CONCEPT OF ECOLOGY-(S4 term 2)

(The Learner understands the concepts of communities, Habitats and ecosystems)

Ecology is the study of living organisms in relation to their environment i.e. the study of interactions between living things and their environment.
The organisms and the environment depend on each other for resources e.g. plants need carbon dioxide and water to manufacture food for animals to feed on.
There are 2 branches of Ecology i.e. Autecology, which deals with the study of individual species of plants and animals and Synecology which deals with the study of communities (plants and animals living under similar conditions)

Terms used in the study of Ecology
Environment: This refers to the immediate surroundings of an organism.
Habitat: This is the place in the environment where an organism lives e.g. mammalian intestines are habitats of tapeworms
Biosphere: This is the surface of the earth where life exists e.g. forests, mountains
Ecological niche: This is the role/ status played by an organism within the community. This refers to the specific mode of life of an organism within its habitat.
Ecosystem: This is the natural unit consisting of biotic and abiotic components interacting to produce a stable system.
Biotic components are the living components while **abiotic components** are the non-living components
Community: This refers to the populations of plants and animals living together in a common environment.
The individuals of the population within the community interact with each other and with the abiotic components of the environment.
Species: This is a group of organisms capable of interbreeding and producing viable offspring.

HABITATS

Classification of habitats:
Habitats are classified into two namely;

1. Aquatic habitats
2. Terrestrial habitats.

1. Aquatic Habitats

These are the habitats in water. They include;

i) Fresh water habitats. These include rivers and lakes. Inhabitants include protozoans (amoeba), fish, aquatic plants such as algae and papyrus.

ii) Marine (salty) water habitats. These are habitats which are found in seas, oceans and swamps. The marine Inhabitants include sea anemones, sea weeds, whales, and fish etc.

ACTIVITY 1

Students of Nabilatuk SS in North eastern Uganda visited the shores of Lake Victoria and they were so excited to see many animal and plant species interacting with the non-living components of the lake shores. However, they also saw a heap of smelling industrial waste dumped at another part of the lake shores and some dead animals.

Their teacher took a sample picture of the wonderful scenery of this fresh water body which the students enjoyed during their study tour at the shores of Lake Victoria.

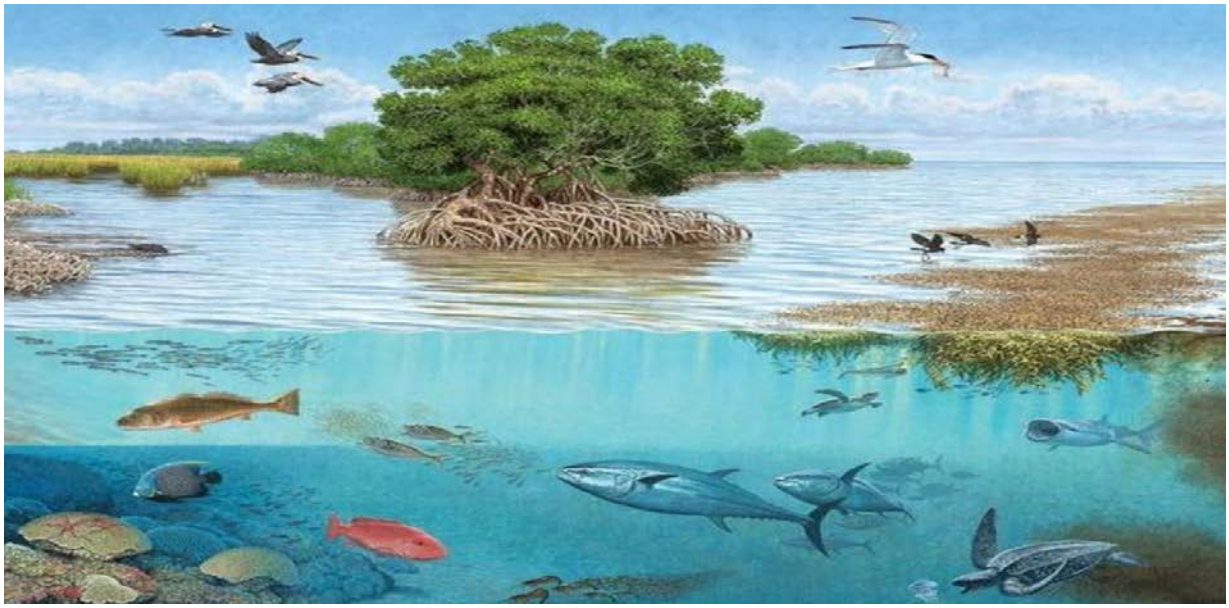


Fig showing different plant and animal species in Lake Victoria..

TASK

a) Identify the type of habitat visited by the students of Nabilatuk SS.
b) List the different species of organisms that you can see in the sample picture taken by their teacher?
c) Explain the dangers of depositing untreated industrial wastes on a fresh water Lake like Lake Victoria?
d) How can the problem(s) in (c) above be mitigated/prevented?
e) Outline the economic importance of lakes to the economy of Uganda?

2. Terrestrial habitats:

These are habitats found on land. They include;

(i) **Forests** where the inhabitants are include birds, insects, fungi, monkeys, etc.
(ii) **Savanna grass land** where inhabitants include birds, grazers, insects, grasses, etc.
(iii) **Desert** where the inhabitants include hardy droughts resistant species like xerophytes, cactus, euphorbia, camels, etc.
(iv) **Underground** where inhabitants include termites, burrowing mammals, and earth worms, etc.

ACTIVITY 2

Kidepo National Game Park is a protected area in north eastern part of Uganda, home to a diverse range of wild life, including lions, Zebras leopards, elephants and giraffes. The park is facing a severe drought for two months now, leading to a shortage of food and water for the animals.

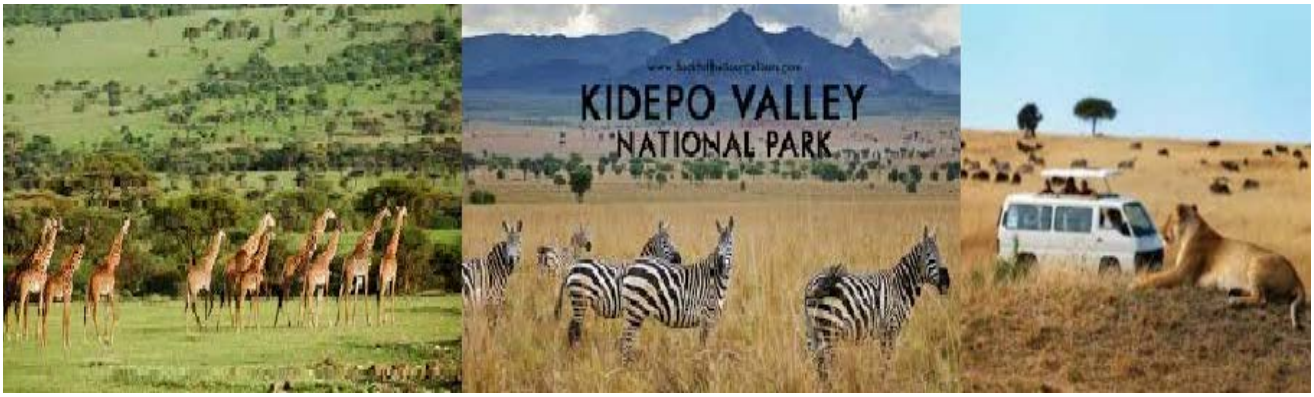


Fig 2 showing a Photo of a terrestrial habitat in kidepo national Game Park

Task

a) What is likely to happen to the Zebras' population in the game park if this condition continues for three more months?
b) How might the vegetation shown in the park change during a drought?
c) What conservation efforts could be implemented to mitigate the effects of drought on the wild life in the game park?

Environment

An organism in an environment is surrounded by different things. Therefore, the environment is divided into two;

A) Physical environment
B) Living environment

A) Physical environment also called the non-living or abiotic components

These include the following;

i) Light; intensity, duration and wave length.
ii) Temperature; air, water and soil temperature.
iii) Water (Rain fall); availability, quality and depth.
ii) Humidity; amount of atmospheric water vapor
iv) Wind and air currents; composition, pressure and movement.
iv) Topography; elevation, slope and aspects.
v) Edaphic factors;

Edaphic factors are factors associated with soil in terms of;

- Soil pH

- Soil Drainage
- Soil Water retention
- Soil Humus content
- Soil Number of living organisms
- Soil Mineral salts, etc.

B) Living Environment (Biotic components)

The living components of the ecosystem consist of producers, consumers, predators, parasites, competitors and man.

1) Producers.

These are the green plants. They fix the sun's energy into the ecosystem in form of organic compounds made by photosynthesis. All other organisms depend on producers for food.

2) Consumers.

These are organisms which depend on other organisms for food i.e. they depend on producers, therefore feed heterotrophically

Levels of consumers:

i) Primary consumers: These are organisms that feed on green plants directly i.e. herbivores e.g. grazers, grasshoppers, etc.

ii) Secondary consumers: These are organisms which feed on herbivores (i.e.carnivores) e.g. members of the cat family feed on antelopes, birds, insects.

iii) Tertiary consumers: These are organisms which feed on secondary consumers e.g. vultures on other birds.

iv) Decomposers: There organisms which feed on dead bodies of plants and animals e.g. bacteria and fungi.

Decomposers are important because they bring about decay in organisms which is essential for recycling of nutrients for reuse by the plants.

If decomposers are absent, materials would accumulate in the environment and no nutrients would be recycled.

FOOD CHAINS AND FOOD WEBS-(S4 Term 2)

(The Learner appreciates the interdependence of organisms in a given ecosystem)

In nature, organisms depend on others for food. The plants obtain energy from the sun and make their own food which will be transferred to other organisms in a feeding relationship.

FOOD CHAIN: A linear sequence of energy flow from producers through a series of organisms in which there is repeated eating and being eaten.

[Or] These are linear relationships which show how members in an ecosystem depend on each other for food.

Food chain involves the flow of energy from the sun to the producers through a series of organisms at different trophic levels.

A trophic level refers to a given feeding level of an organism in the food chain, i.e. producer, primary consumer, secondary consumer and tertiary consumer.

Types of Food Chains

Two types exist.

1) Grazing food chain
2) Detritus food chain

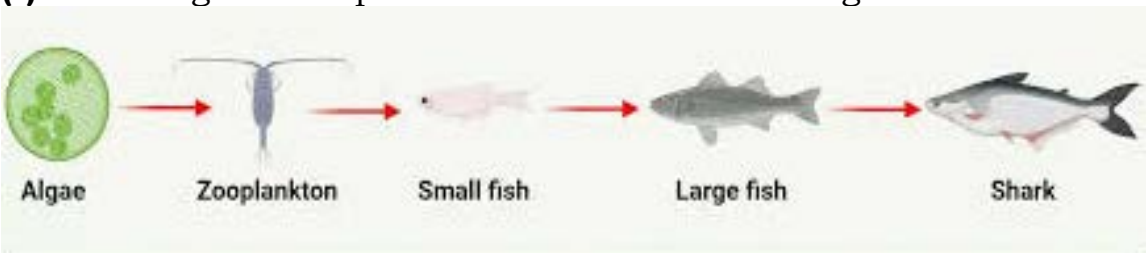
1). Grazer food chain: starts with autotrophs (producers)/green plants which convert carbon dioxide and water into chemical compounds. These are grazed upon by herbivores.

Energy is further transferred to carnivores. It can be in grass land or water body (aquatic).

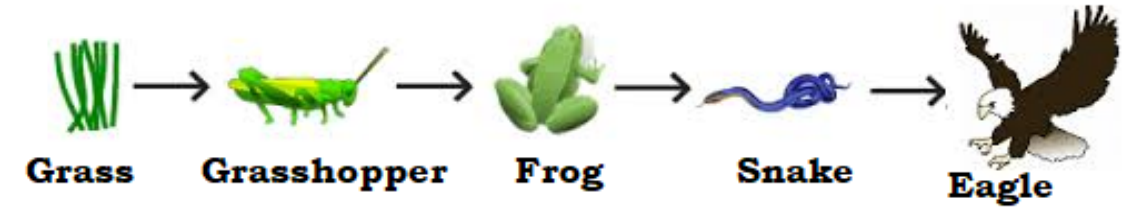
These food chains have the first trophic level occupied by either green plants, or algae and the second level by herbivore.

