CHAPTER 12.1: THE CONCEPT OF ECOLOGY

By the end of this chapter a learner should be able to:

- **Know the meaning of the term ecology (k)**
- **Understand the concepts of communities, habitats and ecosystems (s, u)**

ECOLOGY.

This is the scientific study of the complex relationships between organisms and their environment.

ENVIRONMENT

This is an immediate surrounding of an organism.

COMMON TERMS USED IN ECOLOGY

Biosphere/ Ecosphere

This is part of the earths surface and the atmosphere where living organisms are found (where life exists).

a) **Aquatic region**
   - **Freshwater (lakes, rivers, ponds, streams, wetlands, etc).**
   - **Marine water/ salty water (oceans and estuaries).**

b) **Terrestrial region**
   This covers a few meters deep in the soil and few kilometers in the atmosphere.

Biome

This is a large ecological area on earths surface with distinct flora and fauna which are adapted to that particular environment, for example

- **Tropical rain forests.**
- **Tundra regions**
- **Hot and dry desert regions**
- **Cold deserts**
- **Temperate regions (winters and summers)**

A biome is further divided into zones, each with its unique properties and inhabited by different living organisms.

For example

a) **Forest biome has the following zones**
   - **Ground zone**
   - **Aerial zone**

b) **Aquatic biome can have the following zones**
   - **Surface water**
   - **Intertidal zone**
   - **Benthic zone**

A zone is further divided into habitats with set specific conditions favoring a specific organism.

Habitat

This is a specific location/ locality where an organism normally lives within the environment. For example;

- **Leaf litter for earthworms**
- **Intestines of man for tape worms**
- **Ponds for frogs**
- **Kitchen crevices for cockroaches**

Classification of habitats:

These are classified into two; aquatic habitats and terrestrial habitats.

a) **Aquatic habitats:** These are the habitats in water.
They include;
   - **Fresh water habitats**. These include rivers and lakes, ponds and swamps.
     Inhabitants include
     - ✓ Protozoans (amoeba),
     - ✓ Fish,
     - ✓ Aquatic plants such as algae and papyrus.
   - **Marine (salty) water habitats**. These are ones which are found in seas, oceans Inhabitants include
     - ✓ Sea anemones,
     - ✓ Sea weeds,
     - ✓ whales,
     - ✓ fish, etc

b) **Terrestrial habitats:** These are habitats on land.
They include;
   - **Forests** where the inhabitants are including birds, insects, fungi, monkeys, etc.
   - **Savanna** where inhabitants include birds, grazers, insects, grasses, etc.
   - **Desert** where the inhabitants include hardy droughts resistant species like xerophytes, cactus, euphorbia, camels, etc.
   - **Underground** where inhabitants include termites, burrowing mammals, and earth worms, etc.

Ecosystem

This is a natural unit of the environment composed of living (biotic) and nonliving (abiotic) components whose interaction lead to a self-sustaining system.

It is a community of organisms and their physical environment interacting together as an ecological unit.

Components of the ecosystem

Biotic components; this constitutes all living components in a given ecosystem for example

- Animals such as birds, arthropods, mammals, amphibians
- Plants
- Decomposers and other micro-organisms

Abiotic components; non-living components of the ecosystem (they include physical and chemical factors that influence living organisms in an ecosystem)

For example

- ❖ Climate factors
  - Temperature
  - Light
  - Wind
  - Humidity
  - Rainfall
- ❖ Soil factors
  - Soil pH
  - Soil air
  - Soil water
  - Organic matter
- ❖ Water factors
  - Water pH
  - Water temperature
  - Dissolved oxygen
  - Nutrient content
  - Light penetration
- ❖ Topography
- ❖ Fires

Types of ecosystems

There are mainly two types of ecosystems, namely;

- Terrestrial ecosystem
- Aquatic ecosystem

Aquatic ecosystem

This is an ecosystem found in and around a body of water.

Water provides a more constant and protective environment than land where by there is no desiccation, less affected by sudden and drastic changes in physical and chemical conditions. However, some change due to climatic or seasonal variation

It provides support and dissolved oxygen and nutrients to aquatic organisms.

Aquatic ecosystems are classified into two depending on the concentration of salts in water they contain i.e.

- Fresh water ecosystem.
- Marine ecosystems.

Freshwater ecosystem

This consists of fresh waters of low salt concentration such as lakes, rivers, swamps and ponds.

The water is either slow moving, fast moving or stagnant

Have lower temperatures compared to the terrestrial ecosystem

Temperatures are usually stable throughout the day

Light intensity and temperature decrease with increase in depth

Fresh water habitats can be classified into:

1) Lotic (running water bodies) e.g., rivers and streams

2) Lentic (standing water bodies) e.g., pond, lake and swamps

Marine ecosystem

This constitutes salty water bodies such as oceans and seas

They have lower temperatures compared to terrestrial ecosystem

Light intesitty and penetration increase with increase in depth

Terrestrial ecosystems

These are ecosystems found on land.

It is therefore a land-based community of organisms and the interactions between biotic (living) and abiotic (non-living) components on land.

The major terrestrial ecosystems in East Africa include the following;

Tropical rain forest ecosystem

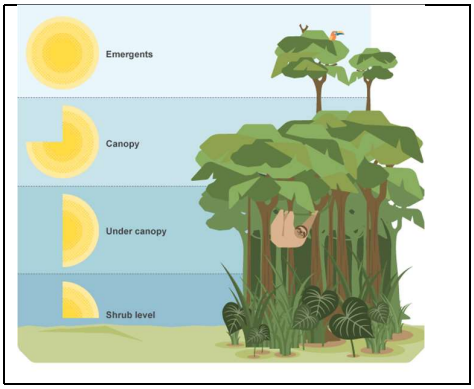
Have high temperatures of 25^0C and 35^0C and receive high monthly rain fall distributed over 10 months of the year i.e., 200 and 400 cm^3 of rain fall annually. Therefore, its warm and moist throughout the year.

They are dominated by broad leaved evergreen tall trees which occupy low altitude zones near the equator.

Species inhabit from forest floor to canopy.

Forest canopy and floor have varied light penetration.

The layers of a tropical rainforest ecosystem:



1. **Emergent Layer:**

Dominates the skyline with trees reaching up to 60 meters (200 feet) tall.

Sparse foliage on tree trunks, but wide leaves in the sunny upper layer.

Trees photosynthesize sunlight, adapting to long droughts or dry seasons.

2. **Canopy Layer:**

Dense and bustling with life.

Home to countless species of birds, insects, and mammals.

Receives abundant sunlight, supporting photosynthesis and diverse plant life.

3. **Understory Layer:**

Located beneath the canopy.

Rich in wildlife, including frogs, snakes, and small mammals.

Adapted to lower light levels and high humidity.

4. **Forest Floor:**

This includes **shrubs**, **herbs**, **lianas**, **shade loving plants** with broad leaves and **thallophytes** e.g., lichen, mosses, liverworts and **shade loving animals**.

Sparse due to limited light penetration.

Houses decomposers like fungi and insects.

Fallen leaves and organic matter enrich the soil

Tropical savanna and grass land ecosystem

Grassland ecosystems are dominated by grasses such as guinea grass, elephant grass, spear grass, and palms.

Has scattered trees and vegetation.

Grasslands are characterized by hot weather with a moderate temperature range.

