

In this unit, we have learnt that:

- J. Tuzo Wilson was one of the first to recognize plate tectonics could be applied to the geological record.
- There are four main stages recognized in the tectonic development of a typical rifted passive margin.
- Three rifts would develop, forming an 'rrr' triple junction.
- The crust, and particularly the upper crust, is assumed to act in a brittle fashion.
- Pre-existing sediments are downfaulted into the graben.

6.0 TUTOR-MARKED ASSIGNMENT

i. Explain the tectonic cycle.
ii. Describe the rifting and the development of ocean basins.
iii. Explain the stages involved in tectonic development
iv. State how rifting is initiated.
v. Mention and explain some Rift Terminologies.

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UNIT 3 TECTONIC EPISODES IN GEOLOGICAL TIME

CONTENTS

1.0 INTRODUCTION

Have you ever thought of how rocks, mountains, hill and minerals came about?

In this unit history of how structural deformations of the earth crust were formed was presented in form of episodes. In this unit the tectonic episodes of Lebanon were presented.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Explain the term tectonic.
- Describe in detail the main features of the different episodes
- Identify the geological time when different structures of the earth were made.

3.0 MAIN CONTENT

3.1 Definition of Tectonic and Meaning of Episode

Tectonic is a branch of geology concerned with structural features. It studies the origin and history of structural deformation of the earth crust. The presentation of the geological history of a specific location presented in a number of broad summaries is referred to as episodes. In this unit the tectonic episodes that will be considered are the one for Lebanon.

3.1.1 Tectonic Episodes in Lebanon

EPISODE 1: 250-200 MA (END PERMIAN TO LATE TRIASSIC) THE FIRST RIFTING

Although there are no rocks of this time period known in Lebanon we can make a fairly good guess as to what events took place in this area from data from surrounding countries.

After the relatively high sea levels in the Permian the seas began to fall during the Triassic so that by the end of the Triassic evaporates and shallow water limestone were probably being deposited.

During the Late Permian to Triassic the supercontinent Gondwana began to break up with the formation of a series of rifts and opening oceanic seaways. This trend towards breakup was to continue until the middle of the Cretaceous. During the Triassic the Tethyan Ocean progressively opened westwards round the northeastern to northwestern margins of what is now Arabia. It is probable that by the Late Triassic sea floor spreading had opened a narrow NE-SW aligned ocean whose eastern margin lay just to the west of the present day continental slope, some 10-20 km west of the modern shoreline .

EPISODE 2: 200-150 MA (EARLY - LATE JURASSIC) STABILITY AND WARM CLEAR SEAS

The oldest rocks seen in Lebanon are Lower Jurassic in age. The main part of the Jurassic sequence in Lebanon is extremely thick (possibly greater than two km) but poorly known largely due to the cliff forming and monotonous character. This massive Jurassic sequence (the Kesrouane Formation) occurs essentially in three main areas. These are a) Mount Lebanon north of the Damascus Road (the Metn and Kesrouane), b) the Chouf and Jebel Barouk and c) the central and southern Anti-Lebanon.

For most of the Jurassic time (210-144 million years ago) the Lebanon region appears to have been a stable area upon which marine lime stones were deposited. Over this area sea levels gradually rose during the Early and Middle Jurassic so that shoreline and tidal flat limestones and evaporates were gradually replaced by shallow marine limestone muds and sands with local patches of corals and sponge reefs.

Whether any seafloor spreading occurred offshore Lebanon at this time is unclear, but until the Late Jurassic the region appears to have been tectonically quiet.

EPISODE 3: 150-100 MA (END JURASSIC - MID CRETACEOUS) UPLIFT, VOLCANOES AND DELTAS

At the start of the Late Jurassic further tectonism began to occur in the region. This probably mainly involved the break up of the area into a distinct series of blocks, some of which rose above the sea and became covered by soils. There was the widespread eruption of basalt lava and ashes from a number of vents. It is probable that this tectonism is related to a renewed phase of breakup of Gondwana; similar Late Jurassic rifting is known across Africa and into southern Arabia. This volcanic and tectonic phase was relatively temporary and there was renewed flooding of the Lebanon area during the last part of the Jurassic to give further limestone deposition. However sometime, either at the very end of the Jurassic or during earliest Cretaceous time, the area underwent more block faulting giving emergence and erosion that possibly lasted for 10 or so million years. The result of this is that the sandy Lower Cretaceous sandstones of the Chouf Formation rest unconformably upon the Jurassic limestones. Associated with this pre-Chouf Sandstone uplift was another phase of basaltic volcanism which continued in places into the middle part of the Cretaceous. In addition to this it seems tectonism it seems as if seafloor spreading continued in the offshore area until mid Cretaceous time.

During the Early Cretaceous Lebanon was covered by a series of swamps, rivers and deltas which has given a widespread sequence of sands and shales up to 500m thick. These Early Cretaceous strata are widely worked for building sand. They also contain good fossil amber with well preserved insects.

During the later part of the Early Cretaceous sea levels began to rise and marine incursions became increasingly prominent. The supply of sands into the Lebanon area began to wane switching off almost totally during the middle Cretaceous when a sea level rise brought in a widespread pure limestone deposition, locally with reefs, across the area. After a brief return to sandstone and clay deposition sea levels rose further to give a return to widespread limestones.

EPISODE 4: 100-50 MA (LATE CRETACEOUS - EARLY EOCENE) HIGH SEALEVELS AND GENTLE FOLDING

After the seafloor spreading which marked the first three episodes the Late Cretaceous saw a major switch in the tectonic pattern as Eurasia and the Africa-Arabia Plate began to come closer together causing the start of the closure of the Tethyan Ocean. Although any collision zone was well offshore and far to the north and northwest of the Lebanon area the first compressional effects seem to have been felt across the area during the Late Cretaceous. This gave rise to the first gentle uplifting of the Mount Lebanon and Anti-Lebanon area so that the main features of Lebanon started to form at this time.

A more obvious feature was that of the very high sea levels which dominated most of Late Cretaceous and Early Tertiary time. These contributed to thick sequences of pale fine limestones and chalks. It is during this time the 'fish beds' formed in local areas of oxygen shortage close to the edge of the carbonate platform. The fine grained limestones seem to cross the Cretaceous-Tertiary boundary with no major change. Whatever did kill off the dinosaurs and ammonites left no obvious signs of its action here.

EPISODE 5: 50-0 MA (MID EOCENE TO THE RECENT) TECTONIC UPLIFT AND CLIMATIC COOLING

The last fifty million years has seen an enormous change in the area from the Mid Eocene time when the area was covered by shallow seas in which limestones were being deposited to its present state of being an emergent and eroding land mass.

At the start of this episode the Africa-Arabian Plate was just beginning to collide with Eurasia and there was still a substantial Tethyan Ocean present . As the plates collided the geology changed. Substantial uplift occurred in the Late Eocene and Oligocene giving a major emergence and the marking out of the threefold NNE-SSW trending pattern of modern Lebanon. During this time the sea was progressively pushed out of the Bekaa depression and restricted to shallow marine incursions along the line of the present day coast. The erosion of some of the main river valleys of Mount Lebanon may have started at this time.

Perhaps ten million years ago the area began to be dissected by the first motions along the faults of the Dead Sea Transform Fault System. These caused new tilting and uplift and caused major disruption of drainage patterns. At the end of the Miocene the Mediterranean dried up and during this time the river valleys may have cut down across the continental shelf.

There has been continued uplift and local tilting over the last five million years and some major disruption of river courses as various blocks slide against one another due to the strike slip faulting. Uplift and local tilting is evidently continuing; evidences for this are the numerous raised beach levels and the continuing seismicity. A classic case of this is the Litani River which, at one point, probably originally flowed due south into the Hula and Jordan valley areas but which had its path blocked by uplift and basaltic volcanism, redirecting it eastwards to the Mediterranean.