Examples of food chains

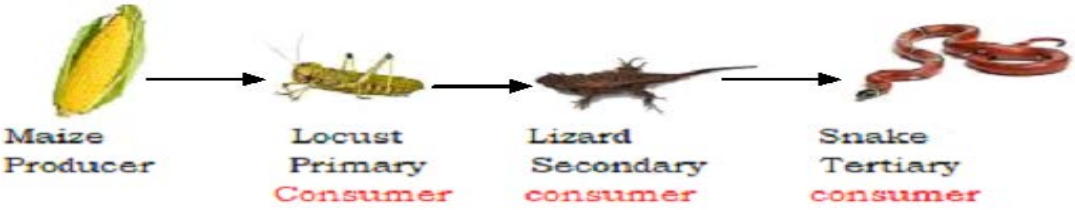
(i) Green algae →Zooplankton → small fish → Large fish → Shark



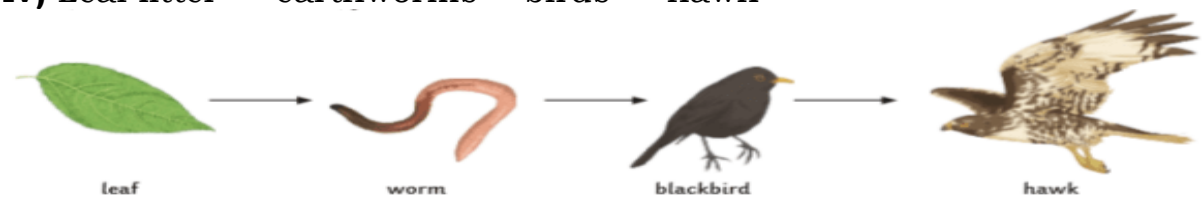
(ii) Grass → Grasshopper → toads → snake →Eagle



(iii) Grass → grasshopper →lizard→ snake→ hawk



iv) Leaf litter → earthworms→ birds → hawk



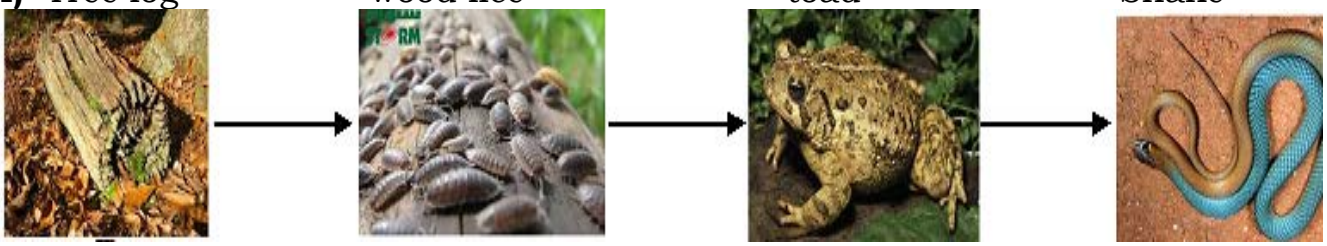
v) Leaf→ Catapillar→ Chameleon→ Snake→ Mangoose

2). Detritus food chain: is the one where the consumers obtain energy from fragments of dead decaying organic matter. This exists in both aquatic and terrestrial habiats.

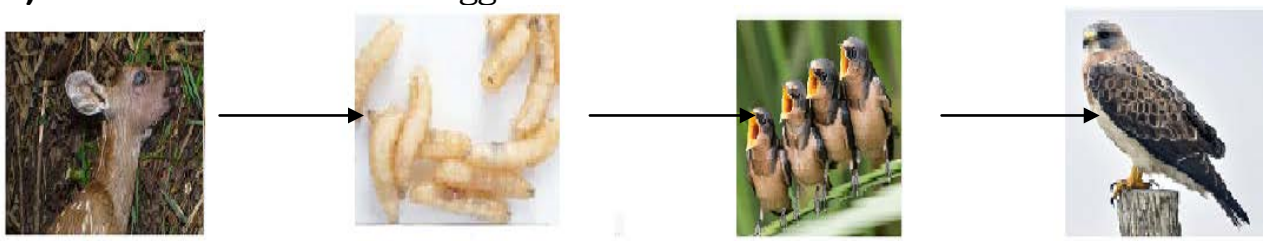
The 1st trophic level is occupied by a decomposing organic matter

Examples of Detritus food chains

i) Tree log → wood lice → toad → Snake

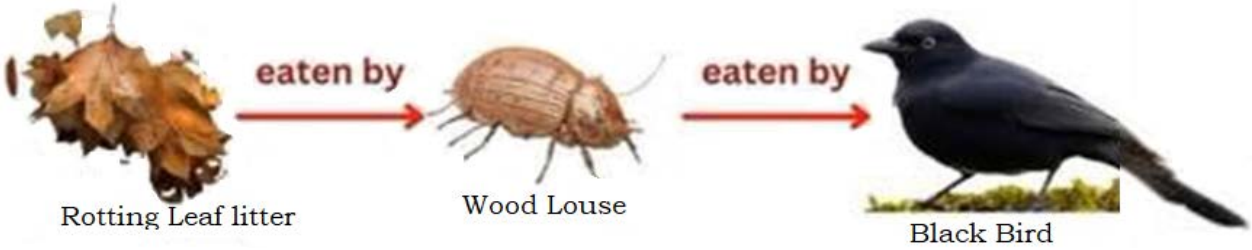


ii) Dead animal → maggots → birds → Hawk



Dead antelope → Blow worm maggots → Birds → Hawk

(iii) Rotting leaf litre → Wood louse → Black Bird



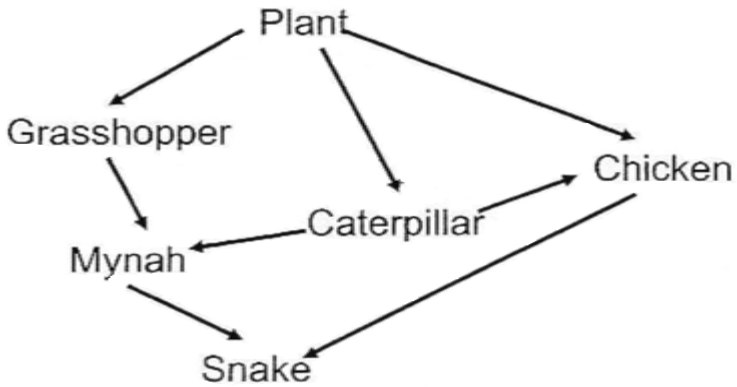
FOOD WEB:

A food Web is a complex nutritional interrelationship that illustrates alternative food sources and predator for each organism. In a food web, there are several food chains.

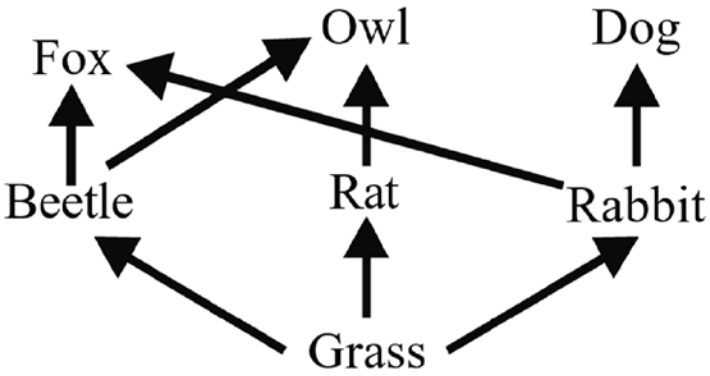
EXAMPLES OF FOOD WEBS IN GRASSLAND

a) Food Web For terrestrial ecosystem

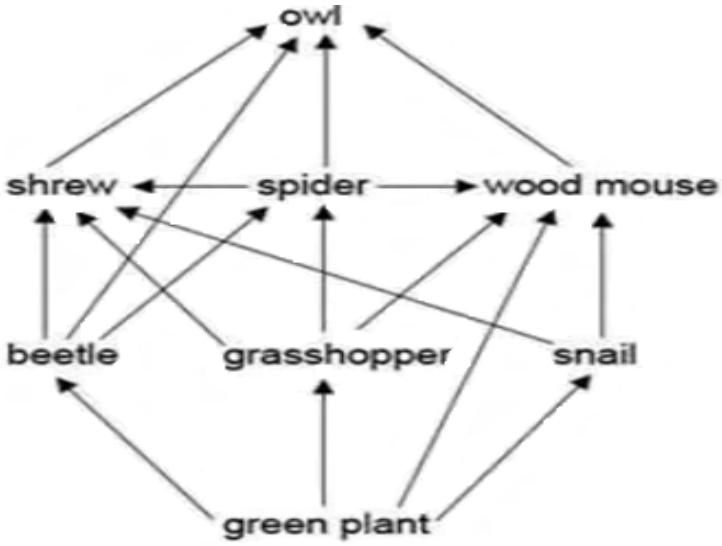
(i)



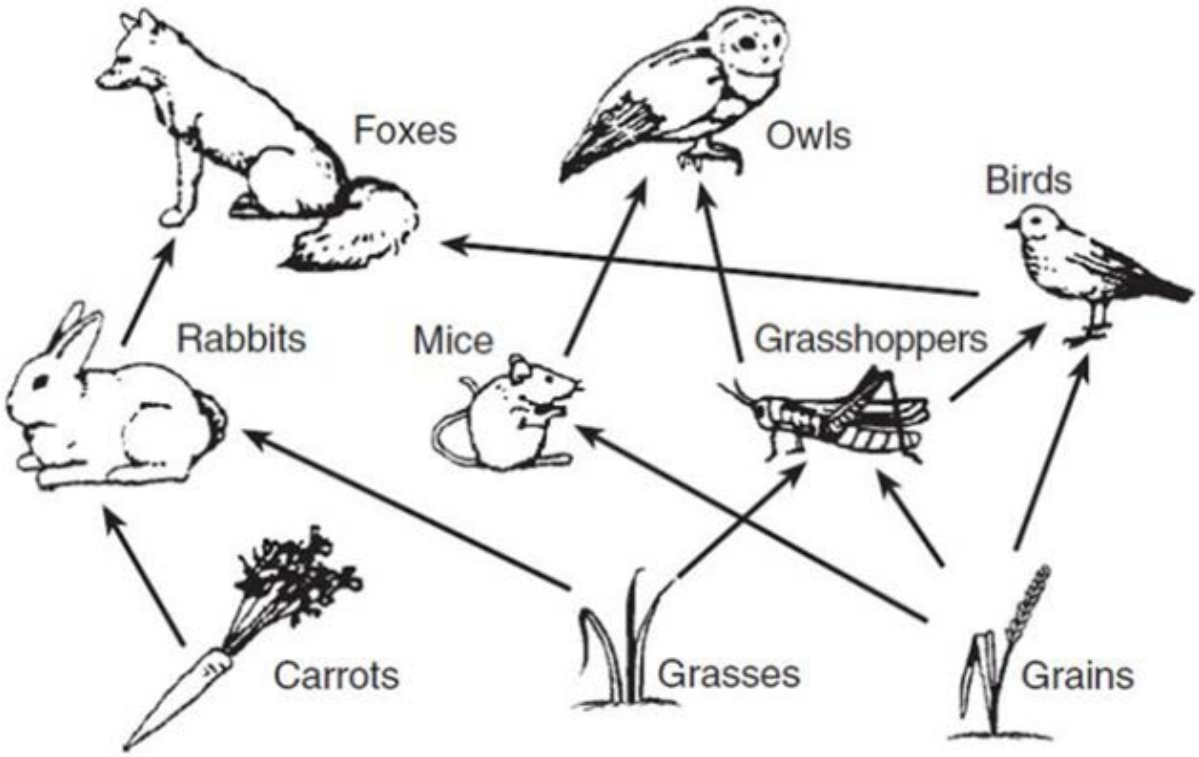
(ii)


Fox
Owl
Dog
Beetle
Rat
Rabbit
Grass

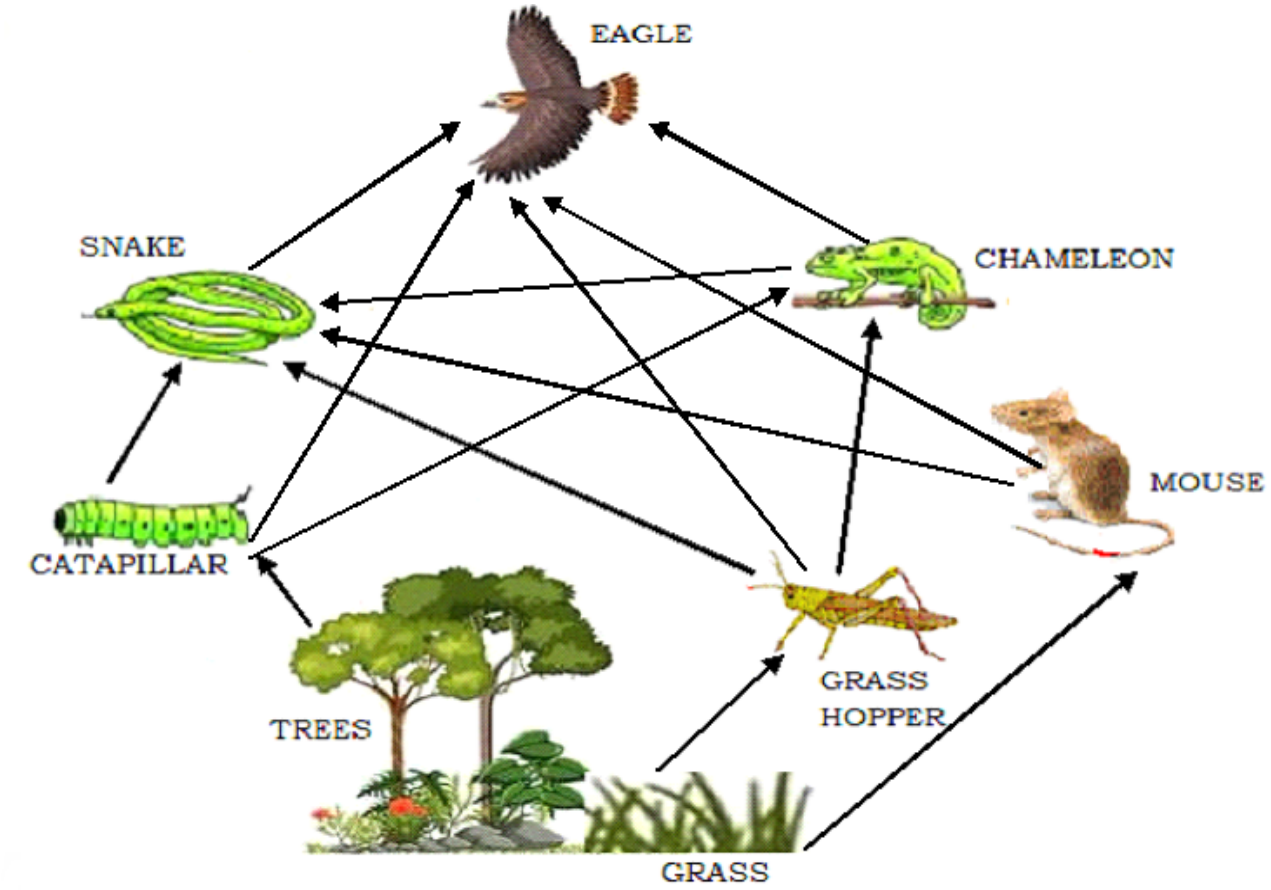
(iii)