Rainfall is about 120cm³ per annum which falls in one period, followed by a long period of drought. It therefore consists of dry and rainy seasons

Has large herds of grazing animals including a variety of numerous hoofed mammals e.g., antelopes, elephants, zebra, giraffes which graze or browse on the vegetation.

Others include predators like lions, cheetahs, scavengers like hyenas, jackals and culture insects most abundant during the dry season which include grasshoppers, termites, ants and locusts.

Reptiles are abundant during the dry season and these include snakes, lizards, chameleons, tortoise, etc.

Desert ecosystems.

This receives little or no rainfall.

Extreme dryness due to very low precipitation.

Has high temperatures during day and cold at night.

Sparse vegetation covers due to water shortage.

Examples of organisms in desert ecosystem include.

Barrel Cactus, Creosote Bush, Bobcat, Coyote, desert tortoise.

Activity

State the ecosystem where the following organisms live and how they are adapted to living there.

a) **Monkeys**
b) **Fish**

……
……
……

A population.

This the group of organisms of the same species living together in a given place at a particular time. For example, a park of lions in Murchison falls nation park is a population

Species.

This is a group of organisms capable of interbreeding to produce reproductively viable offspring. For example, lions are a species because they are capable of producing viable offspring upon interbreeding.

A community.

This refers to different populations of organisms living in the same environment and interacting with one another.

Ecological niche.

This is the role and position any species has within its environment and community and its interaction with the living and non-living environment

It describes how an organism meets its need for food and shelter, how it survives and how it reproduces. this reduces intraspecific competition for resources

For example.

With leaves scattered on the ground and old rotting logs sitting on the forest floor

- **Earthworms may be seen in the soil feeding on decaying organic matter**
- **With centipedes eating small beetles and other organisms**
- **A colony of ants working and feeding on dead strolling around feeding on decaying leaves.**

All the above organisms are fulfilling their ecological role looking at where they live, how they survive and how they reproduce.

CHAPTER 12.2: FOOD CHAINS AND FOOD WEBS

By the end of this chapter, learners should be able to

- **understand the feeding relationships in an ecosystem, and express them using food chains, webs, and pyramids (k, u, s)**
- **appreciate the organisms and processes involved in the carbon cycle, and its role in maintaining the carbon dioxide balance in the atmosphere (u, v)**

Feeding relationships in an ecosystem

This involves the interactions between organisms in an ecosystem based on their consumption of each other. These relationships determine the flow of energy and nutrients within the ecosystem.

This can be expressed in two ways, that is either using food chains or food webs

Food chain

This is a linear sequence of energy flow from producers through a serries of organisms in which there is repeated eating and being eaten

For example

Considering a feeding relationship between grass, grass hoppers, dove and cat

The grass hopper feeds on grass which is a producer, hence grass hoppers are primary consumers on grass

The dove feeds on grass hoppers which qualifies it to be a secondary consumer

Then finally an animal such as a cat feeds on meat from the dove hence being a tertiary consumer

Grass → Grass hopper → Dove → Cat

(Producer) (1º consumer) (2º consumer) (3º consumer)

Detritus food chain:

These types of food chain have their first trophic levels occupied by detritus

Tree log → Wood lice → Toad → Python

Dead animal → Maggot → Birds → Python

Grazer's food chain:

These food chains have the first trophic level occupied by either green plants, or algae and the second level by herbivore.

Grass → Millipedes → Toads → Snakes → Hawks

Grass → Grasshopper → hen →human being

Grass → grasshopper → lizard→ snake→ hawk.

Phytoplankton → zooplanktons → small fish → big fish → crocodile

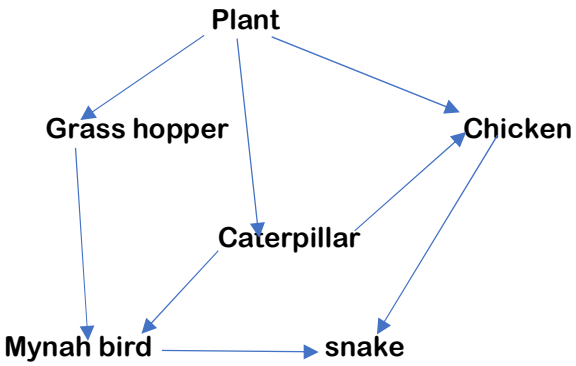
Note:

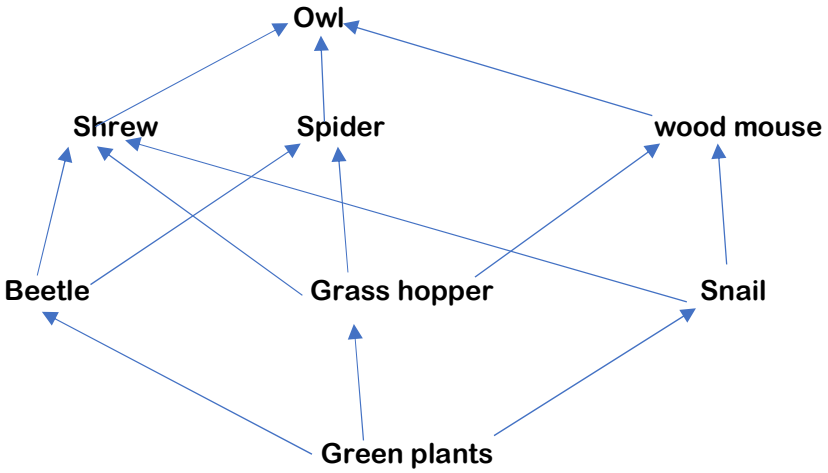
The arrows show the transfer of energy from one organisms (the source of food) to another (the predator).

Food web

This is a complex nutritional interrelationship that illustrates alternative food sources and predator for each organism

The food web consists of a number of interlinked food chains.





Activity

Study the organisms in the table bellow

Guinea grass, Lizard, grass hopper, Hen, Hawk, Termites, frog, Heron, Antelope, Lion, vulture, Maize plant

a) **Use them to construct possible food chains**
b) **Use the constructed food chains to develop a food web**

Trophic level/ feeding level

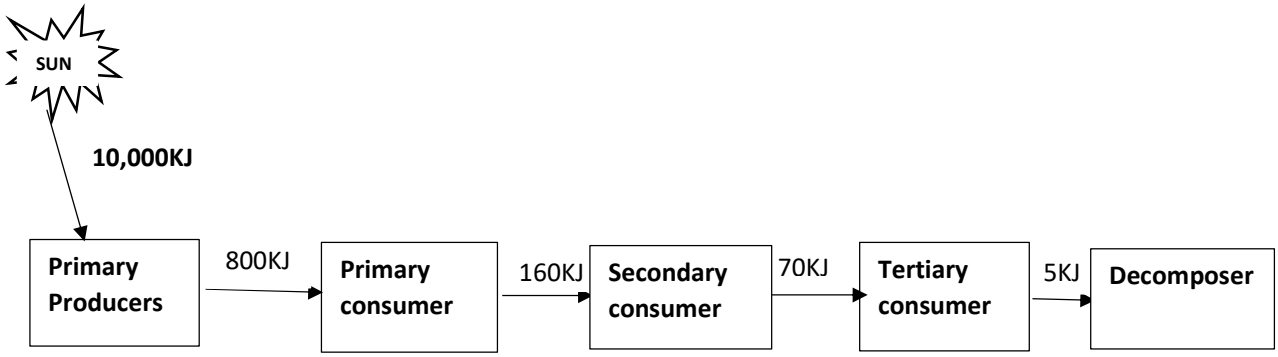
Each stage in a food chain is called a trophic level or feeding level.