Superimposed on the effects of these tectonic events have been the major climatic and sea level changes of the last part of the Cenozoic. The lowering of temperatures over the last two million years gave rise to frequently wetter and colder conditions during the Pleistocene. Some of the best evidence for this can be seen in the way that the southern part of the Bekaa (from Rayak southwards) appears to have been sporadically covered by a large lake with a well marked shoreline at around 970m. The last remains of this lake system can be seen in the Aammiq Wetlands area. The extent to which glaciers were present on the tops of the highest peaks during the Pleistocene glacial periods is uncertain. The evidence suggests that limited glacier systems existed at altitudes above 2500m at the coldest times giving glacial moraines at such places as the Cedars at Bcharré.

From 10,000 years ago the area warmed up and reforestation occurred. Human activity however started to negatively affect the environment on a large scale from around 4000 BC onwards; a process that has increased alarmingly in the 20th Century.

4.0 CONCLUSION

In this unit, an outline of the geological history of Lebanon was given . The characteristic features of the activities that occurred within 50 years in geological time referred to as episode were also presented.

5.0 SUMMARY

- Tectonic is a branch of geology concerned with structural features.
- During the first episode lime stones starts to be deposited by end of Triassic.
- During late permain to Triassic supercontinent Gondwana began to break up form series of rifts and opening sea ways.
- Episode two is characterized by the formation of cliff, marin limestone, rise in sea level, marine limestone, mud and sand corals and sponge reefs develop.
- Episode three is characterized by uplifts volcanoes and deltas.
- Episode four is characterized by the formation of mountains; high sea levels and fish beds are formed in areas of oxygen shortage.
- In episode five Africa-Arabia plate start to collide with Eurasia.
- The collision brings about geological changes uplifts and tilting occur.
- Change in sea level
- Lowering of temperature.

6.0 TUTOR-MARKET ASSIGNMENT

1. Explain the term tectonic
2. Describe in details the main features of the different episodes.

7.0 REFERENCES/FURTHER READING

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UNIT 4 PLATE TECTONIC

CONTENTS

1.0 INTRODUCTION

In this unit you will be learning about the followings: What tectonic plate mean, where they are found, the driving force behind plate tectonic, how massive slabs of solid rock float despite their tremendous weight. Also the main features of plate tectonic, continental drift and plate boundaries.

2.0 OBJECTIVES

By the end of this study you should be able to:

- explain what plate tectonic means
- explain the driving force behind plate tectonic
- explain the theory of continental drift
- describe the 3 types of plate tectonic
- differentiate between the types of plate tectonic

3.0 MAIN CONTENT

3.1 Tectonic Plate

What is a tectonic plate?
A tectonic plate (also called lithospheric plate) is a massive, irregularly shaped slab of solid rock, generally composed of both continental and oceanic lithosphere. Plate size can vary greatly, from a few hundred to thousands of kilometers across; the Pacific and Antarctic Plates are among the largest. Plate thickness also varies greatly, ranging from less than 15 km for young oceanic lithosphere to about 200 km or more for ancient continental lithosphere (for example, the interior parts of North and South America).

From the deepest ocean trench to the tallest mountain, plate tectonics explains the features and movement of Earth's surface in the present and the past. Plate tectonics is the theory that Earth's outer shell is divided into several plates that glide over the mantle, the rocky inner layer above the core. The plates act like a hard and rigid shell compared to **Earth's mantle.** This strong outer layer is called the lithosphere.

The driving force behind plate tectonics is convection in the mantle. Hot material near the Earth's core rises, and colder mantle rock sinks. "It's kind of like a pot boiling on a stove," Van der Elst said. The convection drive plates tectonics through a combination of pushing and spreading apart at **mid-ocean ridges** and pulling and sinking downward at subduction zones, researchers think. Scientists continue to study and debate the mechanisms that move the plates.

Mid-ocean ridges are gaps between tectonic plates that mantle the Earth like seams on a baseball. Hot magma wells up at the ridges, forming new ocean crust and shoving the plates apart. At **subduction zones,** two tectonic plates meet and one slides beneath the other back into the mantle, the layer underneath the crust. The cold, sinking plate pulls the crust behind it downward.

Many spectacular volcanoes are found along subduction zones, such as the "Ring of Fire" that surrounds the Pacific Ocean.

How do these massive slabs of solid rock float despite their tremendous weight? The answer lies in the composition of the rocks. Continental crust is composed of granitic rocks which are made up of relatively lightweight minerals such as quartz and feldspar. By contrast, oceanic crust is composed of basaltic rocks, which are much denser and heavier. The variations in plate thickness are nature's way of partly compensating for the imbalance in the weight and density of the two types of crust. Because continental rocks are much lighter, the crust under the continents is much thicker (as much as 100 km) whereas the crust under the oceans is generally only about 5 km thick. Like icebergs, only the tips of which are visible above water, continents have deep "roots" to support their elevations.

Most of the boundaries between individual plates cannot be seen, because they are hidden beneath the oceans. Yet oceanic plate boundaries can be mapped accurately from outer space by measurements from GEOSAT satellites. Earthquake and volcanic activity is concentrated near these boundaries. Tectonic plates probably developed very early in the Earth's 4.6-billion-year history, and they have been drifting about on the surface ever since-like slow-moving bumper cars repeatedly clustering together and then separating.

Like many features on the Earth's surface, plates change over time. Those composed partly or entirely of oceanic lithosphere can sink under another plate, usually a lighter, mostly continental plate, and eventually disappear completely. This process is happening now off the coast of Oregon and Washington. The small Juan de Fuca Plate, a remnant of the formerly much larger oceanic Farallon Plate, will someday be entirely consumed as it continues to sink beneath the North American Plate.

Plate boundaries

Subduction zones, or convergent margins, are one of the three types of plate boundaries. The others are divergent and transform margins.

At a divergent margin, two plates are spreading apart, as at seafloor-spreading ridges or continental rift zones such as the East Africa Rift.

Transform margins mark slip-sliding plates, such as California's San Andreas Fault, where the North America and Pacific plates grind past each other with a mostly horizontal motion.

Plate tectonics: The main features are:

- The Earth's surface is made up of a series of large plates (like pieces of a giant jigsaw puzzle).
- These plates are in constant motion travelling at a few centimetres per year.
- The ocean floors are continually moving, spreading from the centre and sinking at the edges.
- **Convection currents** beneath the plates move the plates in different directions.
- The source of heat driving the convection currents is radioactive decay which is happening deep in the Earth.

Where is the Evidence for Plate Tectonics?

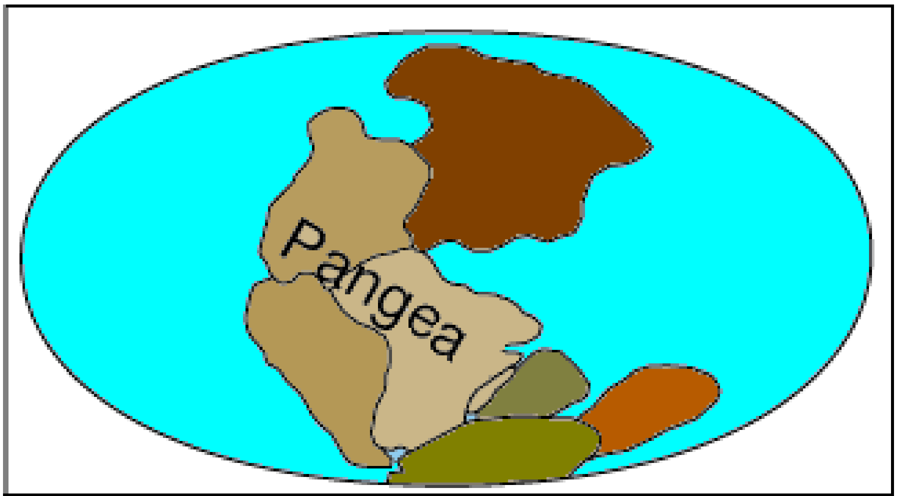
The continents seem to fit together like a giant jigsaw puzzle:

If you look at a map, Africa seems to snuggle nicely into the east coast of South America and the Caribbean sea. In 1912 a German Scientist called Alfred Wegener proposed that these two continents were once joined together then somehow drifted apart. He proposed that all the continents were once stuck together as one big land mass called Pangea. He believed that Pangea was intact until about 200 million years ago

Continental Drift

The idea that continents can drift about is called, not surprisingly, continental drift.