owl
shrew
spider
wood mouse
beetle
grasshopper
snail
green plant

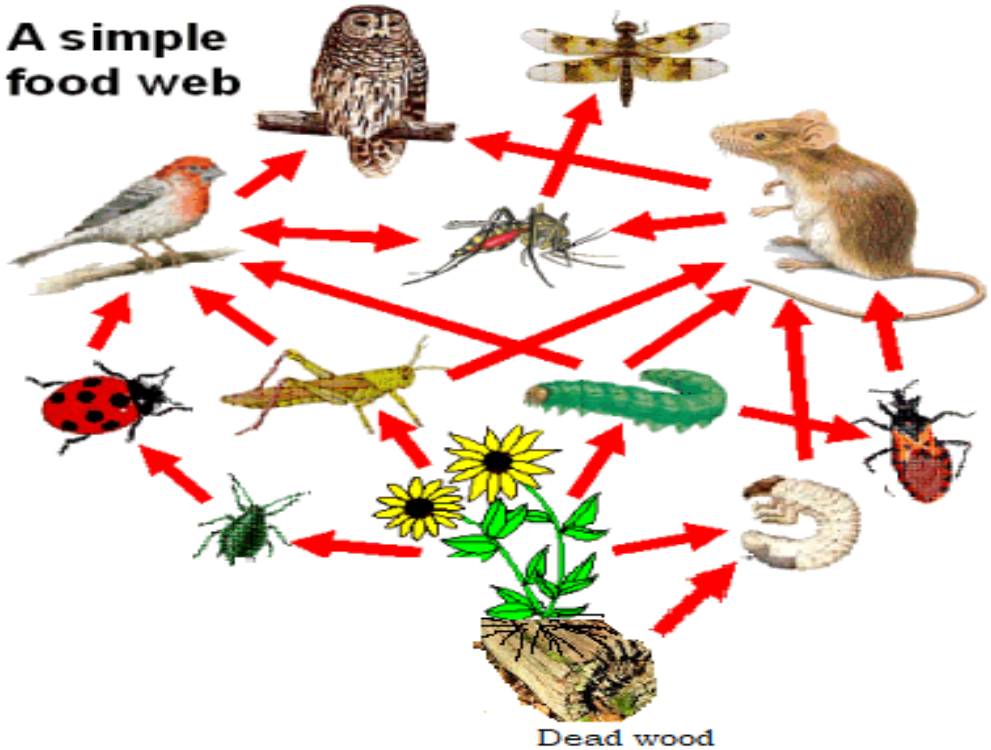
(iv)


Foxes
Owls
Birds
Rabbits
Mice
Grasshoppers
Carrots
Grasses
Grains

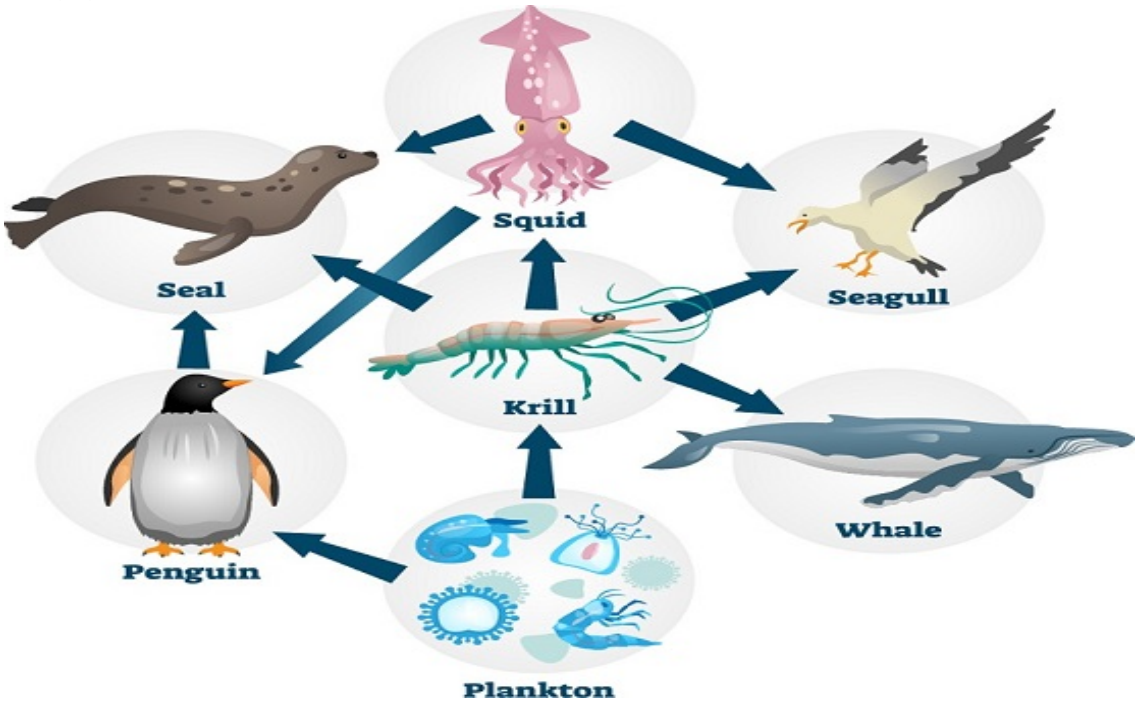
(v)



DETRITUS FOOD WEB



(d) Food web for aquatic ecosystem/Habitat



ACTIVITY 3

Julius Ngobi is a resident of Bugembe town in Jinja district near river Nile. He is a teacher of Biology in one of the Schools in Bugembe. Each time he goes to swim with his friends in the Nile river, he could observe the following organisms interacting in the water; phytoplanktons (green algae), mosquito larvae, small fish, large fish, and crocodiles. Since he could not catch most of them, one day he decided to bring a chart containing pictures of the organisms he saw in the river for his S4 ecology class.

Figure showing interactions among organisms in their habitat

Task

1 (a) As a student of biology, construct a food web and one food chain using the above organisms to explain their interactions in the river Nile:
   (i) Food web
   (ii) Food chain
   (b) Explain what will happen to the rest of the organisms if the crocodiles were removed from the habitat?

2. With reference to a named ecosystem, what is meant by the following terms?
   (i) Ecosystem
   (ii) Energy flow
   (iii) Trophic levels
   (iv) Food web
   (v) Food chain

ACTIVITY 4

A senior one student came to senior four class to collect the duster. Before he asked for permission from the biology teacher requesting for the duster, he was fascinated to see the animals and some plants which the teacher had displayed for the class in a chart. Each animal had at least an arrows pointing at each one of them! Later John asked his brother in s4 to explain to him what all that was about

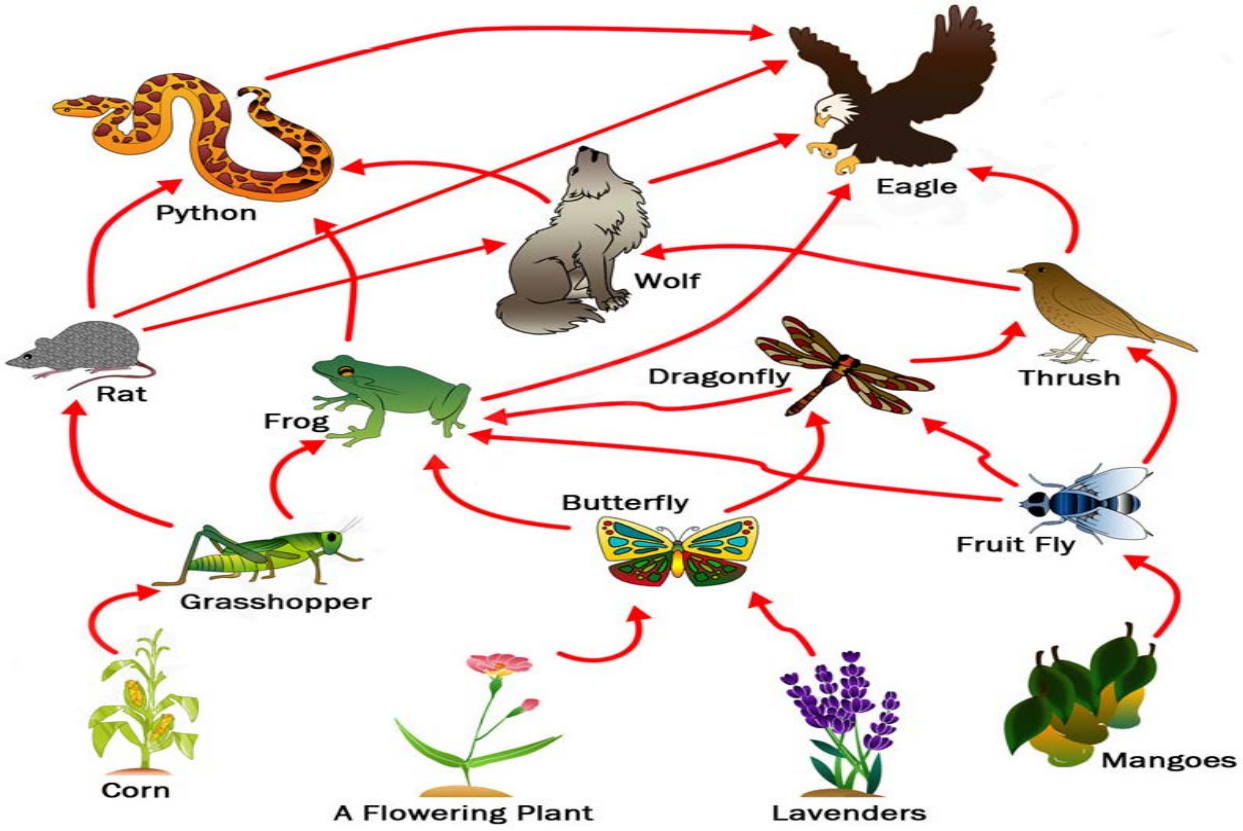


Fig showing the picture in a chart as seen by S1 student

TASK

As a S4 student of biology, help the S1 student to explain

a) What the name given to the arrangement above and from which environment was it obtained
b) Using a pen complete the remaining arrows and explain what the arrows represent
c) Identify all the trophic levels shown in the picture above
d) Construct at least any three food chains from the picture
e) What will happen to the fruit fly if the mangoes were removed in the habitat?

ECOLOGICAL PYRAMIDS

These are histograms that provide information about feeding (trophic) levels in ecosystems. An ecological pyramid therefore, is a graphical representation of food chains in an ecosystem. Examples include, (i).pyramid of numbers (ii) pyramid of biomass (iii) pyramid of energy

NB. Length of a given bar is proportional to the number, energy or biomass at a given trophic level in a given area.

An ecological pyramid is constructed from a food chain because it shows the different energy levels.

The producers are at the base then the successive trophic levels come one after another.

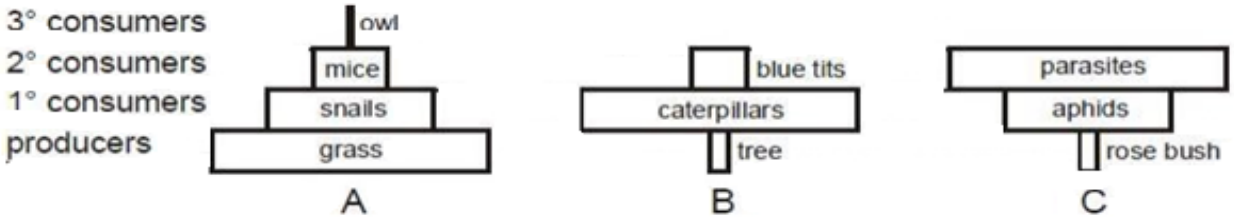
Types of ecological pyramids

i) Pyramid of numbers
ii) Pyramid of biomass
iii) Pyramid of energy

NB: Decomposers are excluded from an ecological pyramid because

(i) Pyramid of numbers.

It is a histogram representing the numbers of different organisms at each trophic level in an ecosystem at any one time.



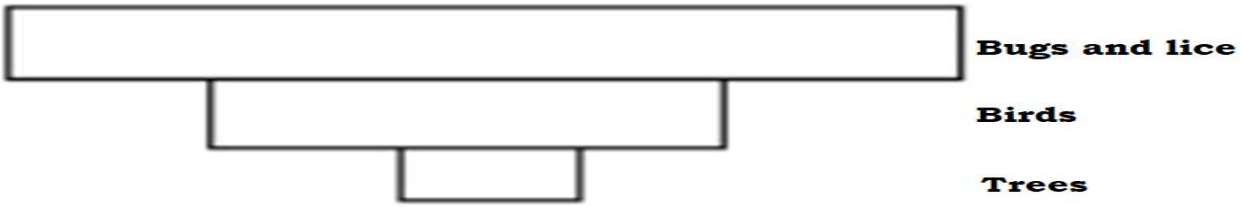
- As a pyramid is ascended, the number of organisms decreases but the size of each individual increases.
- In some cases, the consumers may be more than the producers e.g in a parasitic food chain, inverted pyramids B & C are obtained, because parasites progressively become smaller and many along a food chain.

- **Limitations of pyramid of number**
- Drawing the pyramid accurately to scale may be difficult e.g where there a million plants.
- Pyramids may be inverted
- The trophic level of an organism may be difficult to ascertain.
- The young forms of species may have a different diet from adults.

NB: It must be noted that most ecological pyramids of numbers are always upright. However, in some cases, they may be inverted as shown below

a) Where a cabbage plant is supporting a large number of aphids; which also support a few ants; which in turn support a few birds

b) Where a single tree supports a number of herbivorous birds which in turn support numerous parasites e.g. bugs and lice



NB: Pyramids of Biomass and energy were excluded in CBC

(ii) pyramid of biomass;

This is a histogram showing the total dry mass of organisms present at each feeding level, or it is a diagrammatic representation of the biomass of organisms at each trophic level at a particular time.