This refers to the position from the start of the food chain occupied by a group of organisms in an ecosystem that feed on the same source/type of food

The direction of the arrow in the food chain indicates the direction of flow of energy when one organism feeds on another.

Four or five trophic levels are recognized in an ecosystem i.e. producers, primary consumers, secondary consumers, tertiary consumers and decomposers and there are never more than six.

This is mainly due to loss of energy along the food chain but also lack of sufficient food of preferred types and territorial space may limit the food chains



Primary producers

These are autotrophs capable of synthesizing complex organic food materials from simple inorganic food raw materials for example carbon dioxide and water.

They are responsible for conversion of solar energy into usable energy (chemical energy).

Producers make their own food through photosynthesis/ chemosynthesis.

They include all autotrophs such as;

- **Plants, e.g trees, shrubs, grass**
- **Algae**
- **Blue green bacteria**
- **Sulphur bacteria**

Primary consumers (Herbivores).

These completely depend on producers for energy

They constitute consumers who eat plants for example Insects, most Birds, Most mammals, Water, fleas, Fish, Crabs, Mollusks, Protozoans

Secondary consumers (carnivores and omnivores).

These feed on herbivores. A consumer that eats other animals

For example, birds of prey like eagles, kites and king fisher

Lions, Cheetahs, Tiger, Snakes, Big fish.

Tertiary consumers

These feed on both primary and secondary consumers.

They can be predators that hunt and kill others for food or scavengers (animals that feed on dead organisms but do not kill them) for example vultures, hyenas.

Decomposers

These feed on dead decaying plants and animals converting organic matter to energy and nutrients

They are classified into;

- **Detrivore/macro decomposer; an animal that eats detritus (dead and waste matter not eaten by consumers) E.g., earth worms, rag worms, mites, maggots, wood lice, termites etc.**
- **Saprophytes: A microbe (bacterium or fungus) that lives on detritus.**

Effect of eliminating one trophic level

What happens to a food chain or web when one level of organisms is removed?

Consider food chain below

Grass → Caterpillars → Hens → Fox

Elimination of one trophic level from food chain or web disrupts it

For example

When caterpillars are removed, the following happens

- **The grass will grow tall and spread further because the caterpillars that used to feed it have been removed.**
- **The hens will lack food because they feed on caterpillars which have been removed this causes their number to drop.**
- **The foxes will also reduce in numbers because as the hens die, due to lack of food, the fox lack food too and start to die because they feed on hen.**

Implications

There is need for strict measures against activities which tend to eliminate both habitats and organisms from the ecosystem thus breaking the food chain. For example, deforestation, poaching, use of insecticides, bush burning, swamp reclamation, etc. this will ensure both environmental conservation and sustainability of ecosystem through completion of food chains and webs

Ecological pyramids

These are histograms that provide information about trophic levels in an ecosystem

Each bar that makes up the pyramid represent a different trophic level and their order which is based on who eats what and the flow of energy

Ecological pyramids are of three types;

Pyramid of numbers – this shows the number of organisms at each trophic level in a food chain

Pyramid of biomas – this shows mass of organisms at each trophic level

Pyramid of energy – shows the energy present at each trophic level

Pyramid of numbers

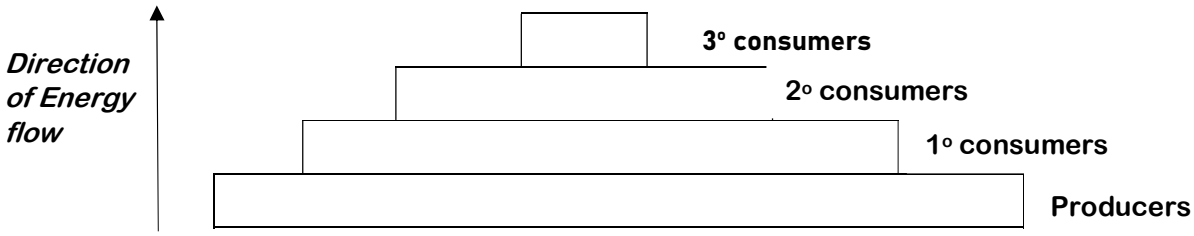
This shows the total number of organisms at each trophic level in a food chain or web

How to construct a pyramid of numbers?

Count the number of organisms at each trophic level

Using a rectangle, in each rectangle represent the number of organisms at each trophic level

Draw a pyramid with producer at the base followed by primary, secondary and finally tertiary consumers.

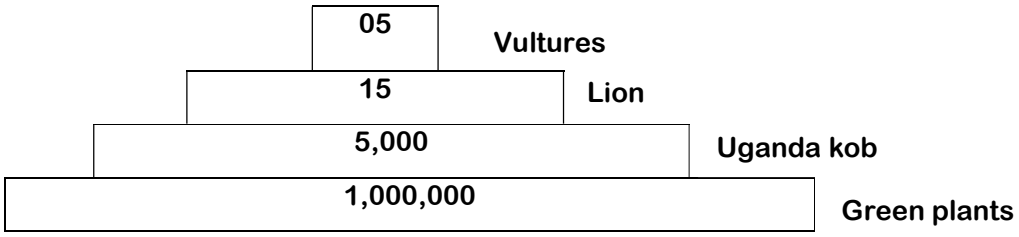


Activity.

a) **Conduct a field study in a selected area of the school to identify organisms that live there. Record the number of organisms identified belonging to each trophic level and use the data obtained to construct the pyramid of numbers**
   .....
   .....
   .....

b) **Use the data below obtained from a field done in Queen Elizabeth National Park in Western Uganda to construct a pyramid of numbers**

Organism	Number
Vulture	05
Uganda Kob	5,000
Green plants	1000,000
Lions	15



Explain the appearance of the pyramid.

The size of the rectangle represents how many organisms exist at each trophic level. For example, the size of the rectangle in the pyramid decreases as you move from producer to tertiary consumers. The number of organisms also decrease as well at each trophic level as you move up the pyramid

CYCLING OF MATERIALS IN AN ECOSYSTEM

The carbon cycle.

This is a serries of events in which carbon in form of carbon dioxide and organic carbon is interchanged between the living and non-living components of the atmosphere to keep the concentration of carbon dioxide in balance

It involves processes like photosynthesis, respiration, combustion, fossilization some of which are controlled by bacteria

Carbon dioxide in the recent time has resulted into global warming. A condition where the temperatures of the earth and atmosphere has increased affecting seasons and life.