When Wegener first put forward the idea in 1912 people thought he was nuts. His big problem was that he knew the continents had drifted but he couldn't explain how they drifted. The old (AND VERY WRONG!!) theory before this time was the "Contraction theory" which suggested that the planet was once a molten ball and in the process of cooling the surface cracked and folded up on itself. The big problem with this idea was that all mountain ranges should be approximately the same age, and this was known not to be true. Wegener's explanation was that as the continents moved, the leading edge of the continent would encounter resistance and thus compress and fold upwards forming mountains near the leading edges of the drifting continents. Wegener also suggested that India drifted northward into the Asia forming the Himalayas and of course Mount Everest.



200 million years ago all of the present-day continents combined to form a single supercontinent called Pangea.

Sea Floor Spreading

It is hard to imagine that these great big solid slabs of rock could wander around the globe. Scientists needed a clue as to how the continents drifted. The discovery of the chain of mountainsthat lie under the oceans was the clue that they were waiting for.

Plates are Created: The crust begins to separate creating a **diverging** plate boundary. When a divergence occurs within a continent it is called rifting. A plume of hot magma rises from deep within the mantle pushing up the crust and causing pressure forcing the continent to break and separate. Lava flows and earthquakes would be seen. When a divergence occurs within a continent it is called rifting.

Plate Tectonic Boundaries
There are three kinds of plate tectonic boundaries: divergent, convergent, and transform plate boundaries.

A divergent boundary occurs when two tectonic plates move away from each other. Along these boundaries, lava spews from long fissures and geysers spurt superheated water. Frequent earthquakes strike along the rift. Beneath the rift, magma—molten rock—rises from the mantle. It oozes up into the gap and hardens into solid rock, forming new crust on the torn edges of the plates. Magma from the mantle solidifies into basalt, a dark, dense rock that underlies the ocean floor. Thus at divergent boundaries, oceanic crust, made of basalt, is created.

When two plates come together, it is known as a **convergent boundary**. The impact of the two colliding plates buckles the edge of one or both plates up into a rugged mountain range, and sometimes bends the other down into a deep seafloor trench. A chain of volcanoes often forms parallel to the boundary, to the mountain range, and to the trench. Powerful earthquakes shake a wide area on both sides of the boundary.
If one of the colliding plates is topped with oceanic crust, it is forced down into the mantle where it begins to melt. Magma rises into and through the other plate, solidifying into new crust. Magma formed from melting plates solidifies into granite, a light colored, low-density rock that makes up the continents. Thus at convergent boundaries, continental crust, made of granite, is created, and oceanic crust is destroyed.

Two plates sliding past each other forms a **transform plate boundary**. Natural or human-made structures that cross a transform boundary are offset—split into pieces and carried in opposite directions. Rocks that line the boundary are pulverized as the plates grind along, creating a linear fault valley or undersea canyon. As the plates alternately jam and jump against each other, earthquakes rattle through a wide boundary zone. In contrast to convergent and divergent boundaries, no magma is formed. Thus, crust is cracked and broken at transform margins, but is not created or destroyed.

4.0 CONCLUSION

Plate tectonic is responsible for the formation of the continents, rocks mountains

5.0 SUMMARY

In this unit you have learnt that:

- A tectonic plate is also called lithosphere plate.
- It is a massive, irregular shaped slab of solid rock composed of continental and oceanic lithosphere.
- Plate tectonic explains the features and movement of earth surface in the present and past.
- The driving force behind plate tectonic is convection in the mantle.
- Continental crust is able to float because it is relatively lightweight while oceanic crust are much denser and heavier.
- Plates can with time disappear.
- Continents were once joined together then they drifted apart.
- There are three kinds of tectonic boundaries which are divergent, convergent and transform plate boundary.

6.0 TUTOR-MARK ASSIGNMENT

i. define plate tectonic
ii. explain plate tectonic
iii. explain the driving force behind plate tectonic
iv. describe the 3 types of plate tectonic
v. differentiate between the three types of plate tectonic

7.0 REFERENCES/FURTHER READING

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MODULE 3 GEOGRAPHICAL CYCLES

INTRODUCTION

In this module, you will be exposed to geographical cycles of erosion in arid climate, protein interaction cycle, karst erosion cycle, marine erosion cycle, hydraulogical cycle and patterns of water movement.

UNIT 1 GEOGRAPHICAL CYCLES OF EROSION IN ARID CLIMATE

INTRODUCTION

1.0 INTRODUCTION

An arid climate is characterized by small rainfall, scanty plant growth. It is an exposed area easily affected by wind that causes weathering and occasional run-off water both contributing to the erosion experienced by the arid climate.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the essential features of an arid climate.
- explain the activities that result in weathering and erosion in an arid climate.
- describe the arid cycle.

3.0 MAIN CONTENT

3.1 The Geographical Cycle of Erosion in Arid Climate

The arid climate.-The essential features of the arid climate, as it is here considered, are: so small a rainfall that plant growth is scanty, that no basins of initial deformation are filled to overflowing, that no large trunk rivers are formed, and hence that the drainage does not reach the sea. The small rainfall and the dry air reduce the ground water to a minimum. In its absence, weathering is almost limited to the surface, and is more largely physical than chemical. The streams are usually shorter than the slopes, and act as discontinuously at their lower as at their upper ends. The scarcity of plant growth leaves the surface relatively free to the attack of the winds and of the intermittent waters. Hence, in the production of fine waste, the splitting, flaking, and splintering of local weathering are supplemented rather by the rasping and trituration that go with transportation than by the chemical disintegration that characterizes a plant-bound soil.

Initial stage.-An arid climate prevails in uplifted largeregions. Antecedent rivers, persisting from a previous cycle against the deformations by which the new cycle is introduced, must be rare, because such rivers should be large, and large rivers are unusual in an arid region. Consequent drainage must prevail. The initial slopes in each basin will lead the wash of local rains toward the central depression, whose lowest point serves as the local base level for the district. There will be as many independent centripetal systems as there are basins of initial deformation; for no basin can contain an overflowing lake, whose outlet would connect two centripetal systems: the centripetal streams will not always follow the whole length of the centripetal slopes; most of the streams of each basin system will wither away after descending fromthe less arid highlands to the more arid depressions. Each basin system will therefore consist of many separate streams, which may occasionally, in time of flood or in the cooler season of diminished evaporation, unite in an intermittent trunk river, and even form a shallow lake in the basin bed, but which will ordinarily exist independently as disconnected headwater branches.

Youthful stage -In the early stage of a normal cycle the relief is ordinarily and rapidly increased by the incision of consequent valleys by the Trunk Rivers that flow to the sea. In the early stage of arid cycle the relief is slowly diminished by the removal of waste from the highlands, and its deposition on the lower gentler slopes and on the basin beds of all the separate centripetal drainage systems. Thus all the local baselevels rise. The areas of removal are in time dissected by valleys of normal origin: if the climate is very arid, the uplands and slopes of these areas are either swept bare, or left thinly veneered with angular stony waste from which the finer particles are carried away almost as soon as they are weathered; if a less arid climate prevails on the uplands and highlands, the plants that they support will cause the retention of a larger proportion of finer waste on the slopes. The areas of deposition are, on the other hand, given a nearly level central floor of fine waste, with the varied phenomena of shallow lakes, playas, and Salinas, surrounded with graded slopes of coarser waste. The deposits thus accumulated will be of variable composition and, toward the margin, of irregular structure. The coarser deposits will exhibit a variety of materials, mechanically comminuted, but not chemically disintegrated, and hence in this respect unlike the less heterogeneous deposits of humid climates from which the more easily soluble or decomposable minerals have been largely removed. The finer deposits will vary from sand and clay to salt and gypsum. The even strata that are supposed to characterize lake deposits may follow or precede irregular or cross-bedded strata, as the lake invades or is invaded by the deposits of streams or winds. While many desert deposits may be altogether devoid of organic remains, others may contain the fossils of land, stream, or lake organisms.