Biomass is the weight of the living matter in the organism measured by either living weight or dry mass

NB: The biomass increases at each successive trophic level.

Example of Pyramid of and biomass

Advantages of Pyramid of Biomas

- Reduces the possibility of forming inverted pyramids because its construction depends on biomass of organisms

NB: Inverted pyramid of biomass is typical of an aquatic ecosystem, because diatoms (phytoplankton) have a lower biomass but with higher productive rate (caused by so rapid turnover rate), therefore capable of supporting a larger biomass of zooplanktons.

Disadvantages/limitations of pyramid of biomass

- Does not allow for changes in biomass at different times of the year e,g deciduous trees have larger biomass in summer than in winter when they shed off leaves.
- Does not take into account rate at which biomass accumulates e.g a mature tree has a large biomass which increases over many years.
- Impossible to measure exactly biomass of the organisms in an ecosystem, because the sample used may not true representation of the whole population.
- Results may not be accurate, e.g where killing is not allowed, the results are obtained by estimating the fresh mass

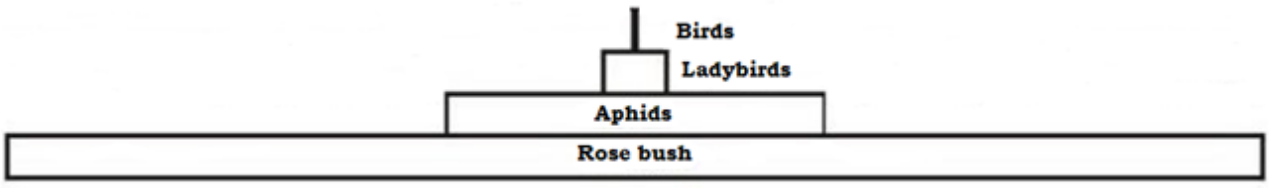
(ii) Pyramid of Energy

This is a histogram showing the total amount of energy present at each feeding level. It is the best way of representing relationships and ecological productivity between organisms in different trophic levels.

- This is because only a proportion of energy is in a trophic level is transferred to the next, energy pyramids are never inverted nor do they have a central bulge.
- More informative than pyramids of numbers and biomass because it shows the amount of energy required to support each trophic level.
- Energy values may be expressed variously as kJ/m2/yr1 or kCal/m2/yr1.
- Explains why the earth can support more people if they eat at lower trophic level (by consuming grains, vegetables and fruits directly rather than passing such crops through another trophic level and eating grain eaters.

At each trophic level, the energy is lost as heat during;
(i) Respiration (ii) Egestion (iii) Death (iv) Decomposition
NB: The energy decreases as it is transferred from one trophic level to another. Therefore, the pyramid of energy is always upright as below

PYRAMID OF ENERGY IN A TERRESTRIAL ECOSYSTEM

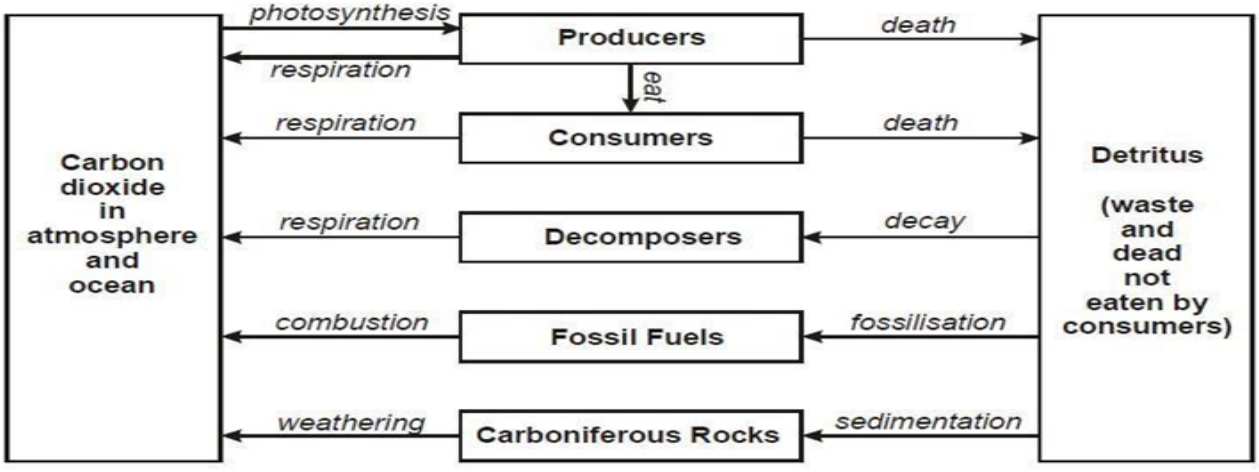


CYCLING OF MATERIALS

Carbon cycle describes the process in which carbon atoms continually travel from the atmosphere to the earth (into living and non-living organisms) and then back into atmosphere.
The carbon cycle is a bio chemical cycle by which carbon is exchanged among the biosphere.
The availability of carbon in the environment is a crucial factor in the maintenance of plant and animal life.

- Based on carbon dioxide gas, making up 0.036% of the volume of the troposphere and is also dissolved in water.
- Carbon fixation involves the reduction of carbon dioxide to large organic molecules during photosynthesis and chemosynthesis.
- During aerobic respiration by all organisms, carbon dioxide is returned to the atmosphere or dissolves in water.
- Over millions of years, buried deposits of dead plant debris and bacteria are compressed between layers of sediment to form the carbon-containing fossil fuels e.g. coal, oil and natural gas, which when burnt release carbon dioxide into air.
- In aquatic ecosystems, carbon dioxide may (i) remain dissolved (ii) be utilized in photosynthesis (iii) react with water to form carbonate ions and bicarbonate ions. As water warms, more dissolved carbon dioxide returns to the atmosphere.
- In marine ecosystems, some organisms take up dissolved carbon dioxide molecules, carbonate ions and bicarbonate ions and these ions react with calcium ions to form calcium carbonate ($CaCO_3$) to build their shells and skeletons.
- When the animals with calcium in shells and skeletons die and drift into deep bottom sediments of oceans, immense pressure causes limestone and chalk to form after a very long period of time.
- Weathering processes release a small percentage of carbon dioxide from limestone into the atmosphere.

THE CARBON CYCLE IN SUMMARY



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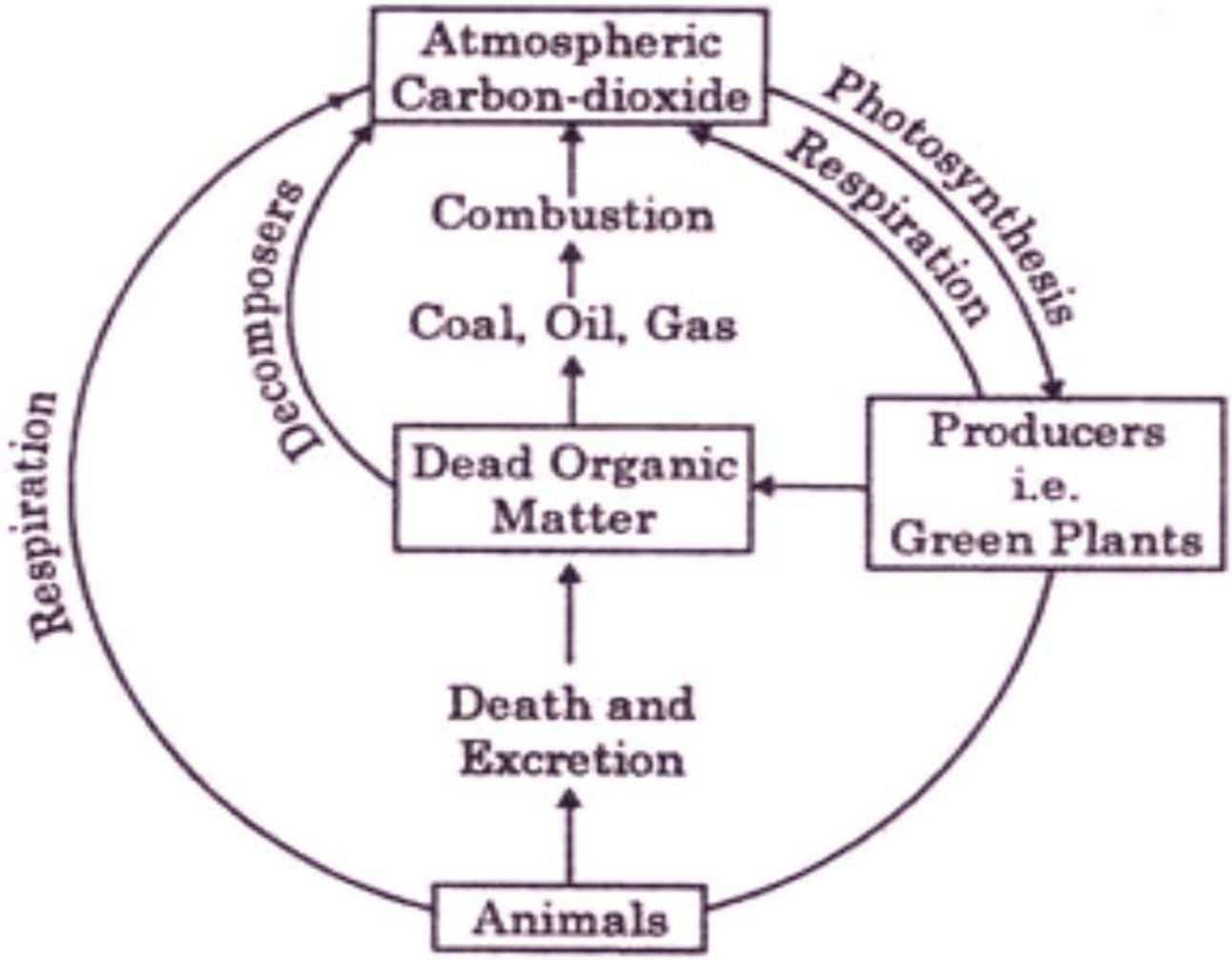


How human activities affect the carbon cycle

i) Cutting down trees and other plants that absorb CO2 through photosynthesis increases carbon dioxide in the atmosphere.

ii) Burning of fossil fuels like coal, petroleum oil and wood adds large amounts of CO2 into the troposphere.

iii) industrial processes such as cement production release CO_2 through lime stone calcination and steel manufacturing also uses fossil fuels and releases carbon dioxide

iv) Agricultural practices including synthetic fertilizer use, leads to soil degradation and CO_2 release.

MITIGATIONS

(i) Use reneable energy resource

(ii) Sustainable land use practices

(ii) tap the solar energy instead of burnig fossils and plant more trees

Key stages involved in the carbon cycle

1. Carbon enters the atmosphere as carbon dioxide
2. Carbon dioxide is absorbed by autotrophs such as green plants.
3. Animals consume plants, thereby, incorporating carbon into their system.
4. Animals and plants die, their bodies decompose and carbon is reabsorbed back into the atmosphere.

OR Burning of carbon containing substances also adds carbon into the atmosphere.

Organisms and processes involved in the carbon cycle and their roles

Plants: These absorb carbon 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.

Micro-organisms: (e.g. fungi and bacteria)

These return carbon to the environment when they decompose dead plants and animals.

Carbon in inedible parts of plants can be released back into the atmosphere through: Decomposers break down the inedible parts of dead plants, thus returning the carbon in their bodies to the atmosphere as carbon dioxide by respiration.

The plant and animal materials may then be available as fossil fuels for combustion in the future.

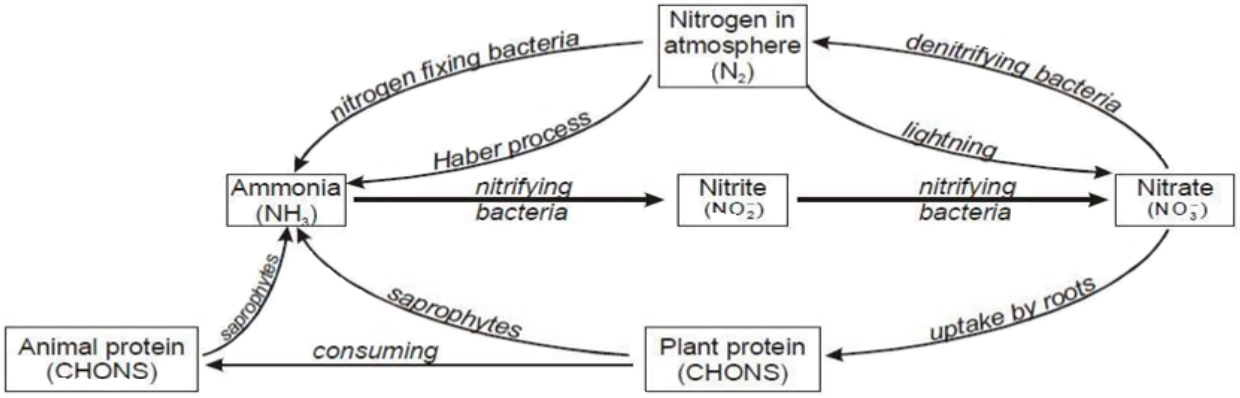
In summary, processes involved include: photosynthesis, respiration, decomposition and combustion.

(b) NITROGEN CYCLE

- Nitrogen is the atmosphere's most abundant element, with chemically unreactive nitrogen gas making up to 78% of the volume of the troposphere. However, N2 cannot be absorbed and metabolized directly by multicellular plants and animals.
- Atmospheric electrical discharges in the form of lightning causes nitrogen and oxygen in the atmosphere to react and produce oxides of nitrogen, which dissolve in rainwater and fall to the ground as weakly acidic solutions .
- Nitrogen fixation occurs when the nitrogen in soil is reduced to ammonium ions, catalysed by (i) nitrogen-fixing bacteria which may be free-living e.g. Azotobacter and Clostridium; symbiotic bacteria in root nodules e.g. Rhizobium or blue- green algae e.g. Nostoc.