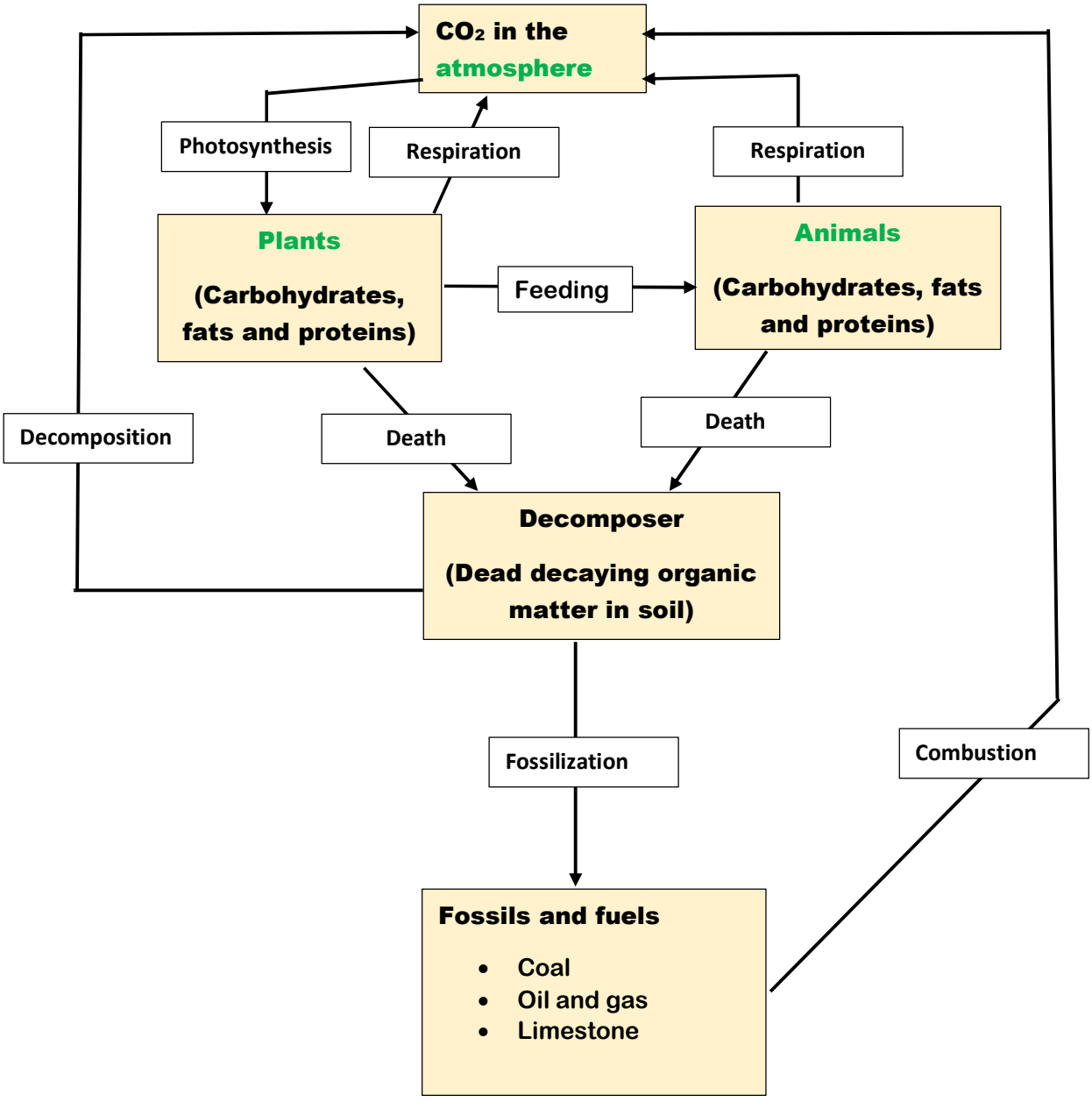
The main source of carbon to terrestrial organisms is Carbon dioxide in the atmosphere or dissolved in water as bicarbonate ions (HCO3-). During photosynthesis Carbon dioxide is absorbed by autotrophs such as plants and blue green algae and converted to organic compounds. These are stored to provide food for herbivores or respiration to release energy and carbon dioxide is released back to atmosphere.

Animals obtain organic food molecules through feeding on plants. While in the body of animals, organic molecules are respired to release energy and carbon dioxide. Saprophytic bacteria and fungi break down organic compound in dead organic materials during decomposition to release carbon dioxide to the atmosphere.

Some of the organic matter in anaerobic areas such as water-logged soils, bottom of still poorly illuminated water etc. are used to form fossil fuels and lime stone when organisms die and are buried without decay.

However, carbon dioxide is released when there is burning of fuels and lime stone. Oceans play in regulating amount of carbon dioxide in the atmosphere as they absorb and release it into the atmosphere depending on the concentrations.

Summary of the carbon cycle



In the process of photosynthesis atmospheric carbon is absorbed by plants as carbon dioxide.

This carbon is transferred from plants to animals feeding on them as carbohydrates, proteins and lipids.

Respiration of plants and animals release carbon back the atmosphere in form of carbon dioxide.

When plants and animals die or excrete carbon moves to the lithosphere.

Decomposers such as fungi and bacteria release carbon dioxide into the atmosphere by their decomposition prosses.

Some of the undecayed living beings buried millions of years ago undergo fossilization to form fossil fuels.

Combustion of these fossil fuels release carbon dioxide back to the atmosphere

Organisms and processes involved in the carbon cycle and their roles

Plants; **these absorb carbon dioxide from the environment during photosynthesis and release it back during respiration.**

Animals; **these obtain their carbon by eating plants and release carbon in form of carbon dioxide into the atmosphere during respiration**

Decomposers such as fungi and bacteria; **these return carbon to the environment when they decompose dead plants and animals**

Un decomposed plants and animals form fossil fuels such as petroleum and once combusted release carbon in the atmosphere as carbon dioxide.

The carbon emissions in the homestead can be minimized by;

- **Planting more trees**
- **Get alternative sources of energy like solar**
- **Use dung to produce biogas**

Note

The carbon cycle ensures that the carbon dioxide level in atmosphere remains approximately at 0.04%. this is important because increase in carbon dioxide level can lead to global warming. this disrupts weather patterns, increase heat related illnesses, wild fires, etc.

CHAPTER 12.3: ASSOCIATION IN BIOLOGICAL COMMUNUITIES

By the end of this chapter, a learner should be able to;

- **Know what competition is and describe how organisms compete in nature (k, u)**
- **Differentiate prey from predators and describe a predator-prey relationship (u, s)**
- **Understand symbiosis, mutualism, commensalism and parasitism and appreciate their roles in an ecosystem (k, u)**
- **Recognise the role of parasites and vectors in the transmission of common diseases (malaria, bilharzia, nagana, and sleeping sickness) (k, u, v)**
- **Know the adaptations of parasites to their mode of life (u)**

Introduction

No living organism can exist as an isolated entity. All living organisms don't live in isolation but continually interact with one another naturally in a given habitat.

Biological associations are relationships or interactions among living organisms. These associations include

- **Competition resulting from similar requirements in the environment**
- **Predator prey relationship**
- **Symbiotic relationships (mutualism, commensalism and parasitism).**

COMPETITION

This is the interaction between organisms/ species in which both require a resource that is in limited supply hence organisms compete for it

Such resources may include

Food, Water, Shelter, Mates, etc

Competition can also be defined as a relationship whereby two individuals of same or different species struggle to obtain resources which are in limited supply.