Streams, floods, and lakes are the chief agencies in giving form to the aggraded basin floors, as well as to the dissected basin margins in the early stages of the cycle; but the winds also are of importance: they do a certain share of erosion by sand-blast action; they do a more important work of transportation by sweeping the granular waste from exposed uplands and depositing it in more sheltered depressions, and by raising the finer dust high in the air and carrying it far and wide before it is allowed to settle. Wind-action is, more- over, peculiar in not being guided by the slopes or restrained by the divides which control streams and stream systems. It is true that the winds, like the streams, tend in a very general way to wear down the highlands and to fill up the basins; but sand may be drifted uphill-dunes may be seen climbing strong slopes and escarpmentsin Arizona and Oregon-while fine dust carried aloft in whirlwinds and dust-storms is spread about by the upper currents with little regard to the slopes of the land surface far below. Sand may be drifted, and dust may be in this way carried outside of the arid region from which it was derived. Wind-erosion may, furthermore, tend to produce shallow depressions or hollows; for the whole region is the bed of the wind, and is therefore to a certain extent analogous to the bed of a river, where hollows are common enough; but in the early stages of the cycle in a region where the initial relief was strong, the action of the wind is not able to make hollows on the original slopes that are actively worked upon, and for a time even steepened, by streams and floods. Hence in the youthful stage wind-blown hollows are not likely to be formed. It is important to notice that a significant, though small, share of wind-swept or wind-borne waste may be carried entirely outside of or "exported" from an arid region.

Mature stage: There is continued erosion of the highlands and divides, and continued deposition in the basins, may here and there produce a slope from a higher basin floor across a reduced part of its initial rim to a lower basin floor. Headward erosion by the consequent or subsequent streams of the lower basin will favor this change, which might then be described as a capture of the higher drainage area. Aggradation of the higher basin is equally important, and a change thus effected might be described as an invasion of the lower basin by waste from the higher one; this corresponds in a belated way to the overflow of a lake in a normal cycle. There may still be no persistent stream connecting the two basins, but whenever rain falls on the slope that crosses the original divide, the wash will carry waste from the higher to the lower basin. Thus the drainage systems of two adjacent basins coalesce, and with this a beginning is made of the confluence and integration of drainage lines which, when more fully developed, characterize maturity. .The most perfect maturity would be reached when the drainage of all the arid region becomes integrated with respect to a single aggraded basin-baselevel, so that the slopes should lead from all parts of the surface to a single area for the deposition of the waste. The lowest basin area which thus comes to have a monopoly of deposition may receive so heavy a body of waste that some of its ridges may be nearly or quite buried. Strong relief might still remain in certain peripheral districts, but large plain areas would by this time necessarily have been developed. In so far as the plains are rock- floored, they would truncate the rockswithout regard to their structure. The most perfect maturity would be reached when the drainage of all the arid region becomes integrated with respect to a single aggraded basin-base level, so that the slopes should lead from all parts of the surface to a single area for the deposition of the waste.

The beginning of old age.-During the advance of drainage integration the exportation of wind-borne waste is continued. At the same time, the tendency of wind-action to form hollows wherever the rocks weather most rapidly to a dusty texture would be favored by the general decrease of surface slopes, and by the decrease of rainfall and of stream-action resulting from the general wearing- down of the highlands. A strong initial relief of large pattern, a quality of rock not readily reducible to dusty waste, and an irregular movement of light winds might give the control of sculpture to the intermittent streams through youth and into maturity; in such a case maturity might be characterized by a fully integrated system of drainage slopes, with insignificant imperfections in the way of wind-blown hollows. In a second region an initial form of weaker relief, a quality of rock readily reducible to dust, and a steady flow of strong winds might favor the development of wind-blown hollows or basins, and here the process of drainage disintegration would set in relatively early and prevent the attainment of mature drainage integration. In any case, as soon as the process of drainage disintegration begins to predominate, maturity may be said to pass into old age.

SELF-ASSESSMENT EXERCISE

1) What do you understand by an arid climate
2) What are the activities that occur in the following stages of erosion in an arid climate which can lead to erosion in the following stages?
    a. Initial stage
    b. Youth stage
    c. Mature stage
    d. Beginning of old
    e. Old age.

4.0 CONCLUSION

The arid climate is highly susceptible to weathering of top soil as a result of attack from wind and water run-off due to lack of vegetation which would have been able to hold the soil together. Arid region occupy relatively uplifted regions which are sloppy from which erosion can easily occur.

5.0 SUMMARY

- An arid climate has very small rainfall and few plants.
- It is devoid of large rivers.
- Weathering in an arid climate is caused by physical processes than by chemical processes.
- The slopes that exist permits water to run down to central depression areas.
- In early of the cycle there is removal of waste from highlands which are deposited on lower gentle slopes.
- In very arid climate both the upland and the slopes are swept bare.
- Both wind and water from the few streams contribute to the erosion in arid climate.
- The lowest basin which has the monopoly of deposition may receive a huge body of waste with time causing its ridge to become buried.

6.0 TUTOR-MARKED ASSIGNMENT

i. Describe erosion cycle in an arid climate.
ii. Explain the essential features of an arid climate.
iii. Describe the activities that occur in an arid climate that causes erosion.

7.0 REFERENCE/FURTHER READING

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UNIT 2 PROTEIN INTERACTION AND KARST CYCLE

1.0 INTRODUCTION

In this unit you will be learning about protein interaction in the body of living organisms. The function performed as a result of protein interaction, types of protein interaction, and factors that regulate protein interaction were discussed. Also karst cycle and the conditions essential for full development of karst topography were also discussed.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain protein –protein interaction
- describe types of protein interaction
- mention factors that regulate protein interaction
- explain the process involved in karst cycle
- give the meaning of karst

3.0 MAIN CONTENT

3.1 Protein – Protein Interaction

This is the intentional physical contacts established between two or more proteins resulting from biochemical reactions and/or electrostatic forces. Proteins are large biological molecules (macromolecules) which consist of one or more long chains of amino acid residues. Proteins are vital in living organisms for catalyzing metabolic reactions, replicating DNA, responding to stimuli and in the transportation of molecules from one location to another. Electrostatic forces are electrostatic interactions between electrically charged particles. Proteins are Important at both cellular and systemic levels.

In the cell proteins undergo molecular processes carried out by molecular machines built from large number of proteins organized by their protein-protein interactions.

Types of protein-protein interactions-

Protein complexes can be in the form of homo-oligomeric or hetero-oligomeric complexes. The homo-oligomeric contain a few monomer units of identified molecules in non-covalent bonding while the hetero-oligomeric complex contains unlimited number of monomers in different macromolecules.

Factors that regulate protein-protein interactions

- Concentration of protein also affected by expression levels and degradation;
- Affinity for proteins or other binding ligands (substrates, ion);
- Concentrations of ligands (substrates, ions);
- Presence of other proteins, nucleic acids and ions;
- Electric fields around proteins;
- Occurrence of covalent modifications.

Protein-protein interaction databases

Hundreds of thousands interactions are generated and collected into biological databases which can be subdivided into primary databases, meta-databases and prediction databases.

- Primary databases- collected information on published protein-protein interactions generated through small-scale or large-scale experimental methods.
- Meta-databases- It is an integration of primary databases information and some original data.
- Prediction databases – They are many protein-protein interactions that are predicted using several techniques.

Protein-protein interaction networks

Information on protein-protein interactions databases are used to develop an interaction network.

Protein-protein interaction as Therapeutic target

Protein-protein interactions are putative therapeutic targets for the development of new treatments as it is promising in the treatment of cancer. From this interaction, available drugs are already on the market to treat various diseases.

SELF-ASSESSMENT EXERCISE

1. Differentiate between homo-oligometric and hetero-oligometric complexes.
2. What are the factors that regulate protein-protein interaction?
3. What do you understand by protein-protein interaction?

3.2 Karst Cycle

Karst is a terrain with a characteristic relief and drainage arising mainly due to higher solubility of rock in natural water than is found elsewhere. It is a dry, upland landscape with underground drainage instead of surface streams. It is so named after a province of Yugoslavia on the Adriatic Sea coast where such formations are most noticeable.