- Nitrification occurs when ammonium compounds in soil are converted first to nitrite ions (highly toxic to plants) by Nitrosomonas bacteria and later to nitrate ions by Nitrobacter bacteria.
- Ammonification (putrefaction) occurs when decomposers e.g. saprophytic bacteria and fungi convert nitrogen-rich organic compounds, wastes like urea and dead bodies of organisms into ammonia and ammonium ion-containing salts.
- Assimilation occurs when inorganic ammonia, ammonium and nitrate ions are absorbed by plant roots to make nucleic acids, amino acids and protein.
- Denitrification occurs when mostly anaerobic bacteria e.g. Pseudomonas denitrificans and Thiobacillus denitrificans in water logged soil and deep in ocean, lake and swamp bottoms convert ammonia and ammonium ions back into nitrite and nitrate ions, and then into nitrogen gas and oxygen. Nitrogen gas is released into the atmosphere while oxygen is used for the respiration of these bacteria.

THE NITROGEN CYCLE IN NATURE



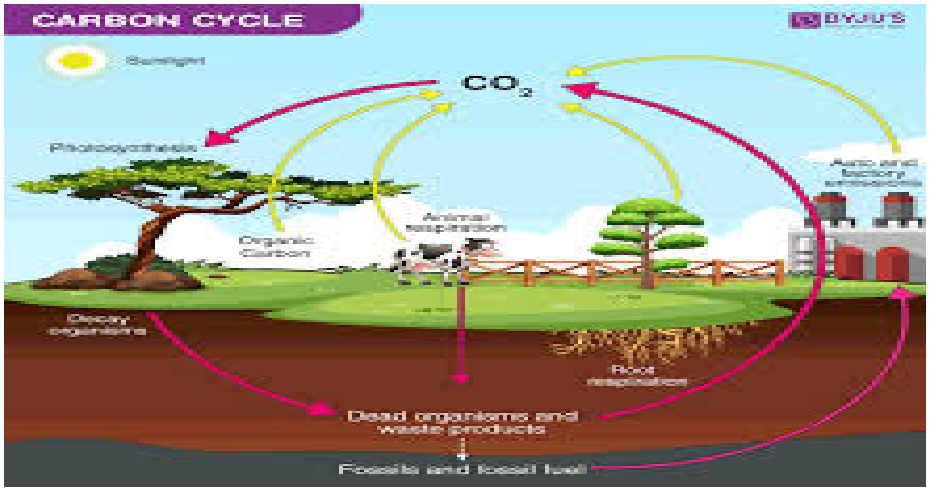
How human activities affect the nitrogen cycle

1. Burning of fuels forms nitric oxide, which reacts with atmospheric oxygen to form nitrogen dioxide gas that reacts with water vapour to form acid rain containing nitric acid. Nitric acid together with other air pollutants (i) damages trees (ii) corrodes metals (iii) upsets aquatic ecosystems.
2. The inorganic fertilizers applied to soil are acted upon by anaerobic bacteria to release nitrous oxide into the stratosphere, where it (i) contributes to ozone depletion (ii) contributes to greenhouse effect.
3. Nitrogen is removed from top soil when we (i) harvest nitrogen-rich crops (ii) irrigate crops (iii) burn or clear grasslands and forests before planting crops
4. Adding nitrogen compounds to aquatic ecosystems e.g. sewage algal blooming, which upon death, their decomposition causes oxygen shortage resulting into death of aerobic organisms e.g. some fish.

5. The accelerated deposition of acidic nitrogen containing compounds e.g. NO2 and HNO3 onto terrestrial ecosystems stimulates growth of weeds, which outcompsete other plants that cannot take up nitrogen as efficiently.

ACTIVITY 5

A senior one Art class was tasked by their teacher to create a piece of an artistic painting to be used for sensitizing the community on the importance of the natural environment to all living organisms and use it to explain the circulation of carbon in nature. John painted his plan as shown below



Task

a) As a student of biology use John's painting to explain clearly to the public how carbon is circulated in nature.

(b) With diagrammatic illustrations describe the flow of energy and the cycling of nitrogen in any named ecosystem.

(c) Suggest reasons why felling and removal of forest trees result in changes in the levels of nutrients in the soil.

(c) WATER CYCLE/ HYDROLOGICAL CYCLE

This is powered by energy from the sun and by gravity, and it involves;

(i) evaporation(conversion of water into water vapour)

(ii) Transpiration (evaporation from leaves of the water extracted from soil by roots and transported throughout the plant)

(iii) Condensation (conversion of water vapour into droplets of liquid water)

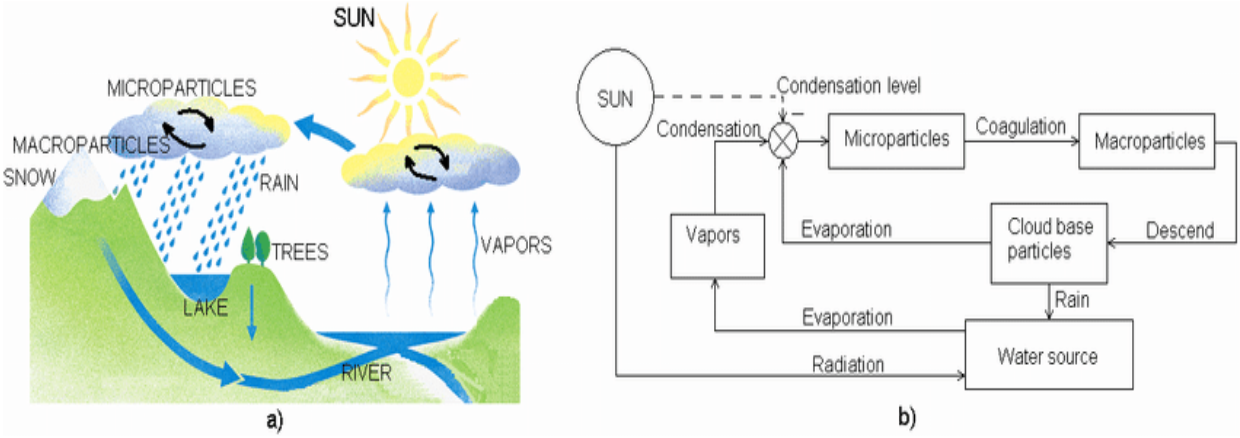
(iv) Precipitation (rain, hail, snow and sleet/freezing rain)

(v) Infiltration (movement of water into soil)

(vi) Percolation (downward flow of water through soil and permeable rocks to ground storage areas called aquifers)

(vii) Runoff (down slope surface movement back to the sea to resume the cycle)

THE NATURAL WATER CYCLE



ASSOCIATIONS IN BIOLOGICAL COMMUNITIES-(S4 Term 3)

(The learner appreciates that organisms naturally interact in different ways with one another in a given habitat

In nature, organisms tend to relate in their ecosystems. This leads to competition or association.

Competition is a relationship whereby two individuals of the same species or different species struggle to obtain resources which are in limited supply. For example; plants competing for light, carbon dioxide, water, mineral salts, pollinators, and sites for spores and seeds to germinate; while animals compete for food, mates, breeding sites and shelter from predators

Competition is simply an interaction between organisms or species in which both (organisms or species) require a resource that is in limited supply, hence, organisms compete for it. Such resources usually include: food, water, shelter and mates

Types of feeding associations

They are mainly two, namely;

1) Intraspecific associations/competition
2) Interspecific associations/competition

1) Intraspecific associations/Competition

This is the association or competition between members of the same species for the same resources.

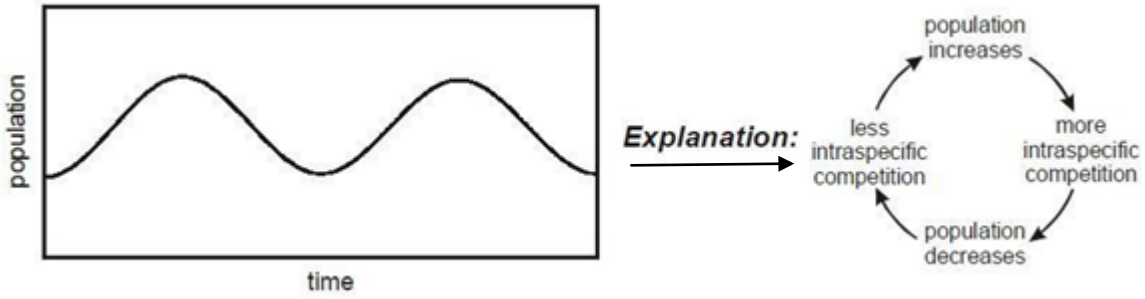
Examples include;

i) Social insects (termites, bees, etc.)
ii) Territoriality e.g. in Uganda Kob where males defend others in the territory

How intraspecific associations maintains populations

- Intraspecific competition tends to have a stabilising influence on population size.
- If the population gets too big, intraspecific population increases, so the population falls again.
- If the population gets too small, intraspecific population decreases, so the population increases again

Graphical Illustration



Intraspecific competition in the animals for the same prey /food

Figure showing competition in the animal kingdom for the same resource

2) Interspecific Association/Competition

These are the associations or competition between members of two or more different species for food, space, good hiding place, water, sunlight, nesting sites or any other limited resource.

OR: These are associations or competition among organisms of different species for the same limited resource and they include;

i) Predation.
ii) Symbiosis

Competition is very intense when there is significant overlap of niches, and in this case one of the competing species must;

(i) Migrate to another area if possible

(ii) Shift its feeding habits or behavior through natural selection and evolution

(iii) Suffer a sharp population decline or

(iv) Become extinct in that area, otherwise two species can never occupy exactly the same ecological niche.

ILLUSTRATION OF INTERSPECIFIC COMPETITION AMONG DIFFERENT ANIMALS

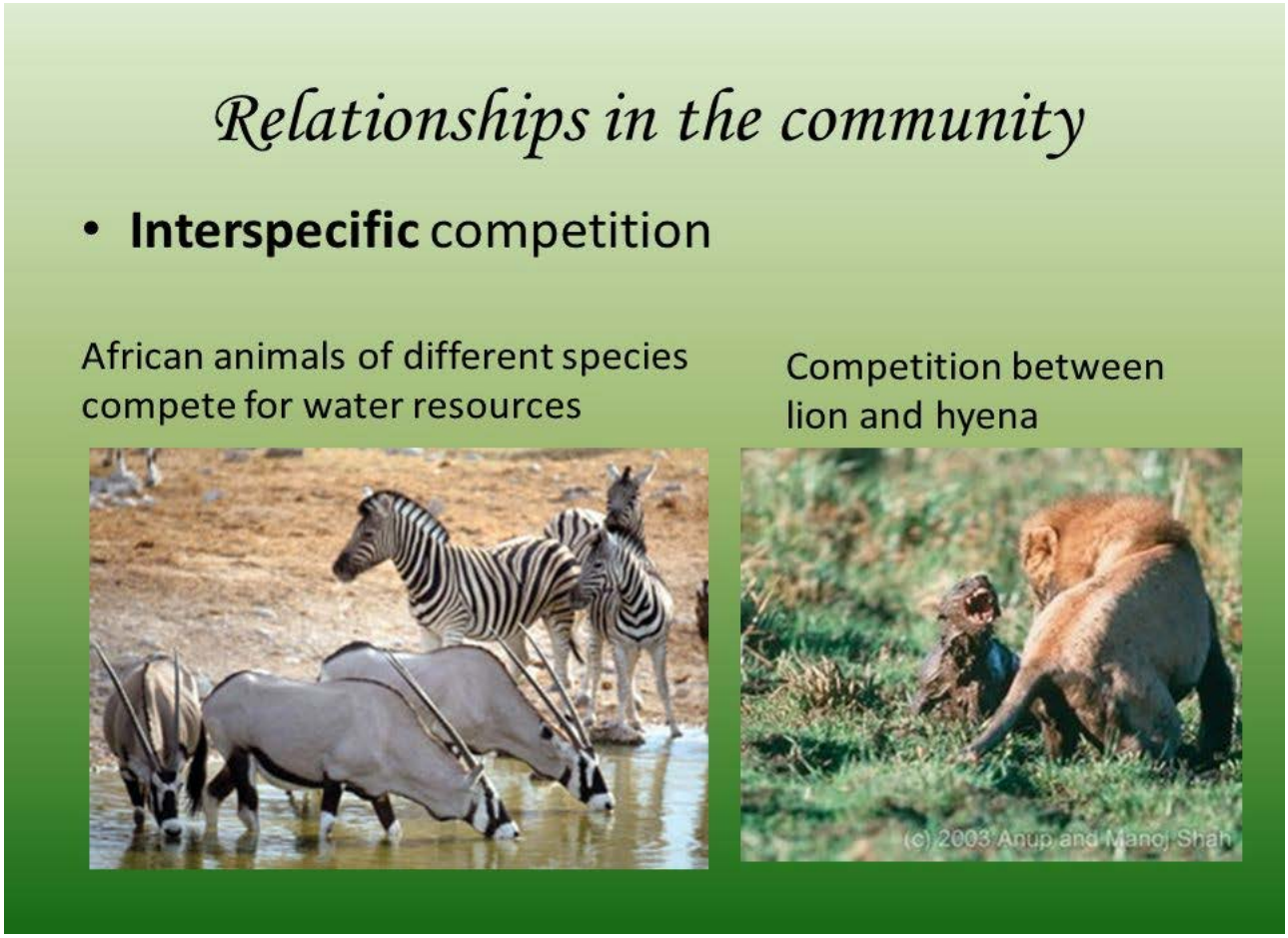


Figure shows interspecific competition among the different animals for the same resource

Biological significance of competition to organisms

Competition plays a very important role in ecology and evolution as follows;

1. Competition leads to the evolution of better adaptations within a species. The best competitors are the ones who survive and get to pass on their genes. Hence, their offspring will have an increased chance of survival because their parents out-competed their conspecifics.
2. Competition leads to species diversity. In a short run, competition cause a reduction in the number of species living within an area, preventing very similar species from co-occurring.