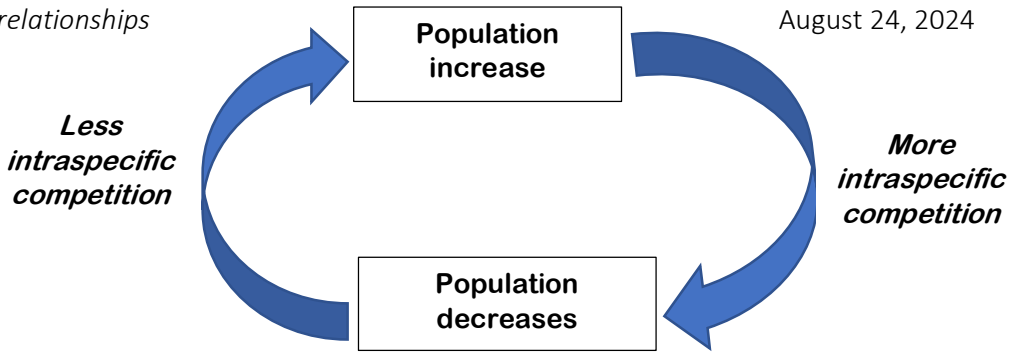
For example; plants competing for light, carbon dioxide, water, mineral salts and pollinators

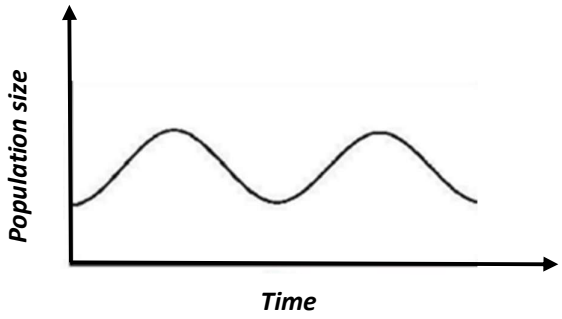
Animals compete for food, mates, breeding sites and shelter from predators

Competition can be between members of the same species (intraspecific competition). This tends to have a stabilizing influence on population size

If the population gets too big, intraspecific competition increases forcing the population to fall again.

If the population gets too small, intraspecific competition decreases so the population increases again.





Competition between members of two or more species for food, space, good hiding place, water light (*interspecific competition*).

Competition is very intense when there is overlap of niches

In this case one of the competing species must; -

- **Migrate to another area if possible**
- **Shift its feeding habits or behavior through natural selection and evolution.**
- **Suffer a sharp decline in population**
- **Become extinct in that area**

Biological significance of competition to organisms

Competition leads to the evolution of better adaptations within a species.

The best competitors are the ones who survive, reproduce and get to pass on their genes to offsprings. Hence their offsprings will have an increased chance of survival.

Competition also leads to species diversity. In the short run cause, a reduction the number of species living with in an area, preventing very similar species from co-existing

PREDATOR- PREY RELATIONSHIP

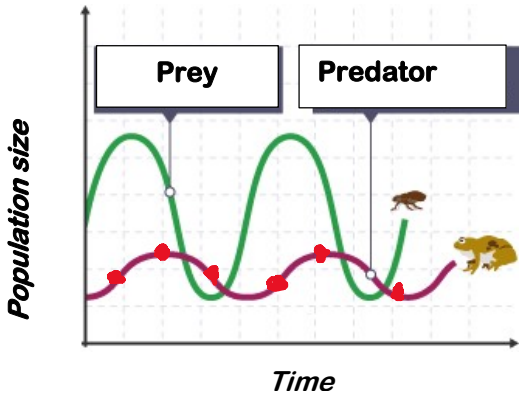
This is a relationship where members of one species (predator) hunts, kills and feeds on whole or part of another living organism/species called prey.

A predator is an animal that hunts, kills and feeds on another living organism called prey.

A prey is a living organism that is fed on by a predator

Examples	
Predators	**Prey**
Lion **Cat** **Leopard** **Wild dogs**	**Antelope** **Rat** **Giraffe** **Buffalo**

A graph showing the variation in the predator and prey population overtime



The population of prey is higher than that of the predator at the start. This leads to an increase in the number of predators as they have sufficient food (the prey).

The population of the prey reaches a maximum earlier than the predator

Further increase in the predator population leads to a decrease in the prey population because the prey is being fed on by predators.

When the number of preys goes down, the predator starves due to scarcity of food. This makes their population to reduce too.

When the predator number decreases below that of the prey, the population of the prey increases again due to the fact that predators are few and thus a low pressure on the number of preys

Evolutionary significance of predator prey relationship

Predation usually eliminates the unfit (aged, sick and weak). This gives the remaining prey access to the available food supply, enhances chances of reproductive success and longtime survival, thus pass on their good traits to their off springs which can improve their evolution.

SYMBIOTIC RELATIONSHIP

Symbiosis; **This is a close physical and long-term biological interaction/association between two different species of organisms.**

The common types of symbiotic relationships that occur in nature include;

- **Mutualism**
- **Commensalism**
- **Parasitism**

Mutualism

This is the interaction between organisms of two or more species in which each organism benefits from the interaction.

For example

1. **Leguminous plants and nitrogen fixing bacteria (rhizobium).**

The plants obtain nitrates while bacteria obtain shelter, sugars and vitamins.

2. **Algae and fungus (Lichens)**

Algae carries out photosynthesis providing nutrients to the fungus while algae are protected by the fungus from intensive sunlight and desiccation.

Minerals absorbed by the fungus are also passed onto the algae

3. **Cellulose digesting bacteria in the gut of ruminants such as goats, cattle and sheep. Ruminants obtain sugars and amino acids while bacteria obtain shelter and food**

The role played by mutualism

This relationship results into exchange of resources such as shelter, food and other nutrients or may even help in exchange of services such as protection, transportation

or health care with in the ecosystem thus contributing to its sustainability. The interaction helps the growth and survival of both organisms

Commensalism

This is an association between two organisms of different species in which one benefits whereas the other neither benefits nor harmed.

For example

1. Cow and cattle egrets

The egrets get food in form of insects forced to fly by the grazing animals. The cattle do not gain or lose in any way.

2. The shark and the remora

The remora is a small fish that lives as a commensal attached to the shark by its sucker. When the shark feeds, the remora feeds on left overs of the shark. The shark neither benefits nor loses.

The role played by commensalism

It results into one organism benefiting from the other without harm. Therefore, the one that obtains resources (such as shelter, food and other nutrients or service such as protection, transportation or healthcare) within the ecosystem resulting into survival.

Parasitism

This is an association between two organisms of different species in which one benefits(parasite) and then causes harm to the other organism(host).

An organism called parasite obtains part or all its nutrients from the body of another organism of different species called a host

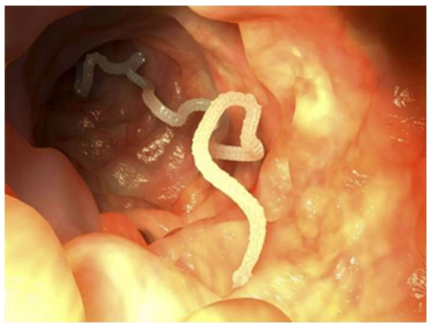
Parasites donot usually kill their hosts but the host suffers harm usually in form of diseases. For example;

1. Ticks and herbivores.

The tick obtains shelter and food by sucking blood from the herbivore which does not benefit but instead harmed.

2. Tape worms and humans.

Tape worms obtain shelter in the intestines of human being and food by sucking already digested food. The human body doesn't benefit but instead is harmed.



The role played by parasitism in an ecosystem.

Parasites influence host behaviors and fitness. They also regulate the host population size hence important in shaping community and ecosystem structure

The role of parasites and vectors in disease transmission.

A parasite is an organism that obtains part or all its nutrients from the body of another organism of different species called host to which it causes harm.

The parasite is usually smaller than its host in size.

Parasites donot usually kill their hosts but the host suffers harm.