The main example of a limestone (or 'karst') region in Ireland is the Burren region in north Co. Clare. The term 'karst' originated in a region of Slovenia/Croatia, near the Adriatic Sea, and it is used to signify an area of limestone in which the rock is exposed at the surface of the landscape and where there is mainly underground rather than surface drainage

Conditions Essential for Full Development of Karst Topography

- Presence of soluble rocks, preferably limestone at the surface or sub-surface level.
- These rocks should be dense, highly jointed and thinly bedded.
- Presence of entrenched valleys below the uplands underlain by soluble and well- jointed rocks. This favours the ready downward movement of groundwater through the rocks.
- The rainfall should be neither too high nor too low.
- There should be a perennial source of water.

Weathering or denudation in a limestone region is affected by carbonation, and this process is fundamental to the understanding of the region's physical geography. Limestone, or calcium carbonate ($CaCO_3$), is a sedimentary rock formed by the compressing of the remains of dead sea creatures.

Weathering of the rock is made easy by the fact that limestone contains bedding planes (horizontal cracks) and joints (vertical cracks) allowing water to pass through the rock. The chemical weathering of limestone, or carbonation, occurs when the rock is attacked by rainwater. The chemical equation for this process is $CaCO_3 + H_2CO_3 = Ca(HCO_3)_2$, i.e., Limestone + Carbonic acid (rainwater) = Calcium Bicarbonate (soluble limestone).

Surface Limestone Features

The most common surface feature to be found in the Burren is limestone pavement with clints (slabs of rock) and grooves caused by weathering of the surface joints (grikes). Other surface features to be studied include swallow holes (through which surface water disappears underground), dry valleys (created by the loss of surface water), karrens (tiny weathered hollows), uvalas (created by the joining of swallow holes), poljes (when uvalas join), dolines (a closed hollow) and turloughs (seasonal pond). All of these features result from carbonation

Underground Limestone Features

Underground features are formed from water, for example by streams flowing down through the permeable rock. Constant weathering of the limestone causes the bedding planes to be enlarged sufficiently to form an underground cave. The cave then becomes home to many distinctive features. Evaporation of the water seeping through the cave leaves behind deposits of calcium carbonate, referred to as dripstone. Dripstone hanging from the ceiling creates stalactites, while stumps developing on the cave floor are called stalagmites. When they both join, a column or pillar is formed. A curtain is yet another dripstone feature

The Karst Cycle of Erosion

Youth

Youth begins with the surface drainage on either an initial limestone surface or one that has been laid and is marked by progressive expansion of underground drainage. **.** In the youthful stage, impermeable rock is removed and the limestone is hit by carbonation to form features such as limestone pavements and swallow holes

Gradually, the upper impervious layer is eroded. Dolines, sink holes and swallow holes are particularly characteristic of this stage. No large caverns exist and underground drainage has not yet completed its course.

Maturity:In maturity, carbonation has progressed to form a dry valley, dolines, turloughs, caves. Surface drainage is limited to short- sinking cracks ending in swallow holes or blind valleys. Cavern networks are characteristic of this stage. This is the time of maximum karst development. Late maturity marks the beginning of the decline of karst features. The portions of cavern streams are exposed through karst windows. These expand to form large uvalas, and detached areas of original limestone upland begin to stand out as hums.

Old Age:

During old age, weathering has removed so much of the limestone that only the rock with greater resistance to attack remains. Large-scale removal of limestone mass leaves behind a karst plain. There is a reappearance of surface drainage with only a few isolated hums as remnants of the original limestone terrain.Hums refer to hills of rock .

SELF-ASSESSMENT EXERCISE

1) 1 What do you understand by kast?
2) 2 Describe the features of surface limestone.
3) 3 List the conditions essential for full development of karst topography.

4.0 CONCLUSION

Protein interaction is the intentional physical contact established between two or more large molecules which consists of long chain of amino acid .The interaction of these proteins are vital in living organisms since all life and life processes are controlled by proteins. You also learnt that karst is the terrain with characteristic relief nd drainage arising mainly due to high solubility o rock in natural water.

5.0 SUMMARY

In this unit you have learnt that

- Protein – Protein interaction is the contact established between two or more proteins resulting from biochemical reactions.
- Proteins are vital in living organism
- There are two types of protein-protein interactions homo-oligomeric and hetero-oligomeric
- There are factors that regulate protein-protein interaction.
- Karst is a terrain with a characteristic relief and drainage arising mainly due to higher solubility of rock in natural water than is found elsewhere.
- Karst means limestone
- The term karst originated in a region of Slovenia/Croatia near the Adriatic sea.
- It is used to signify an area of limestone of the landscape and where there is mainly underground rather than surface drainage.
- Conditions essential for full development of karst topography.
- Weathering of the rock is made easy by limestone contains bedding planes and joints allowing water to pass through the rock.
- Surface limestone features include pavement with clint and grooves causes by weathering of the surface joints.
- Other surface features include swallow holes, dry valleys, karrens, poljes, dolines and turloughs.

- Underground limestone features re formed from water by streams flowing down through permeable rock.
- Constant weathering of limestone forms underground cave.
- Evaporation of the water seeping through the cave leaves behind deposits of calcium carbonate called dripstone.

6.0 TUTOR-MARKED ASSIGNMENT

i. Describe protein-protein interaction.
ii. Describe types of protein interaction.
iii. Mention factors that regulate protein- protein interaction.
iv. Explain the process involved in Karst cycle.
v. What does karst mean?
vi. Describe the features of surface and underground limestone.

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UNIT 3 MARINE EROSION CYCLE

CONTENTS

1.0 INTRODUCTION

Marine cycle occurs on an elevated and steeply land mass is bordered by deep water close to the shore. The activities in the marine that causes movement of the water cuts far inland destroying the shoreline.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

3.0 MAIN CONTENT

3.1 The Marine Cycle of Erosion for a Steeply Sloping Shoreline of Emergence

The marine cycle operates when an intermittently elevated and steeply sloping land mass is bordered by deep water close to shore. The beginning and end of the sequence harmonize with the established cycles of erosion for shorelines of emergence and submergence. The shoreline cycle begins when, as the result of crustal deformation, the sea floor has risen, or when an ecstatic lowering of sea-level has occurred. Temporarily, it does not matter whether the emergence is accomplished in one or more stages. The sequence ends when the advancing sea has cut sufficiently far inland to destroy all remnants of the pre-uplift shoreline. The cycle is divided into four stages which are as follows.

Early Youth: As soon as the coast shows appreciable modification it is in early youth. This occurs when a low sea cliff has been cut, and consequent streams which cross the newly exposed sea floor are entrenched as their length is decreased by the advancing sea. Smaller streams construct alluvial fans on the terrace surface.

Late Youth: The shoreline is in late youth when the encroaching sea has consumed a significant portion of the emerged floor, perhaps about half the area between the sea cliff of early youth and the pre-uplift or highest shoreline. The coast is backed by a sea cliff whose height is determined by the amount of original elevation, the initial slope of the sea floor, and the measure of retreat. Most of the larger consequent streams, having lowered their channels nearly to sea- level, have incised deep arroyos and barrancos across the terrace floor. As the alluvial fans, formed in early youth by smaller streams, are truncated by wave cutting, a composite cliff develops, exposing along its face a blanket of detrital material resting upon a rockbench. Finally, a nearly balanced state between prograding and retrograding of the shoreline is reached.

Maturity in the type of cycle here recognized is reached when waves once again attack the base of the pre-uplift sea cliff. All trace of the terrace then vanishes, and the height of the new sea cliff is added to that of the surviving remnant of its predecessor. A steeply sloping shoreline of emergence reaches maturity in the cycle when not only the lowermost but also the uppermost terraces are destroyed, and the sea removes all trace of emergence. Shouldrenewed uplift occur and a new terrace be exposed, the shoreline will be rejuvenated and will then return to early youth. As long as terraces or former sea cliffs-save the highest-are present, the coast is in some stage of youth.

Old Age: During old age the character of the coastline is determined by differences in rock hardness and by the relief of the land mass under-going attack. From this point onward in the cycle, which has now lost its unique character, it is not possible to distinguish the coast- line from that of any other type in a similar stage.

4.0 CONCLUSION

The marine cycle occurs on an elevated and steep land mass which is bordered by deep water close to the shore. The activities in the water cause the movement of water to cut far inland destroying the shoreline.