1. Predation

This is a relationship whereby members of one species ***(the predator)*** feed on all or part of a living organism of another species ***(the prey).***
Therefore, predators are only found where there is prey e.g. herbivores are found where there is suitable plant material.
A **predator** is an animal that feeds on another live organism.
A **prey** is the live organism that is fed on by the predator

ACTIVITY 6

An American tourist visited Murchison Falls Game Park in northwestern part of Uganda in Masindi District. While there he took several pictures of different animals associated with feeding relationships. When he returned to Kampala, he decided to print four photos labeled A, B, C and D on a large paper. The next day he visited Mengo SS and while interacting with S3 students he showed them the photo and tasked them to explain the ecological relationship.

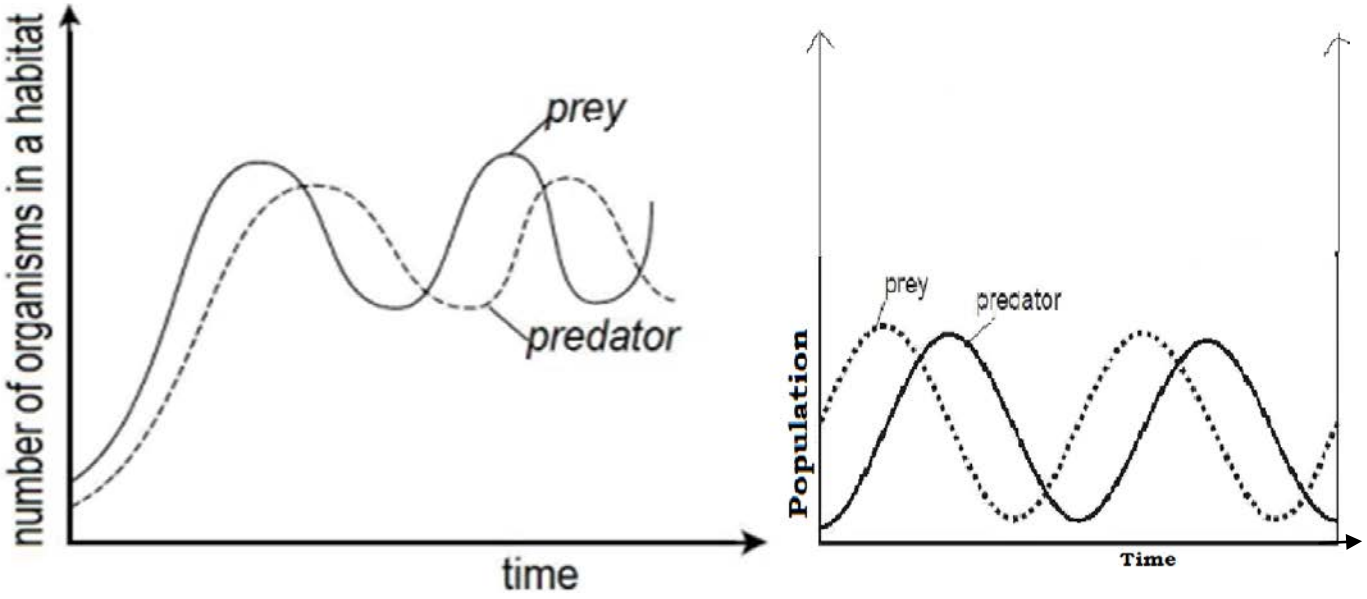
Figure showing Pictures of different animals in a game park associated with feeding relationships

TASK

As a biology student who has studied ecology, help the S2 students understand the feeding relationships by;

a) (i) Identifying the ecological relationship shown above
   (ii) List the names of all the animals in the photograph A, B, C and D
b) (i) With evidence from the above figure, name two habitats shown
(c) State with examples the adaptations of the organisms belonging to the habitat you mentioned in (b) above to their survival as;
   (i) Survival as prey
   (ii) Survival as predator

The Graphs below showing the predator –prey relationship



Description of the changes in population numbers:

-Initially, the population of the prey is higher than the population of the predator;✓

-Within a short time, both populations of prey and predator increase rapidly;✓but the population of the prey reaches a maximum earlier than the predator.;✓

-As the prey population decreases rapidly,; the predator population continues to increase gradually; for a short time then attains a maximum;✓then also decreases rapidly.;✓ 07scores

- As the predator population continues to decrease,✓ the prey population starts to increase rapidly;✓ followed by a rapid increase in predator population; the cycle is repeated.

Explanation for the observed changes in populations:

At the beginning, there are more prey than predator to provide food to the predators.

When the predator population is low, they get enough food and few preys are eaten so they both increase rapidly. The large number of preys provides food to predators, so the predators reproduce fast and increase in numbers.

The increased predator population eats many preys and the prey population crashes.

The decrease in prey numbers causes the predators to starve and even their reproduction reduces, so the predator numbers crash. Finally, the very low number of predators allows the prey population to recover, causing the cycle to start again.

How predators are suited for capturing prey

- They have keen eyes for locating prey e.g. wolves, African lions hunt in groups.
- Praying mantis, chameleon have cryptic coloration/camouflage that enable them to walk to prey unnoticed.
- Nocturnal predators e.g. bats have highly developed sense for detecting sound made by prey.
- Some snakes which have glands to secrete poison (venom) which the fangs inject into prey to immobilize it (prey).
- Web-spinning spiders use their silky cob webs to catch small sized ground walking or flying insects.
- Some have soft pads at the bottom of their feet so that they are not easily detected as they walk towards prey
- Some have stinging cells which paralyze their prey e.g. sea anemones
- Have long and sharp canines which pierce and kill prey
- Well-developed limbs which increase the speed of locomotion to chase and capture prey

Significance of Predation

(a) Determines distribution and abundance of the prey because:
- An increase in the number of predators results into decrease in the number of prey.
- Predators will always be found in places of their potential prey.

(b) Predation leads to dispersal of animals which reduces competition since it involves movement of animals from place to place.

(c) Predation is a biological control method.

How prey species are suited to avoid predation

- Ability to run, swim or fly faster.
- Possession of highly developed sense of sight or smell alerting the presence of predators.
- Possession of protective shells e.g. in tortoise and snails for rolling into armor-plated ball.
- Possession of spines like in porcupines or thorns (cacti and rose-bushes) for pricking predators.
- In some lizards tails break off when attacked, giving the animal enough time to escape.
- Other preys gain some protection by living in large groups e.g. schools of fish, herd of antelope, flocks of birds.
- Some prey scare predators by puffing up e.g. blowfish or spreading wings e.g. peacock.
- The flesh of some slow-moving fish is poisonous e.g. porcupine fish.
- Some preys secrete poisonous or repellant substances e.g. scorpions, caterpillars, some grasshoppers and Culex mosquito eggs

- The electric fish Malapterurus (a cat fish) produces high voltage discharge that shocks any predator that makes contact with it.
- Other prey employ alarm signals and calls e.g. ants, various fish, small birds and mammals.
- Group defense occurring among those that live and feed in herds like the Buffalos.
- Some prey species discourage predators by secreting chemicals that are poisonous (e.g. oleander plants), irritating (e.g. bombardier beetles), foul smelling (e.g. stinkbugs and skunk cabbages) or bad tasting (e.g. monarch butterflies and buttercups).
- Some species gain protection to avoid predation by mimicking (looking and acting like) other species that are distasteful to the predator.

2. Symbiosis

Symbiosis (from Greek, sumbíōsis, "living together", from sún, "together", and bíōsis,"living") is any type of a close and long-term biological interaction between two different biological organisms, be it mutualistic, commensalistic, or parasitic.

The organisms, each termed as symphonists, may be of the same or of different species.

Symbiosis can be obligatory; which means that one or more of the symbionts entirely depend on each other for survival, or facultative (optional); when they can generally live independently.

When one organism lives on the surface of another, such as head lice on humans, it is called ectosymbiosis; when one partner lives inside the tissues of another, such as Symbiodinium within coral, it is termed endosymbiosis.

The different Forms of symbiotic relationships

i) Commensalism: This is an association between organisms of different species in which one benefits while the other neither benefits nor harmed. E.g. Buffalo and white egrets, epiphytes and host plant, etc.

The Orchids on a tree, Epiphytes and host plant

The Buffalo with white Egrets

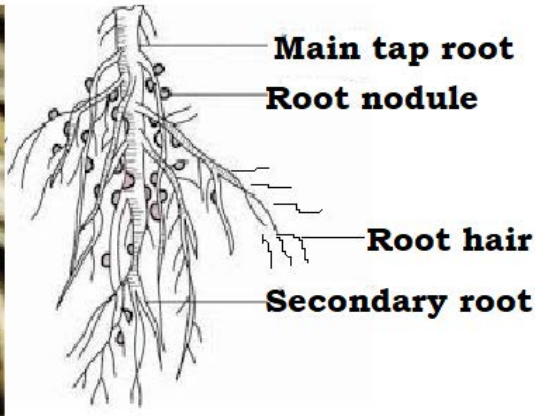
ii) Mutualism:

This is an interspecific association in which both organisms benefit.

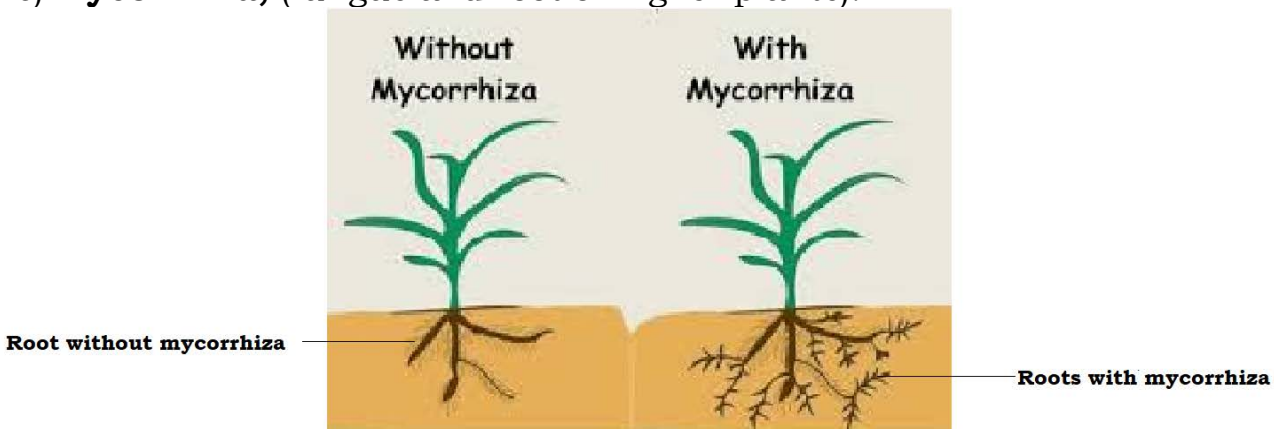
Examples of mutualism include the following

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

b) **Leguminous plants;** e.g. clover and nitrogen fixing bacteria (rhizobium) in the root nodules. The plants obtain nitrates while bacteria obtain shelter, sugars and vitamins.



c) **Mycorrhiza;** (fungus and root of higher plants).

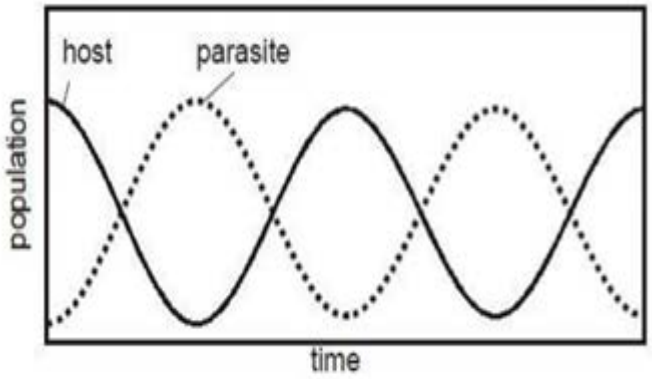


d) **Lichens;** algae and fungus. Algae carries out photosynthesis providing nutrients to the fungus while the algae is protected by the fungi from intense sunlight and desiccation, minerals absorbed by the fungus are also passed onto the algae.