Many parasites live permanently on their host (**ecto-parasites) e.g.,** ticks, fleas and leeches). or in their hosts body (**endo- parasites**) e.g., plasmodium tapeworm and liver fluke.

If the organism has to live parasitically at all times, it is said to be **an obligate parasite,** for example Phytophthora.

Facultative parasites are fungi that can feed either parasitically or saprotrophically, for example Candida. These sometimes kill their host and feed on it saprophytically

A vector is an organism that acts an intermediate host for the parasite and transmits a disease or parasite from one organism to another.

Biological vectors such as mosquitoes and tsetse flies carry pathogens that can multiply within their bodies and deliver them to new hosts usually by biting.

The mechanical vectors such as house flies and cockroaches pick up infectious agents on the outside of their bodies and transmit through physical contact.

Parasites and the disease they cause, mode of transmission and their vectors

Parasite	Disease	Mode of transmission	Vector
Plasmodium	Malaria	Bite by infected female anopheles mosquito.	Female anopheles' mosquito.
Trypanasoma	Sleeping sickness	Bite by an infected tse-tse fly.	Tse-tse fly.
	Nagana		
	Trypanasomiasis		
Schistosomia	Bilharzia	Contact with infected water.	Snails.

Other vectors

Vector	Disease	Pathogen	Mode of transmission
House fly	Cholera	Vibrio cholerae	Eating contaminated food or drinking contaminated water
	Dysentery	Escherichia coli	
	Trachoma	Chlamydia trachomatis	

How to prevent and control vectors from spreading diseases or parasites

Vector	Methods of prevention/ control
Female anopheles mosquito	• Draining stagnant water to minimize their breeding sites. • Oiling stagnant water to kill mosquito larvae. • Using mosquito repellants to reduce the number of mosquito bites • Using biological control mechanisms like introducing fish in ponds around communities. • Slashing away bushes which act as breeding grounds for mosquitoes.
Tsetse flies	• Wearing long sleeved shirts and pants in neutral colors that blend with background environment. • Inspecting vehicles before entering since the flies are attracted to moving bodies. • Avoiding bushes where tsetse flies are known to be.
House flies	• Keeping the home clean • Covering left over food • Covering pit latrines and compost pits • Spraying using insecticides to kill house flies

Water snails	• Avoid swimming in fresh water. • Swim only in chlorinated swimming pools. • Boiling water before drinking.

Adaptations of parasites to their mode of life

	Adaptation	Example
Reproductive	Hermaphrodite condition allowing self fertilisation, if necessary.	Taenia (liver fluke) Fasciola(tapeworm)
	Use of secondary hosts as vectors.	Taenia Fasciola Plasmodium
	Enormous numbers of reproductive bodies, i.e., eggs, cysts and spores.	Taenia Fasciola
	Resistance of reproductive bodies when external to the host.	Phytophthora (potato blight)
	Have more than one host for increased survival.	Tick Plasmodium
	Some produce many young ones thus increasing their chances of survival	Plasmodium
Structural	Absence or degeneration of feeding and locomotory organs	Fasciola Taenia
	Highly specialised mouthparts as in fluid feeders.	Pulex (flea) Aphis (aphid)
	Boring devices to enter host.	Nematode worms
	Attachment organs such as hooks and suckers.	Taenia Hirudo (leech) Fasciola
	Outer covering resistant to attack by digestive enzymes.	Taenia Fasciola
	have body colour resembling that of the host for camouflage	Ticks
	Reduction of sense organs associated with the constancy of the parasite's environment and don't need to move around to obtain food	Taenia
Physiological	Anticoagulant production in blood feeders.	Pulex Hirudo
	Production of digestive enzymes to aid penetration into host.	Cuscuta
	Ability to respire adequately in anaerobic conditions.	Gut parasites

CHAPTER 12.4: HUMANS AND THE NATURAL ENVIRONMENT

By the end of this chapter, a learner should be able to;

- **Understand there is a world-wide focus on sustainability and its importance (u)**
- **Know and give examples of natural resources found in Uganda (k, u)**
- **Appreciate and describe natural factors and human influences that may have an impact on ecosystems, and make suggestions about how to preserve the natural environment for all living things (u, s, v)**
- **Understand the sources, effects and control of air, land and water pollution (u, s, v)**

Natural resources in Uganda

Natural resources

These are naturally occurring raw materials found on and below the Earth's surface formed without any human intervention.

Earth's most common natural resources include sunlight, air, water, soil, stone, plants, animals, and fossil fuels.

They are essential for humanity to fulfill necessities like food, building, and clothing, electricity generation, fuel for transportation, and make fertilizers.

Types of natural resources.

Based on their availability

1. Renewable natural resources.

Renewable resources are resources that can be replaced during human lifetime.

They are available to us in abundance. However, the rate at which they are renewed may differ.

Examples include;

- **Sunlight**
- **Air**
- **Water (lakes, rivers swamps)**
- **Plants (forests)**

2. Non-renewable Resources

These are natural resources that cannot be readily replaced by natural means quickly enough.

They are available in limited quantities and thus can get exhausted with time.

Examples include;

- **Fossil fuels, such as coal, petroleum**
- **Natural gas**
- **Minerals like gold, silver, copper.**

Based on Their Source

1. Biotic Resources

Biotic resources are resources derived from the living things of the biosphere.

They include;

- Plants, forests, grass lands.
- Animals like insects, monkeys, lions, earth worms, etc.
- Micro organisms like bacteria, fungi etc.
- Fossil fuels.

2. Abiotic Resources

Abiotic resources are resources obtained from non-living and inorganic materials.

- Sunlight
- Air
- Water and water bodies
- Soil
- Minerals like gold, silver, copper, and aluminium

Benefits of various natural resources to the ecosystem

Natural resource	Life sustaining benefits
Swamps	• Swamps are vital in water purification by filtering out sediments, nutrients and pollutants before it joins lakes and rivers. • Swamps act as a breeding place for aquatic organisms like frogs. • Swamps are habitat to diverse animal and plant species like fish, frogs and papyrus. • Swamps absorb excess water during heavy rain reducing the risk of flooding. • Swamps aid in rain fall formation through evapotranspiration. • Swamps are a source of medicinal plants and herbs. • Source of food in form of fish for human consumption. • Source of raw materials like papyrus, reeds etc. for crafts and constructions etc. • Swamps provide water for home and industrial use.
Lakes	• Lakes are habitats for numerous organisms like fish, aquatic plants, etc. • Breeding ground for various organisms like fish. • Aid in rainfall formation through evaporation. • Lakes absorb excess water during heavy rainfall reducing flood risks. • Lakes are source of food in form of fish to man.
Rivers	• The river is a breeding ground for aquatic animals. • The river is a habitat for aquatic organisms. • The river contributes to the rainfall cycle. • It is a source of food (e.g., fish) to man.
Forests	• Forests produce oxygen through photosynthesis supporting life. • Forests absorb carbon dioxide mitigating climate changes like global warming. • Aid in rainfall formation through evapotranspiration. • Trees hold soil in position preventing soil erosion. • Forests are habitats for various organisms like monkeys, snakes, etc.

	• Source of food to man and other animals in form of fruits. • Source of herbal medicinal plants for treating various diseases. • They act as breeding grounds.

World wide focus on sustainability and its importance

Sustainability consists of fulfilling the needs of current generations without compromising the needs of future generations.

The sustainable development goals (SDGs)

Sustainable development goals (SDG)/Global goals are a collection of 17 interlinked goals designed to be a basis to achieve a better and more sustainable future for all.