5.0 SUMMARY

- The Marine erosion cycle is divided into four stages
- Early youth stage experiences a cut in the sea cliff.
- In late youth a significant portion of the emerged floor has been consumed by encroaching sea.
- Most of the large consequent streams incise deep arroyos and barrancos across the terrace floor lowering their channels near the sea level.
- At maturity waves attack the base of the pre-uplift sea cliff.

- All trace of terrace vanishes
- The sleepy sloping share line is said to reach maturity in the cycle when the lowermost and the uppermost terraces are destroyed and all trace of emergence are removed.
- If renewed uplift occurs and a new terrace is exposed, the shoreline will be rejuvenated and return to early youth.
- At old age the cycle loses its unique character.

6.0 TUTOR-MARKED ASSIGNMENT

i. Describe marine erosion cycle
ii. How can damaged terrace be rejuvenated?
iii. Differentiate between early youth and late youth.
iv. Distinguished between maturity and old age.

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UNIT 4 HYDROLOGICAL CYCLE

CONTENTS

1.0 INTRODUCTION

The Hydrological Cycle is the journey that water takes when it circulates from the land to the sky and back to the land. Thesun' heat provides energy which evaporates water from the earth's surface. Plants also lose water to the air - this is called transpiration. Water vapour condenses, forming tiny droplets in clouds.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the Hydrological Cycle.
- explain howthe Hydrological Cycle works.
- enumeratehow water supply and sewage disposalfit into the Hydrological Cycle

3.0 MAIN CONTENT

3.1 The Hydrological Cycle

The Hydrological Cycle is simply the journey water takes as it circulates from the land to the sky and back to the land again.

The heat from the sun provides energy which evaporates water from the earth's surface (oceans, lakes, atmosphere and continents). Plants also lose water to the air - this is called transpiration. The water vapour condenses, forming tiny droplets in clouds.

When the clouds meet cool air over land, precipitation (rain, sleet, or snow) is triggered, and water returns to the land (or sea). Some of the precipitation soaks into the ground.

Groundwater is trapped water between rock or clay layers. Most water flows downhill as runoff (above ground or underground), which eventually returns to the seas as slightly salty water.

Water is the most widespread substance to be found in the natural environment and it is the source of all life on earth. Water covers 70% of the earth's surface and the distribution of water throughout the earth is not uniform. Some places have more rainfall than others.

Three states ofwater exists that is, liquid, solid and invisible vapour. It forms the oceans, seas, lakes, rivers and the underground waters found in the top layers of the earth's crust and soil cover. While in the solid state, it exists as ice and snow cover in polar and alpine regions. A certain amount of water is contained in the air as water vapour, water droplets and ice crystals, as well as in the biosphere.

3.2 What is the Hydrological Cycle?

This is the total amount of water on the earth and in its atmosphere and the earth's water is always in movement. Oceans, rivers, clouds and rain, all contain water and are in a frequent state of change and the motion of rain and flowing rivers transfers water in a never-ending cycle. This circulation and conservation of earth's water as it circulates from the land to the sky and back again is called the 'hydrological cycle'

3.3 How does the Hydrological Cycle work?

There are stages of the cycle which include the following:

- Evaporation
- Transport
- Condensation
- Precipitation
- Groundwater
- Run-off

- **Evaporation:** Water is transferred from the surface to the atmosphere through the process of evaporation, this process involve the water changing from liquid to gas. The sun's heat provides energy to evaporate water from the earth's surface. A steady stream of water vapour from theland, lakes, rivers and oceans and plants also lose water to the air through the process of transpiration.80% of all evaporation is from the oceans, while the remaining 20% comes from inland water and vegetation.

- **Transport:** This is the movement of water through the atmosphere, specifically from over the oceans to over land. Some of the earth's moisture transport is visible as clouds, which themselves consist of ice crystals and/or tiny water droplets. Clouds are propelled from one place to another by the jet stream, surface-based circulations like land and sea breezes or other mechanisms. A typicalcloud of 1 km thick contains only enough water for a millimetre of rainfall, while the amount of moisture in the atmosphere is usually 10-50 times greater than this.Most water is transported in the form of water vapour, which is actually the third most abundant gas in the atmosphere.
- **Condensation:** The transported water vapour condenses, forming tiny droplets in clouds.
- **Precipitation:** The primary mechanism for transporting water from the atmosphere to the surface of the earth is precipitation. When the clouds meet cool air over land, precipitation, in the form of rain, sleet or snow, is striggered and water returns to the land (or sea). A proportion of atmospheric precipitation evaporates.
- **Groundwater:**Some of the precipitation soaks into the ground and this is the main source of the formation of the waters found on land - rivers, lakes, groundwater and glaciers.Some of the underground water is trapped between rock or clay layers - this is called groundwater. Water that infiltrates the soil flows downward until it encounters impermeable rock and then travels laterally. The locations where water moves laterally are called 'aquifers'. Groundwater returns to the surface through these aquifers, which empty into lakes, rivers and the oceans. Groundwaterunder special circumstances can even flow upward in artesian wells.
- **Run-off:**Most of the water which returns to land flows downhill as run-off. Some of it penetrates and charges groundwater while the rest, as river flow, returns to the oceans where it evaporates. As the amount of groundwater increases or decreases, the water table rises or falls accordingly. When the entire area below the ground is saturated, flooding occurs because all subsequent precipitation is forced to remain on the surface.Different surfaces hold different amounts of water and absorb water at different rates. As a surface becomes less permeable, an increasing amount of water remains on the surface, creating a greater potential for flooding. Flooding is very common during winter and early spring because frozen ground has no permeability, causing most rainwater and melted water to become run-off.

3.4 Howdoes Water Supply and Sewage Disposalfit into the Hydrological Cycle?

Water flows into Ocean Rivers, lakes and into groundwater storage and it also flows into homes and taps. A network of underground pipes, pumping stations and treatment works ensures that clean, fresh drinking water is delivered by local water utility to various homes every day of the week. After water has been used, the water utility collects, transports and then cleans this dirty water and returns it safely back into rivers where it can continue its journey downstream to the sea.

The water utility's responsibility begins at the precipitation stage of the hydrological cycle. Utilities in some water-scarce countries encourage the collection of rainwater from rooftops or rainwater harvesting but in most of Europe the hydrological cycle begins with surface waters.

3.5 Completing the Cycle

The river continues its journey back to the sea where the cycle starts again. Water evaporates to form clouds, condenses to droplets and eventually falls as rain on to the ground.

4.0 CONCLUSION

The circulation and conservation of earth's water as it circulates from the land to the sky and back again is called the 'hydrological cycle. The total amount of water on the earth and in its atmosphere and the earth's water is always in constant movement. Oceans, rivers, clouds and rain, all contain water and are in a frequent state of change and motion.

5.0 SUMMARY

In this unit, we have learnt that:

- The Hydrological Cycle takes when water circulates from the land to the sky and back to the land.
- There are stages of the cycle.
- As the amount of groundwater increases or decreases, the water table rises or falls accordingly.
- Water flows into Ocean Rivers, lakes and into groundwater storage and it also flows into homes and taps through a network of underground pipes.

6.0 TUTOR-MARKED ASSIGNMENT

i. Discuss the importance of the hydrological cycle.
ii. Explain how the hydrological cycle works?
iii. Discuss howwater supply and sewage disposalfit into the Hydrological Cycle?

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UNIT 5 PATTERNS OF WATER MOVEMENT IN THE OCEAN

1.0 INTRODUCTION

In this unit patterns of water movement in the ocean will be discussed along with the factors that affect each movement.

2.0 OBJECTIVES

At the end of this unit, you should be able to

- Define current
- Explain the general distribution of ocean currents.
- Distinguished between cold and warm currents
- List the four types of currents
- Explain coastal upwelling and coastal sinking
- Differentiate between waves and tides.
- Describe the six types of waves

3.0 MAIN CONTENT

3 1 Patterns of Water Movement in the Ocean

There strong relationship between the Earth's atmosphere and the oceans. We live at the bottom of one and at the top of the other. The atmosphere is an ocean of air, and the seas, an ocean of water. In many respects, the atmosphere and the oceans are similar. For example, there are air currents and ocean currents, atmospheric waves (long and short) and ocean waves, and the land (terrain) beneath the sea is much like that beneath the atmosphere. There are three patterns of water movement in the ocean which are discussed under the following: currents, waves and tides

3.1.1 Currents

Ocean currents are organized, coherent belts of water in horizontal motion. The general distribution of ocean currents is as follows:
At middle (below 40°N latitude) and low latitudes, warm currents flow pole ward along the eastern coasts of continents and cold currents flow equator ward along the western coasts. This is true in both hemispheres.
In the Northern Hemisphere at high latitudes, cold currents flow equator ward along the east coasts of continents, and warm currents flow pole ward along the western coasts.