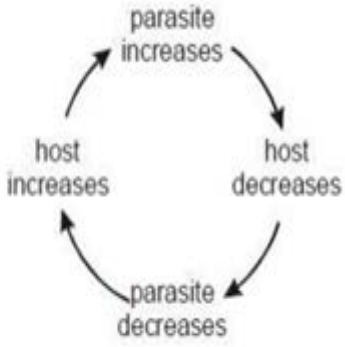
Below is a mutualistic association between Algae and Fungus

iii) Parasitism

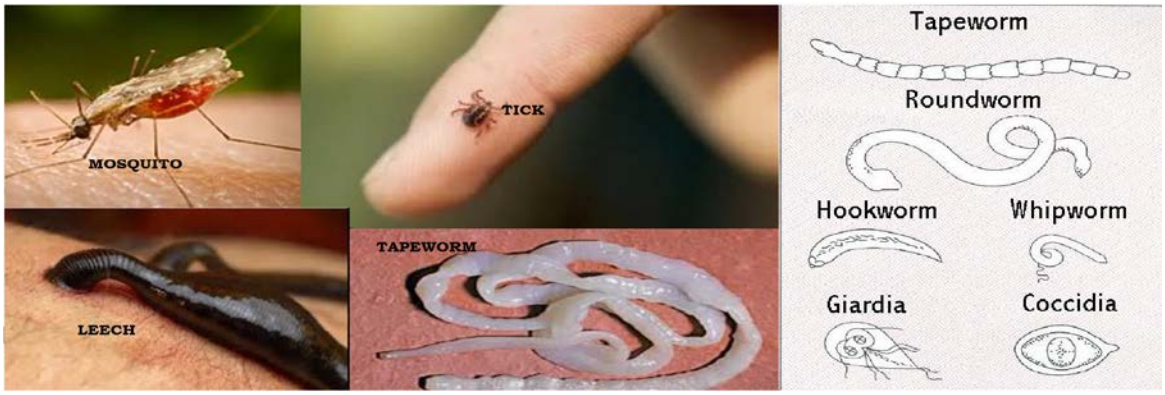
An organism called parasite obtains part or all its nutrients from the body of another organism of different species called host and causes harm.
The parasite is usually smaller than its host in size.
Parasites do not usually kill their hosts, but the host suffers harm.
Many parasites live permanently on (**Ectoparasites**) or in their hosts (**Endo parasites**) while some visit their hosts only to feed.
Some parasites are **facultative**, live on or in the host for some time e.g. Pythium (a fungus) that causes damping of seedlings, on killing the seedlings, lives as a saprophyte on their dead remains and others are obligate (live on or in the host for their entire lives. The graph below illustrates the relationship between the host and the parasite



Explanation:



SOME COMMON EXAMPLES OF PARASITES



Characteristics of parasitism

1. The parasite and the host are of different species
2. Parasites are usually smaller than their hosts
3. The host suffers harm from the association
4. The parasite gains both nourishment and protection from the host

Feeding methods of parasites

i) Sucking:

- This is employed by parasites that depend on body fluids like blood and tissue fluid.
- They include ticks, lice, tape worms, etc.

ii) Absorption:

- These feed on nutrients from digested food
- Absorption occurs over the body surface of parasites
- They include ascaris, liver flukes, etc.

Adaptations of parasites for their life

For a parasite to be successful in its way of life, it needs adaptations to overcome challenges;

Challenge	Nature of parasite	Adaptation
Finding/ reaching the host	Endo and ectoparasites	• Use of vectors to find and reach the host • Occupying strategic places where they can be picked up by vectors or hosts e.g. in food
Attaching on to the host	Ecto and endoparasites	• The ecto parasites have claws and teeth for attachment • The endo parasites have suckers and hooks for attaching inside organs
Entering the host	Endoparasites	• Piercing organs and cutting plates such as in hook worms
Protection from the host	Endo and ecto parasites	• Camouflage through resembling the body color of the host by ecto parasites • Production of mucus to protect themselves against digestion by enzymes secreted by host in endoparasites
Reproduction	Endo and ecto parasites	• Most have short life cycles • Produce very many offspring • Use of both sexual and asexual reproduction by some parasites
Surviving adverse conditions	Endo and ecto parasites	• Most are able to suspend development for some time when the conditions are not favorable e.g. bladder worms in taenia, cysts in bacteria and protozoans.

Examples of parasites (research adaptations of each to its mode of life)

i) Tape worm(Taenia spp)

ii) Plasmodium

iii) Schistosoma (the blood fluke)

iv) The tick:

Summary of adaptations of parasites

- Some parasites have hooks for attachment to the host e.g. the tape worm.
- Some have suckers for attachment to the host e.g. the blood fluke and the tape worm.
- Some ectoparasites have claws for attachment to the host e.g. the tick
- Some ectoparasites like the tick have body color resembling that of the host for camouflage
- Some parasites secrete mucus to protect them against digestion by the host's enzymes.
- Some parasites secrete substances to neutralize the hosts
- Some parasites have dorsal ventrally flattened bodies in order to reduce the distance across which materials diffuse.
- Some parasites have body surfaces that are permeable to nutrients.
- Some have long, folded bodies to increase surface area for diffusion of nutrients.
- Some parasites have more than one host to increase chances of survival
- Some produce many young ones thus increasing their chances of survival.
- Many are able to suspend development for some time when conditions are not favorable e.g. as bladder worms in tape worm.
- Some parasites are hermaphroditic and can carry out self-fertilization.
- Some are adapted to live in conditions of low oxygen supply e.g. the tape worm.
- Some blood feeding parasites like the mosquito can produce anti-coagulants.

HUMANS AND THE NATURAL ENVIRONMENT-(S4 TERM 3)

The learner appreciates that Uganda has different natural resources that our activities have an impact on these resources, and recognizes the reasons why countries have committed to Global Sustainable Development Goals.

Human impact on the environment includes changes to biophysical environments, ecosystems, biodiversity and natural resources caused directly or indirectly by man.

Food for thought

The natural environment has proven to be friendly to human survival, but are we being friendly to it?

How are humans impacting nature?

Sustainability of natural resources

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

Sustainability is not just an environmental care concern but also constitutes concerns for social well-being and economic development.

Sustainable Development Goals (SDGs)

This is a collection of 17 interlinked global goals designed to be a blueprint for peace and prosperity for people and the planet, now and into the future. The SDGs were set up in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030.

There is international commitment to countries that are working together to transform the world by 2030.

These countries include: Finland, Denmark, Sweden, Norway, Austria, Germany, France, Switzerland etc.

The scope and 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.

This encourages;

- Planning of economic growth to ensure least environmental impact
- Meeting current economic needs without compromising global environmental conditions for the generations to follow.
- Making the earth a better environment for its prolonged sustainance .

IMPORTANCE OF SDGs

They play a role in combating the urgent environmental, political and economic challenges facing the world.

AVTIVITY 8

During the Non-Aligned Movement (NAM) summit held in Kampala-Uganda in 2016, many international flags and banners hung at Munyonyo Common wealth Resort so as to honour the countries that attended the summit. However, what caught the eye of one journalist on that day was not the flags, but a beautiful banner displayed at the entrance of the resort. He took a clear eye catching picture consisting of many common global developmental symbols which was published on New vision that very week. The symbols have been given meanings in the attached table as shown below;

Common Global Symbols with their meanings

GOAL NO.	SDG	GOAL NO.	SDG
1	No poverty	10	Reduced inequality.
2	Zero hunger	11	Sustainable cities and communities.
3	Good health and well-being	12	Responsible consumption and production.
4	Quality education.	13	Climate action .
5	Gender equality.	14	Life below water.
6	Clean water and sanitation.	15	Life on land.
7	Affordable and clean energy.	16	Peace and justice strong institutions.
8	Decent work and economic growth.	17	Partnerships to achieve the goal.
9	Industry, Innovation and infrastructure.		

TASK

You are a member of the debating club in your School and you have been selected to represent your School in a national youth day to make a key note address on SDGs. Using internet with a note book and a pen, research on any five of the above Sustainable Development Goals (SDGs') and write a speech you will make on making sustainable development Goals in your country a reality: In your presentation include how the goals can be achieved, challenges that may arise and how these challenges can be mitigated.

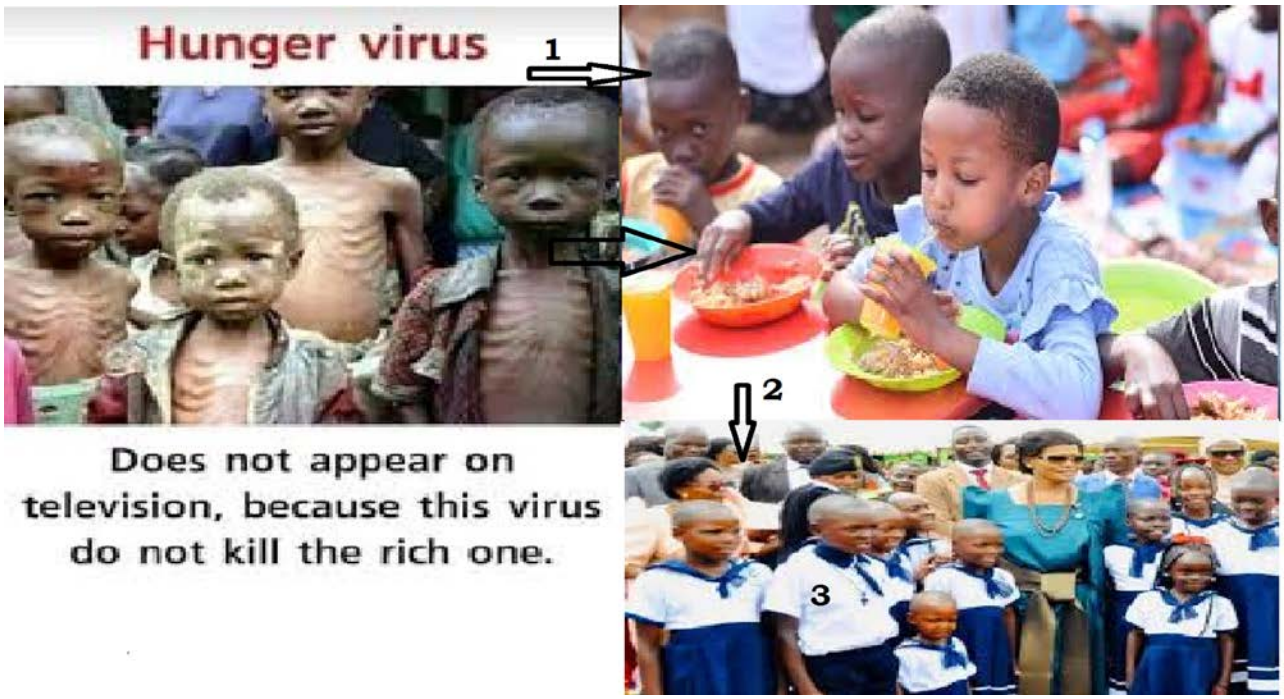
HOW GOALS 1,4 AND 8 ARE BEING MET IN UGANDA.

GOAL 1: NO POVERTY.

This goal can be attained through;

- Modernization of agriculture to increase income earned.
- Promoting employment outside agriculture by micro-finance, advisory services and vocational training.
- Promoting sustainable resource use by raising awareness, including the encouragement of communal initiatives to protect common property resources such as swamps and forests etc.

Moving the image of the Ugandan children from Image 1 to 2 & 3



GOAL 4:- QUALITY EDUCATION

- Creating an enabling environment in each district through building the capacity of district officials, resolving key challenges to access quality education ,and helping plan and coordinate education delivery at district and regional levels.
- Improving education governance through mentorship and other approaches being used to strengthen local accountability and collaborative partnership between schools ,parents and communities
- Supporting teachers' competencies through regular supervision and assessment by head teachers.
- Strengthening the effectiveness of primary schools through regular school performance review leading to the development and revision of schools improvement plans.

GOAL 8:- DECENT WORK AND ECONOMIC GROWTH

- Encouraging entrepreneurship and job creation ,as effective measures to eradicate forced labor ,slavery and human trafficking
- Promoting socio development programs like the Uganda Women Entrepreneurship programme (UWEP) to equip and empower women with skills and financial services to encourage enterprise growth ,value addition, economic empowerment and decent work.
- Promoting socio economic empowerment of the youth through the youth livelihood programme (YLP).
- Putting in place laws against human trafficking and salary in the name of employment opportunities abroad and against child labor.

NATURAL RESOURCES

- A natural resource is anything not made by man obtained from the environment to meet human needs and wants
- While some resources are directly available for use e.g. solar energy, fresh air, wind, fresh surface water, fertile soil, wild edible plants others, become available after processing has been done e.g. petroleum, metallic elements like iron, ground water, and modern crops.

over exploited to those

There are 2 types of natural resources; **renewable** and **non-renewable** natural resources

Renewable natural resources are called so, because they can grow again or never run out.

Non-renewable natural resources are things that can run out or be used up. They usually come from the ground.

Uganda is rich in many of these resources, ranging from those that are under-utilized.

CLASSIFICATION OF NATURAL RESOURCES

Type of natural resource & its definition	**Examples**
(i) Perpetual resources. Resources that are replaced (renewed) continuously on human time scale.	• Solar energy (ii) wind (iii) tides.
(ii) Renewable resources Resources that are replenished (replaced) fairly rapidly (hours to decades) through natural processes as long as the usage is not faster than the replacement	(i) Fresh water (ii) fresh air (iii) fertile soil (iv) animals and plants (Forests, grasslands)
(iii) Nonrenewable resources Resources that exist in a fixed quantity or stock in the earth's crust. On the shorter human time scale, they are depleted much faster than they are formed.	(i) Fossil fuels (e.g. coal, oil, natural gas) (ii) metallic minerals (e.g. copper, iron, aluminium) (iii) non-metallic minerals (e.g. salt, clay, sand, phosphates).

Further terms associated with natural resource.

Term and definition	Examples and/or comments
(i) Sustainable yield The highest rate at which a renewable resource can be used indefinitely without reducing its availability supply	In spite of the renewability, renewable resources can be depleted or degraded
(ii) Environmental degradation The process when the resources natural replacement rate is exceeded resulting into a decline in its availability	Urbanization of productive land, excessive soil erosion, deforestation, ground water depletion, over grazing of grass lands by livestock, reduction in the earth forms of wild life by elimination of habitats and species, pollution, water logging and salt build up in the soil
(iii) Recycling of resources This is the reprocessing of a resource into new products	Old aluminum saucepans and copper items can be recycled
(iv) Reusing of resources Using of resources over and over in the same form.	Glass bottles of alcoholic and soft drinks can be collected washed and refilled many times
(v) Wild life This includes plants and animals that occur in their natural environment	Forests and wild animals

Identifying the natural resources in Uganda and how they are affected by Human activities

Summary of the Natural resources shown in the pictures above

Picture	Natural Resource	Renewable/non-renewable resource	Uses of the resources to man
a)	Sun/sunlight energy/solar energy	Renewable	• Generating solar electricity • Supports growth of plants • Drying crops like maize for long time storage
b)	Water	Renewable	• Generating hydro electricity • Raw material in some factories • Used in domestic activities such as cooking, and washing
c)	Wood/trees/ Forests	Non-renewable	• Provide fuel for cooking • Used in construction • Raw material for many factories such as paper manufucturing.
d)	Minerals (Gold)	Non-renewable	• Is a natural currency • For teeth replacement • For manufacture of jewelry like watches, necklaces, ear pins and rings.