They were developed in 2015 by the United Nations General Assembly and are intended to be achieved by 2030.

About 193 countries have committed to the SDG and these include Kenya, Finland, Burundi, and many others.

The countries are committed to SDG in order to;

- Achieve better distribution of wealth and resources
- Achieve equitable access to opportunities and information
- Build a more sustainable global economy
- Achieve basic levels of goods and services for all

About half of the SDG are related to natural resources which include

- **Zero hunger**
- **Good health**
- **Quality education**
- **Clean water and sanitation**
- **Affordable clean energy**
- **Sustainable cities and communities**
- **Climate action**
- **Life below water**
- **Life on land**

Importance of SDGs

The SDGs call to action to end poverty and inequality, protect the planet and to ensure that all people enjoy health, justice and prosperity. They play a role in combating the urgent environmental, political and economic challenges facing the world.

Factors affecting natural environment

The natural environment is affected a number of factors, some of these factors occur in nature (natural factors) while others originate from human activities (human factors).

These factors are known to interrupt the association of organisms in a given ecosystem

Natural factors	Human factors
• Earth quakes. • Volcanic eruption. • Wild fires. • Drought. • Algae blooms.	• Urbanization. • Road construction. • Industrialization. • Charcoal burning. • Poaching. • Improper disposal of wastes. • Inorganic fertilizer, pesticide and herbicide use. • Minning • Deforestation. • Swamp reclamation. • Overgrazing

Problems that arise in an ecosystem due to the above factors and how to overcome them.

Factor	Challenges arising	How to overcome them
Urbanization	• Environmental pollution i.e., water, air and sound pollution resulting into human diseases like lung cancer, cholera, dysentery, etc.	• Proper disposal of wastes • Revegetation /afforestation to restore habitats,

	• Deforestation/de-vegetation leading reduced rainfall, habitat loss, etc. • Loss of biodiversity/life forms due to direct killing, clearance of their habitats and breeding grounds. • Loss of habitats for organisms like snakes due to de-vegetation • Loss of breeding grounds for other organisms. • Swamp reclamation leads to flooding resulting into habitat loss and death of some organisms. • Global warming due to emission of large quantities of greenhouse gasses in the atmosphere • Eutrophication of nearby water bodies, leads into growth of algae blooms and its effects.	breeding grounds for other organisms • Digging water channels to reduce flooding
Road construction	• De-vegetation/deforestation • Loss of biodiversity • Loss of habitats and breeding grounds • Air pollution	• Re- afforestation • Planting cover crops
Industrialization	• Deforestation • Loss of biodiversity • Loss of habitats and breeding grounds • Swamp reclamation • Flooding • Air, water and land pollution • Global warming • Eutrophication leads to algae bloom growth. • Soil erosion • Silting	• Afforestation. • Digging trenches. • Treatment of industrial effluents. • Clearing algae bloom • De-silting water channels • Plant cover crops along river banks
Charcoal burning	• Deforestation • Loss of biodiversity • Loss of habitats • Air pollution • Global warming • Soil erosion	• Alternative energy sources • Afforestation • etc.

Pollution

This is the release of substances or energy into the external environment in such quantities and for such duration that may cause harm to living organisms or their environment.

It involves the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

These harmful materials are called pollutants

Pollutants include;

- **Noise**
- **Heat and radiation as different forms of energy**
- **many chemical compounds and elements and excretory products.**

The parts of external environment affected include air, water and land.

Types of environmental pollution

- **Air pollution**
- **Water pollution**
- **Land/ soil pollution**

Air pollution

Air pollution is the contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere and are injurious to human being, plant and animal.

Sources, effects and control of air pollution

Pollutant	Sources	Effects/consequences	Control
Carbon dioxide	• Motor vehicle exhausts. • Combustion of fossil fuels. • Tobacco smoking	Global warming (warming of the earth's atmosphere as a result of a blanket of carbon dioxide preventing escape of solar radiations higher into space).	• Planting more green plants to utilize CO_2 • Using alternative sources of energy sources like solar.
Carbon monoxide	• Incomplete combustion of fossil fuel or other product. • Vehicle emission. • Burning of coal.	• Headache. • Dizziness. • In blood CO combines with haemoglobin which reduced the affinity of haemoglobin towards oxygen	• Using alternative sources of energy sources like solar. • Installing exhaust filters in cars.

Sulphur oxides	• Combustion of Sulphur containing fuels, oil and coal gas	• Lung diseases. • Irritation of eyes. • Asthma resulting into death if in high concentrations • Forms acid rains that corrode buildings, raises the acidity of soil, and damages organisms. • Affects plant growth and kills lichens	• Use of Sulphur free fuels like natural gas • Installation of Sulphur dioxide extraction units in industrial chimneys
Hydrogen sulfides	• Burning fuels • Oil refineries • Wood pulp processing • Sewage • Bacterial decomposition of animal wastes	• Harms plants • Irritation of eyes • Respiratory tract infection • Loss of smell	• Use of wet scrubbers in oil refineries • Proper aeration of sewers
Nitrogen oxides	• Car exhaust emissions • Industrial fuel gasses	• Acid rain formation • Contributes to global warming if in high concentrations.	Installing exhaust filters in cars and catalytic converters in chimneys of factories
Chlorofloro carbons (CFC's)	• Propellants for aerosol cans. • Coolants in air conditioners and refrigerators • Medical sterilizers.	• Destruction of the ozone layer permitting greater penetration of UV light to cause global warming	Ban on the use of CFC's
Smoke	• Factories, steel works, oil refineries, chemical plants and motor vehicles • Tobacco smoking • House smoke and soot from combustion of wood fuel.	• Photochemical smog that results in effects like intense eye irritation, headache, sickness and breathing difficulties. • Causes lung diseases when inhaled • Coats leaf surfaces presenting a barrier to sunlight penetration reducing photosynthesis. • Stomatal blockage reducing photosynthesis	• Alternative energy sources that are environmentally friendly • Installing exhaust filters in cars and catalytic converters in chimneys of factories. • No smoking

Dust	• Solid fuel ash • Wind erosion • Quarrying • Minning	• Lung diseases • Stomata blockage reducing photosynthesis. • Low visibility leading to accidents	• Installation of dust precipitators in industrial chimneys • Wearing of face masks when in dust environments • Water dusty roads

Water pollution

The introduction of undesirable biological or chemical substance in water which adversely affect living organism.