In monsoonal regions, ocean currents vary with the seasons, and irregular coastlines can cause deviations in the general distribution of ocean currents Characteristics

Classifications
Currents are classified as either warm or cold currents based on the water temperatures advecting into a region.

Cold currents
A cold current brings cold water into warm water. Cold currents are usually found on the west coast of continents in the low and middle latitudes (true in both hemispheres) and the east coast in the northern latitudes in the Northern Hemisphere.

Warm currents
A warm current brings warm water into cold water and is usually found on the east coast of continents in the low and middle latitudes (true in both hemispheres). In the Northern Hemisphere they are located on the west coasts of continents in high latitudes.

Types of Currents
There are four types of currents that we will be concerned with: wind-driven, density, hydraulic, and tidal. Wind driven and tidal currents will have the greatest effect on amphibious operations, due to their proximity to the littoral (shore) zone. However, depending on the location of the operation, density and hydraulic currents can come into play ad must be understood.

Wind driven currents do not flow in the same direction as the wind. Due to carioles, the surface current moves in a direction 45 degrees or less to the right of the wind (in the Northern Hemisphere). The surface mass of water moves as a thin lamina, or sheet, which sets another layer beneath it in motion. The energy of the wind is passed through the water column from the surface down. The resulting surface current flows at 1 to 2 percent of the speed of the wind that set it in motion. Each successive layer of water moves with a lower speed and in a direction to the right of the one that set it in motion . The momentum imparted by the wind will gradually be lost, resulting in water at some depth (usually approximately 300 feet) moving slowly in a direction opposite the surface current.

Density currents (geopotential)
This current is caused by density differences, or gravity differences between currents. It retains its unmixed identity because its density differs from that of the surrounding water.

Hydraulic currents
Hydraulic currents are small-scale thermohaline subsurface circulations caused by the differences in sea level between two water bodies. These currents are commonly found in straits separating water bodies. The best example of a hydraulic current is that current set up in the Strait of Gibraltar.

The water level in the eastern Mediterranean Sea is 15 centimeters (cm) lower than in the Straits of Gibraltar, due to the excessive evaporation in the Mediterranean Basin. The evaporation cools the water and it sinks as it becomes denser. This cold dense water exits the Mediterranean Basin through the Straits of Gibraltar as an opposite flowing current underneath the incoming water. This process is typical of all closed, restricted basins where evaporation exceeds precipitation.

Tidal Currents
Tidal currents are the horizontal expression of the tidal forces and are especially significant in the littoral zone, where they become the predominant flow. Tides are waves that have lengths measured in hundreds of miles and heights ranging from zero to more than 50 feet.

Wind-Induced Vertical Motions
Just as wind blowing across the ocean's surface produces horizontal motion within the surface layer of the ocean, it also produces vertical motion.

In the ocean, vertical circulations can be either wind-induced or thermohaline in nature. With wind-induced circulations, lateral movements of water masses cause vertical circulations within the upper water mass. When surface currents carry water away from an area, upwelling occurs. When surface currents carry water into an area, down welling occurs. Equatorial upwelling is due to the North and South Equatorial Currents flowing westward, diverting the water pole ward. The net effect of this movement is a deficiency of water at the surface between the two currents. Water from deeper within the upper water mass comes to the surface to fill the void.

Coastal upwelling
Cold water rising to the surface is common along western coasts of all continents

The presence of this cold upwelled surface water produces cool summer weather with frequent fogs and (as a bonus) excellent year round fishing. The prevailing wind flow is parallel to the coast, the direction depends on the hemisphere (northern or southern). Surface waters are transported away from the coast due to coriolis force which causes surface waters to move at right angles from the prevailing winds.
The presence of the continent means that the surface water that has been moved out to sea must be replaced from below. Due to the steep slope of the ocean floor along the west coasts of continents the water from the ocean bottom that rises up to replace the water moved out to sea is considerably colder than the normal surface water. This slow upward flow is from depths of 100 to 200 meters (300 to 650 feet). Dissolved nutrients, phosphates, and nitrates in this cold water support abundant phytoplankton (minute, floating aquatic plants) and fish populations

Coastal sinking
Warm surface waters sinking along the coastlines climatological effects are less obvious than with upwelling, but the abundance and distribution of fish may be radically changed by sinking water. The prevailing wind flow is parallel to the coast, the direction depends on the hemisphere (northern or southern). Open ocean surface waters are transported toward the coast. The presence of the continent causes the surface water that has been moved toward the coast to pile up and sink, well below its normal density level. Because there is no difference between the open ocean surface water and the coastal water, areas of coastal sinking are often hard to identify, except by the associated fish populations. (The results of which are one of the devastating results of El Niño.) Figure 2–10 shows both upwelling and sinking conditions from above and from the side.
Areas of coastal upwelling and sinking may alternate at the same spot along a coast, if the prevailing winds change and have sufficient duration (e.g., northeast/southwest Monsoon in the northern Indian Ocean).

3.1.2 Waves and Tides

The ocean surface is rarely still. Disturbances ranging from gentle breezes at the surface to earthquakes many kilometers beneath the ocean bottom can generate waves.

Winds cause waves that range from ripples less than 1 centimeter high to giant, storm-generated waves more than 30 meters (100 feet) high. Tides also behave like waves but are so large that their wavelike characteristics are not easily seen. Seismic sea waves, caused by earthquakes, cause catastrophic damage and loss of life, especially in lands bordering the Pacific Ocean.

416. Waves

Waves are visible evidence of energy moving through a medium. Winds, earthquakes, and the attractions of the Sun and Moon are the waves' three most important generators. Each wave has varying differences of the same characteristics). Each wave has a "crest" (peak, or highest part of the wave) and a "trough" (lull, or lowest part of the wave).

Classification

There are several classifications of ocean waves, with each having distinct characteristics. Ocean waves, known as swell waves (or short waves) can have the greatest effect on amphibious operations due to their affect on surf zone conditions.

Progressive waves

Waves that are manifested by the progressive movement of the wave form are known as progressive waves. Water particles move in circular or elliptical orbits as the wave passes. The radius of these orbits decreases rapidly with depth. Theoretically, the diameter at depth of one-half of the wavelength is 1/23rd of the diameter at the surface. The rise and fall of the free surface can be attributed to convergence and divergence of the horizontal motion of water particles. The horizontal flow at the wave crest is the direction of propagation .

Therefore, while particles are in the crest of a passing wave, they move in the direction of wave propagation. The horizontal flow at the trough is opposite to the direction of propagation. Consequently, while particles are in the trough, they move in the opposite direction. Particles that are in the half of the orbit that is accomplished in the trough are moving at a lower speed than those in the crest-half of the orbit. Convergence takes place between the crest and trough and the surface rises. Due to a decrease in the velocity with depth, with particle motion faster in the crest than the trough, there is a small net transport of mass in the direction of propagation. Below the depth of perceptible motion of water particles, the pressure is not influenced by the wave.

Standing waves

Standing waves are composed of two progressive waves traveling in opposite directions. Horizontal velocity within a standing wave is

"ZERO" at every point when the wave reaches its highest and lowest points. Vertical velocity is also "ZERO" at half-way between the crest and trough.

Forced waves

Forced waves are those waves that are maintained by a periodic force. The period of the forced wave is always the same as the period of the force. Such an example includes tides.

Free waves

Free waves are caused by a sudden underwater impulse such as seismic activity. The period of a free wave depends on the dimension of the ocean floor area and the effects of friction. A prime example of a free or seismic wave is a tsunami.

Short waves

The last two classifications of ocean waves depend on where the wave exists with respect to the depth of the water. Short waves are those that exist in water depths that are greater than one-half of the wavelength. The velocity of the wave depends on wavelength, but independent of depth. This classification of wave is also called deep water or surface waves.