Pollutant	Source	Effects	Control
Sewage (liquid waste composed of faeces, urine, water, detergents and other substances).	Domestic and urban areas from toilets, washrooms, showers, kitchen, etc.	Increase in nutrient levels(eutrophication) in water bodies, leading to rapid algal growth.	Sewage treatment
Inorganic chemicals (Acids, toxic metals like Pb, Hg, salts) and plant nutrients like nitrates, phosphates and ammonium salts.	• Inorganic fertilizers from farms. • Raw sewage discharge • Detergents • Industrial effluents.	-Eutrophication which leads to rapid growth of algae and green protists. -Excessive levels of nitrates if drank in water lowers the oxygen carrying capacity of blood and kills unborn babies. -Lead damages the nervous system, liver and kidneys. -Alter water pH affecting aquatic life. -Increased load of heavy metals like mercury, cadmium and arsenic which are poisonous to aquatic life	Proper disposal of wastes Recycling waste materials

Biological pollutants (bacteria, viruses, protozoa, fungi and worms)	• **Sewage discharge.** • **Defecation in water bodies**	**Diseases like cholera, dysentery.**	**Proper waste disposal.** **Sewage treatment**
Sediment and other suspended solids (Soil and silt)	**soil erosion in nearby area**	**Can cause turbidity in water, reducing light penetration and consequently photosynthesis is reduced.** **Destruction of aquatic habitats and breeding grounds.**	**Planting trees and other vegetation.**
Organic compounds	• **Oil spills by oil tanks.** • **Burst fuel pipes during transport** • **Application of agrochemicals like pesticides from farms** • **Waste products of manufacturing**	**-Toxic to aquatic species leading to their death.**	**Spraying onto oil sleeks naturally occurring bacteria such as pseudomonas that digest oil** **Use of floating booms to prevent oil sleeks from reaching sensitive shore line**
Heat	• **Industries releasing heated water into water bodies.**	**Increase in water temperatures reduces oxygen levels which may harm aquatic species.**	**Cooling the water before discharge into water bodies.**

NOTE;

Organic matterS present in water are degraded by microorganism present in water which require oxygen.

If large amount of organic matter present in waste water, then large amount of oxygen is required by the microorganism to degrade the waste. Therefore, oxygen content in water decrease. The amount of oxygen consumed by microorganism is referred as Biological Oxygen Demand (BOD). High level of BOD means large amount of waste present in water.

How eutrophication occurs and its effects

This is a process by which the concentration of nutrients such as phosphates and nitrates builds up in water bodies

Eutrophication is mainly caused by heavy use of nitrogen fertilizers which are leached into lake and discharge of domestic or industrial sewage containing phosphates and nitrates into water bodies.

The nutrients cause phytoplankton (algae and aquatic plants) to grow rapidly forming an algae bloom across the water surface reducing light penetration Hence, aquatic plants cannot photosynthesize, less oxygen is released into the water.

The quantity of suspended organic matter usually from dead algae and plants or from sewage increase.

These are later decomposed by increased saprophytic aerobic bacteria and fungi. This reduces amount of dissolved oxygen in water due to increased demand for oxygen by aerobic saprophytic microorganisms (biological oxygen demand, BOD).

As a result, other aquatic organisms e.g., fish, frogs begin to suffocate, die and decompose. This contaminates the water, making it murky and smelly.

Land pollution

Soil pollution can be defined as introduction of undesirable substance in soil which adversely affects its physical, chemical and biological properties

Sources of pollution	Ecological effects
Use of pesticides in households or agricultural fields	• Non-specific ones may kill beneficial organisms and disrupt food chains • May get concentrated along a food chain and affect fertility of birds resulting from formation of thin shelled eggs • Slow to breakdown resulting into long term effects • Washed into water or to other areas causing pollution
Heavy metals from industrial wastes, mines,	• Toxic to plants and animals • May be washed into rivers • Destroy soil organisms

Use of inorganic fertilizers	• **Destroy soil texture and structure, which encourages soil erosion** • **Alter soil pH** • **Run off into rivers causing eutrophication** • **Harmful to plants and soil organisms**
Domestic wastes e.g., sewage, plastics, rubbish hips	• **Transmission of communicable disease** • **Destruction of habitats where rubbish is pilled** • **Rubbish heaps may harbor pest for human crops** • **Anaerobic decay may produce methane** • **Burning may cause air pollution** • **Untreated sewage may end up in water causing eutrophication**

Controlling land Pollution

- **Recycle and Reuse of non-biodegradable materials.**
- **Use organic wastes to produce fertilizers and generate power**
- **Use of chemical fertilizers should be reduced. Bio fertilizers and manure should be used in their place.**
- **Instead of pesticides, biological control of pests be used where possible.**
- **Use biodegradable packing materials.**
- **Ensure that you do not litter on the ground and do proper disposal of garbage**
- **Burning rubbish to reduce its bulk**
- **Create dumping ground away from residential areas**

ENVIRONMENT CONSERVATION

This is the practice of protecting and preserving the natural environment to ensure its health and sustainability for future generations.

It involves protecting natural resources, preserving biodiversity, pollution control and ensuring sustainable resource management to maintain the health of our ecosystem.

It is important to reduce the negative impacts that humans have on the environment to conserve the biodiversity of ecosystems.

WAYS OF CONSERVING THE NATURAL ENVIRONMENT.

- **Cutting down on amount of garbage by recycling and reusing materials. This conserves natural resources and land fill space.**
- **Volunteering for clean ups in the community.**
- **Through educating oneself and other people to understand the importance and value of natural resources.**
- **Through treatment of sewage and waste air before releasing it to the environment.**
- **Buy less plastic and using reusable or biodegradable shopping bags.**
- **Through using long lasting electric bulbs as a way of reducing green house gas emissions.**

- Through planting trees which provide food and oxygen. These also act as wind breakers as well as protecting the soil from erosion.
- Through use of alternative sources of energy such as bio gas other charcoal to prevent cutting down of trees.
- Through increased use of bikes and less of cars in order to cut on both amount of fuel used and air pollution due to exhaust fumes.

Solid waste management

Garbage is a collection of unwanted materials generated in homes, institutions, hospitals or other work places for example peelings, packaging materials like cans, bottles bags and card boards and domestic refuse.

Their accumulation causes unpleasant sight, smell and yet their disposal is costly in terms of vessels transport and dumping sight construction and maintenance.

One solution to the garbage problem is the reuse of some of the items which are still of use and recycling of materials instead of dumping them for example recycling of paper reserves trees.

Components of garbage that can be re-used or recycled and how

Component	What it can be put to use for
Organic matter	Used as composite manure for agriculture
Bottles	Containers for storage of drinks like passion juice.
Straws	Make mats, hats and decorations

Component	How it can be recycled
Metals	Melted to make other metal products
Tin	Melted to make other tin products
Plastics	Heated and remolded to make other plastic products
Paper	Shredded and used to make other paper products
Glass	Heated and remolded to make other glass products
Tyres	To make foot wear straps, decorations and swings for children

HOW RECYCLING IS TAKING PLACE IN UGANDA

- After collection, recyclables are sent to a recovery facility to be sorted, cleaned, and processed into materials that can be used in manufacturing.
- More and more of today's products are being manufactured with recycled content. Common house hold items that contain recycled items include newspapers and paper towels etc.
- Purchasing new products made from recycled materials.

PRACTICES TO IMPROVE RECYCLING

- **Separate biodegradable from non-biodegradable materials.**
- **Recycle bottles, cans, paper and cardboard.**
- **Flatten cardboard and papers to save space and facilitate processing.**
- **Keep food and liquid out of your recycling.**
- **Avoid bagging recyclables, these plastic bags can wrap around machinery, causing jams at recycling facilities.**
- **Avoid recycling small items because they can jam the recycling equipment.**
- **Ensuring that recyclables are clean, empty and dry.**
- **Avoid buying non-recyclable materials that can't be separated.**
- **Avoid wish-cycling, which is the act of putting items that cannot be recycled in recycling bins. This leads to contamination of recyclables and damage to recycling equipment.**
- **Compelling manufacturers print recycling guides in local languages.**

Significance of recycling and re- use of garbage

Recycling or re-use of means that no much new material will be needed to manufacture materials.

For food waste, this can be used to make manure, this leads to increased harvest and reduce on the use of chemicals for fertilizers hence reduce pollution of water sources.