Long waves

Short waves become long waves as they approach the surf zone. Long waves are waves that exist in water depths that are less than one-half of their wavelength. Here, the velocity of the wave depends only on the depth to the bottom and is independent of wavelength.

Tides

As mentioned earlier, tides are caused by gravitational attraction between the Earth, Sun and Moon. The changes or difference in feet between high tide and low tide is referred to as tidal range. Tidal range can play a major factor as to the timing of a landing. A large tidal range (some places as much as 50 feet) on a shallow sloped beach will expose a great deal more of the near shore bottom during low tide than a beach with a steeper slope (i.e., a tidal range of 20 feet on a beach with a slope of 1:50 will expose 500 feet more of beach at low tide). Tidal information can be retrieved from various sources, including Geophysics Fleet Mission Program Library (GFMPL) software on Tactical Environmental Support System (TESS) and Mobile Oceanography Support Facility (MOSS). It will be necessary to know the latitude and longitude of the area of operations (AOA); and from there one can narrow the information down. GFMPL information will be valid for the day(s)chosen

4.0 CONCLUSION

The interaction between the ocean and the circulation of the lower atmosphere (surface wind) is the primary cause of the surface current in the ocean. Currents are caused by wind, density (differences between gravity of currents) and difference in sea level between two water bodies wind cause waves, while tides are caused by gravitational attraction between the earth, sun and the moon.

5.0 SUMMARY

Surface currents are caused by interaction between ocean's surface and the circulation of lower atmosphere.
Currents are organized, coherent belts of water in horizontal motion.
Current can be warm or cold depending on the temperature of the water.
There are four types of currents depending on the underlying cause.
Wind can also induce vertical motions in the ocean.
Pattern of movement of water in the ocean also contributes to the weather of a place

6.0 TUTOR-MARKED ASSIGNMENT

i. Why does the surface water move away from the California coastline when the prevailing winds blow parallel to the coastline.
ii. What are cold currents and where can they be found.
iii. What can you say about wind-driven currents in regard to the movement of current and the mass transport of water?
iv. Where hydraulic currents are normally found?
v. Does upwelling and coast sinking occurring the same area? Explain why or why not.
vi. What is the primary cause of tide?
vii. What determines the height of tides?
viii. What is the primary cause of tides?

7.0 REFERENCES/FURTHER READING

Pattern of Water Movement in the Ocean Currents: Moving Water. www.usc.org.cases-west/.../movingwater8thGbackground.pdf.

Ocean Waves-Styles and Patterns. Earthsci.org/processes/ weather/ waves/waves.html

UNIT 6 PATTERN OF WATER MOVEMENT IN THE ATMOSPHERE

CONTENTS

1.0 INTRODUCTION

Have you ever thought that the oceans performs more functions than that of serving as natural habitat for aquatic creatures? In this unit the role played by the ocean in determining the climate of the planet was highlighted. The importance of ocean in heating the planet , evaporation of ocean water which precipitates into rain and its role in conveying warm and cold water were also discussed.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- mention that the ocean plays in determining the climate of the planet.
- explain how the ocean serves as heater for the planet.
- Explain how the ocean distributes heat around the globe.
- mention the factor that helps to regulate regional temperature

3 0 MAIN CONTENT

3.1 Pattern of Water Movement in the Atmosphere

Ocean plays a fundamental role in shaping the climate zones we see on land. Even areas hundreds of miles away from any coastline are still largely influenced by the global ocean system.

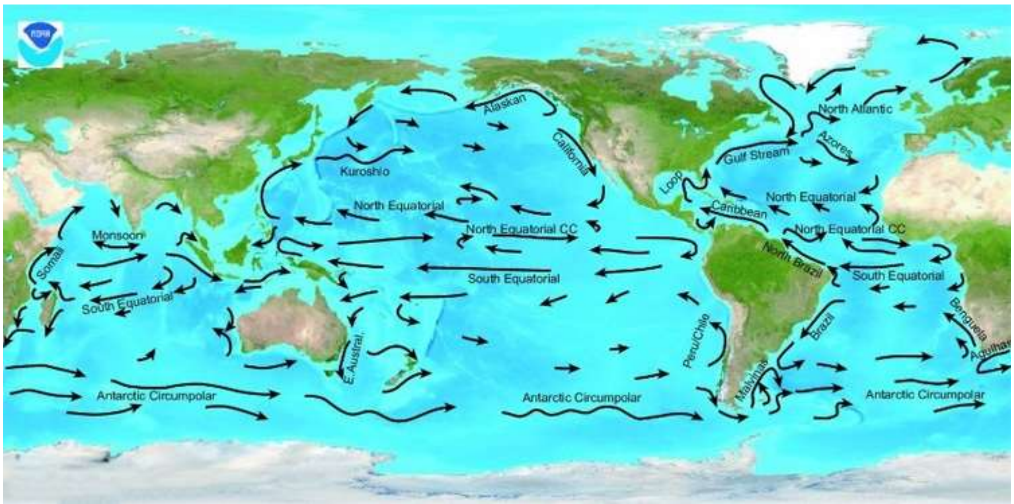

Illustration of major ocean currents throughout the globe
Ocean currents act as conveyer belts of warm and cold water, sending heat toward the polar regions and helping tropical areas cool off.

The world’s ocean is crucial to heating the planet. While land areas and the atmosphere absorb some sunlight, the majority of the sun’s radiation is absorbed by the ocean. Particularly in the tropical waters around the equator, the ocean acts a as massive, heat-retaining solar panel. Earth’s atmosphere also plays a part in this process, helping to retain heat that would otherwise quickly radiate into space after sunset. The ocean doesn't just store solar radiation; it also helps to distribute heat around the globe. When water molecules are heated, they exchange freely with the air in a process called evaporation. Ocean water is constantly evaporating, increasing the temperature and humidity of the surrounding air to form rain and storms that are then carried by trade winds, often vast distances. In fact, almost all rain that falls on land starts off in the ocean. The tropics are particularly rainy because heat absorption, and thus ocean evaporation, is highest in this area.

Outside of Earth’s equatorial areas, weather patterns are driven largely by ocean currents. Currents are movements of ocean water in a continuous flow, created largely by surface winds but also partly by temperature and salinity gradients, Earth’s rotation, and tides (the gravitational effects of the sun and moon). Major current systems typically flow clockwise in the northern hemisphere and counterclockwise in the southern hemisphere, in circular patterns that often trace the coastlines.

Ocean currents act much like a conveyer belt, transporting warm water and precipitation from the equator toward the poles and cold water from the poles back to the tropics. Thus, currents regulate global climate, helping to counteract the uneven distribution of solar radiation reaching Earth’s surface. Without currents, regional temperatures would be more extreme-super hot at the equator and frigid toward the poles-and much less of Earth's land would be habitable

4.0 CONCLUSION

The ocean is responsible for shaping the climate, heating the planet, producing rain, distributing cold and warm water making the equator and the poles habitable since the current produced by the ocean help in even distribution of solar radiation reaching the earth surface.

5.0 SUMMARY

In this unit you have learnt:

- Ocean is responsible for regulating global climate
- The Ocean is important forheating the planet
- when water molecule is heated they exchange freely with air by evaporation
- Increasing the temperature and humidity of the surrounding air form rain and storm outside the earth's equatorial area, weather patterns are driven largely by ocean current.
- Ocean water help transport warm water and precipitation from equator to the pole and cold water from poles back to tropics.
- Current helps to regulate regional temperature from being extreme

6.0 TUTOR-MARKED ASSIGNMENT

i. Mention the role of the ocean in determining the climate of the planet
ii. explain how the ocean serves as heater for the planet.
iii. explain how the ocean distribute heat around the globe
iv. mention the factors that help to regulate regional temperature.

7.0 REFERENCES/FURTHER READING

How does the Ocean Affect Climate? http://oceanexplorer.noaa.gov/facts/climate.html.

Ocean waves-styles and Patterns. Earthsci.org/processes/weather/waves/waves.htm.

Ocean Structure and Circulation. www.meteor.lastate.edu/gccourse/alumni/ocean/test.html