Renewable and non-renewable natural resources in Uganda

Renewable natural resources	Non-renewable natural resources
Climate (rainfall, sunlight, and wind) Forests Lakes Rivers	Land, Oil reserves Minerals like copper, Gold, limestone, cobalt and iron, etc. Salt Glass Cement Lime

How human activities affect natural resources

Human activities for examples, *overpopulation*, *pollution*, *burning fossil fuels* and *deforestation* have triggered climate change, soil erosion, poor air quality and undrinkable water, hence, over exploitation of the natural resources to their degradation and exhaustion.

Ways of conserving the natural resources in Uganda for future use

- ***Practice recycling of materials***
  This can be controlled by promoting use of ceramic, metal or glassware instead of water bottles, plastic cups or plates. To encourage use of fabric grocery bags rather than plastic bags. Therefore, re-using items is a great way to reduce waste and keep excess trash out of landfills
- ***Volunteer for clean ups in our communities***
- Use renewable energy-with efficient lights such as solar lights, energy saving bulbs and conserve energy(fuels) instead of cutting down trees.
- Conserve water used in homes and industries. i.e. turn off the water when not in use.
- Walk short distances, or use bikes, cars are one of the biggest contributors of depleting fossil fuels and producing gas emissions in air. So try to find alternative modes of transportation whenever possible.

Factors affecting the natural environment

Some of these factors occur in nature (natural factors) while others originate from human activities.

Natural Factors	**Man made factors**
➢ Earth quakes	➢ Deforestation
➢ Volcanic eruption	➢ Overpopulation
➢ Wild fires	➢ Pollution
➢ Droughts	➢ Burning fossil fuels
➢ Algal blooms	➢ Improper disposal of wastes

POLLUTION

It 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.

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.

Harm caused by pollutants.

- Disruption of life support systems for living organisms. - Damage to wild life, human health and property.
- Nuisances such as noise and unpleasant smells, tastes and sights.

Categorisation of pollutants basing on their persistence in the environment

(a) Degradable (non-persistent) pollutants: Are the pollutants that are broken down completely or reduced to acceptable levels by natural physical, chemical and biological processes.

Biodegradation: is the breakdown of complex chemical pollutants into simpler chemicals by living organisms (usually specialized bacteria) e.g. sewage is a biodegradable pollutant.

(b) Slowly degradable (persistent pollutants): Are those that take a longer time to degrade e.g. DDT - an insecticide, and plastics e.g. plastic bags.

c) Non-degradable pollutants: these cannot be broken down by natural processes e.g. the toxic elements lead, mercury, arsenic, selenium

Types of pollution

They include the following:

1) Air pollution,
2) Water pollution,
3) soil pollution
4) Thermal pollution,
5) Sound pollution.

1)AIR POLLUTION

Figure showing emission of air pollutants from industries and motor vehicle exhausts

TABLE SHOWING SUMMARY OF THE AIR POLLUTANTS, SOURCES, EFFECTS AND CONTROL MEASURES

Pollutant	**Source(s)**	**Effects/consequences**	**Control measures**
1. Carbon monoxide	**(i)** Motor vehicle exhausts, **(ii)** Incomplete combustion of fossil fuels **(iii)** Tobacco smoking	**(i)** Prevents oxygen usage by blood by forming carboxy-haemoglobin, which may cause death **(ii)** Small concentrations cause dizziness and headaches	• Efficient combustion of fuels from industries and homes • Avoid smoking • Vehicle exhaust gas control
2. Sulphur dioxide	Combustion of sulphur containing fuels, oil and coal gas	• Causes lung diseases, irritation of eye surfaces and asthma resulting into death if in high concentrations • Forms acid rains, which increases soil pH. • Reduces growth of plants and kills lichens. **NB.** *Lichens are indicator species for sulphur dioxide pollution. The presence of many lichen species in a place indicates low level of sulphur dioxide pollution in that area.*	**i)** Use of Sulphur free fuel e.g. natural gas. **(ii)** Installation of Sulphur dioxide extraction units in industrial fuels and chimneys.
3. Ozone	**(i)** Motor vehicle exhausts **(ii)** combustion of fossil fuels to form nitrogen dioxide which decomposes to form oxygen atoms that combine with oxygen molecules to form ozone.	Low level (tropospheric) ozone causes: **(i)** Internal damage to leaves hence reducing photosynthesis. **(ii)**Eye, throat and lung irritation which may result into death. **(iii)**Internal damage to leaves which severely reduces photosynthesis. **(iv)** Greenhouse effect by absorbing and radiating heat which raises the temperature at the earth's surface. High level (stratospheric) ozone offers protection against excessive solar heat by absorbing solar ultraviolet radiation which would reach the earth's surface.	**(i)** Vehicle exhausts gas control e.g. in USA
4. Smoke	**(i)** House coal, smoke, soot **ii)**Motor vehicle exhausts **iii)** tobacco smocking **iv)** Incomplete combustion of refuse in incinerators and bonfires.	**(i)** Causes lung diseases when inhaled **(ii)** Sunlight barrier, hence reducing photosynthesis. **(iii)**Stunted growth of plants **(iv)** Stomatal blockage hence reducing photosynthesis	**(i)** Usage of smokeless fuels **(ii)**Efficient combustion **iii)**No smoking **iv)** Vehicle exhausts gas control

5. Dust	**(i)** Solid fuel ash **(ii)** soil as wind blows **(iii)** quarrying **(iv)** mining, etc	**i)** Lung diseases **(ii)** stomatal blockage **iii)** Stunted growth of plants. **(iv)** Smog – forms when temperature inversion occurs (layer of warm air traps cool air containing dust and smoke close to the earth' surface)	**i)**Installation of dust precipitators in industrial chimneys. **ii)** Efficient combustion. **iii)** Wearing of face masks by factory workers.
6. Carbon dioxide	**(i)**Motor vehicle exhausts **ii)** combustion of fossil fuels	Increased carbon dioxide causes Greenhouse effect – warming up of the earth's atmosphere as a result of the blanket of carbon dioxide, preventing escape of solar radiation higher into space.	**(i)**Planting more green plants, **(ii)** Reduction in combustion of fossil fuels by relying on alternative sources of energy e.g. solar
7. Nitrogen oxides & nitrogen dioxide)	**(i)** Car exhaust emissions **(ii)** industrial fuel gases	**(i)**Acid rain formation **(ii)** contribute to greenhouse effect	**(i)** Car exhaust control
8.Chlorofluoro carbons CFCs	**(i)** Aerosol propellants, **(ii)** refrigerator **(iii)** air conditioner coolants **(iv)** Expanded plastics. E.g. bubbles in plastic foam used for insulation and packaging (polyurethane form)	Enters stratosphere, the chlorine reacts with ozone hence reducing the ozone layer and permitting greater penetration of UV light to cause global warming.	Ban on the use of CFCs
9. Noise	**(i)** Discos **(ii)** road traffic, **(iii)** engines **(iv)** machines, **(v)** aeroplanes **(vi)** firearms	**(i)** Hearing impairment, **(ii)** total deafness **(iii)** nervous disorders	**(i)** Effect laws against excessive noise **(ii)** put on ear muffs and plugs while in industry
10. Radioactive fallout from explosions	**(i)** Nuclear weapons **(ii)** Nuclear power fuels.	Ionizing radiation causes cancer	Nuclear power control

GREENHOUSE EFFECT AND GLOBAL WARMING

1. Greenhouse effect

- This is a description of the condition which results when greenhouse gases i.e. gases in the troposphere (atmosphere's inner most layer extending about 17km above sea level) like carbon dioxide, water vapor, methane and nitrous oxide allow mostly visible light, some infrared radiation and ultraviolent radiation from the sun to pass through the troposphere to the earth, which transforms this solar energy to longer-wave lengths-infrared radiation (heat) which then rises into the atmosphere.
- Molecules of greenhouse gases absorb and emit this heat into the troposphere as even longer-wave-length infrared radiation, which causes a warming effect of the earth's surface and air. The tropospheric gases act like a glass of large green house surrounding the earth.

2. Global warming

This is the observed average global temperature rise of 0.8oC since 1900 as result of the enhanced natural greenhouse effect. **The origins of greenhouse gases are;**

- Combustion of fossil fuels by motor engines and industries releases carbon dioxide and methane into the troposphere.
- Deforestation and clearing of grasslands reduces the uptake of carbon dioxide in photosynthesis.
- Ruminant fermentation produces methane, which is released into troposphere.
- Use of aerosol propellants, which contain CFCs that are105 times worse than carbon dioxide as greenhouse gases
- Cultivation of rice in swamps and paddy fields causes anaerobic fermentation, which produces methane.
- Use of inorganic fertilizers causes the release of nitrous oxide.

Effects of global warming.

- Rise in sea level due to melting of polar ice and thermal expansion of seas.
- Altered temperature gradients cause cyclones and heavy rains as water evaporates quicker.
- Species migration which are likely to cause pests/diseases to extend their ranges.
- Reduced cropped fields due to drier weather.
- Increased crop yields because of more rainfall and longer growing seasons in some regions.
- Flooding low-lying islands and coastal cities.
- Extinction of some animal and plant species.
- Increased death of human population.
- Greatly increased wild fires in areas where the climate becomes drier.

ACID RAIN (Formation)

- Combustion of fossil fuels releases sulphur dioxide and nitrogen oxides into the atmosphere.
- Catalyzed by ammonia and un burnt hydrocarbons, these oxides react with water in the clouds to form solutions of **sulphuric acid** and **nitric acid**, which make up acid rain.

Effects of Acid rains

- Hydrogen ions bound to soil particles are displaced into runoff water by the $SO4^{2-}$ ions from sulphuric acid, causing formation of soft exoskeletons, which results into death of invertebrates.
- Aluminum ions are displaced from soil by SO_4^{2-} ions into water where it interferes with gill functioning in fish causing their death.

- Aluminum ions are displaced from soil by SO_4^{2-} ions into water are toxic when absorbed by plants.
- The leaching action of acid rain removes calcium and magnesium ions from soil causing poor formation of middle lamella and chlorophyll in leaves.
- Contributes to humans respiratory diseases such as bronchitis and asthma.
- Can leach toxic metals such as lead and copper from water pipes into drinking water.
- Damages statues and buildings.
- Decreases atmospheric visibility, mostly because of sulphate particles.
- Promotes the growth of acid-loving mosses that can kill trees.
- Loss of fish population when the pH lowers below 4.5

Prevention

- Installation of SO2 extraction units (wet scrubbers) in chimneys of industries.
- Cleaning up of exhaust emissions by encouraging several pollutants to react with one another to give less harmful products in catalytic converters.
- Reduce coal use.
- Increase use of renewable resources.
- Tax emissions of sulphur dioxide, "polluter pays principle" should be adopted everywhere.

(2) WATER POLLUTION

Sewage discharge into rivers: Sewage is liquid waste (composed of faeces, urine, water, detergents and other substances) from industries and/or homes carried through pipes called sewers.

Effects of untreated sewage discharge into rivers

Discharge of untreated sewage into a river has an immediate effect on the aquatic environment, causing many changes in both the abiotic and biotic components. Some of these changes are due to specific chemical pollutants (e.g. heavy metals such as cadmium from industrial processes, and pesticides from agriculture) with the effects varying according to the chemicals present in the discharge.

ACTIVITY 9

The ecosystem of Lake Kyoga, which is a vital source of water and livelihood for millions of people in Uganda, is facing severe water pollution due to untreated sewage disposal which is transported into the water body through pipes called sewers from nearby towns and villages. The water quality of the Lake has deteriorated significantly with high levels of bacterial contaminations, nutrient runoff, and floating debris.

Figure showing the deposition of wastes into lake Kyoga

TASK

1. a) Explain the meaning of the following terms
   (i) Ecosystem
   (ii) Sewage
   b) What are the potential effects of this sewage disposal on the ecosystem of Lake Kyoga and the communities that depend on it?
   c) What measures can be taken to mitigate the impacts of this problem?
   e) Outline the major economic significance of the natural aquatic ecosystem like Lake Kyoga to the economy of your country?

2. In another occasion, Dr. Vianney Natugonza, a senior lecturer at Busitema University maritime Institute, narrates that fish often ingest plastic wastes after confusing them to be food. Subsequently, "fish may develop a false sense of satisfaction which reduces its actual food intake. Which again affects the growth and the survival," further notes Natugonza, a fishery sciences researcher. He insists that the impact on fish ultimately affects the people and their livelihoods.

a) Explain how these plastics end up in water bodies?

b) What happens when plastics go into the water bodies and how does this impact the lakes' resources and the people who depend on them?

c) Suggest solutions or mitigations on how the problem of plastic wastes in lakes can be managed?

Addition of inorganic chemicals, plant nutrients and sediments into Lakes

Pollutant	**Source(s)**	**Effects/consequences**	**Control measures**
1. Plant Material	(i) Nitrate (NO^-) (ii) phosphate(PO_4^{3-}) and (iii) ammonium(NH_4^+) ions **NB:** *The nutrient enrichment of water bodies is termed as* ***eutrophication***	**(i)** -Raw sewage discharge, detergents and other chemical release from industries, leaching of inorganic fertilizers e.g. NPK from farmland	**(i)**Rapid growth of algae and green protists (algal blooming/dramatic first growth of algae) **(ii)** reduces light penetration in water leading to **(iii)** Death and decay of algae, which depletes water of dissolved oxygen, killing fish and other aerobic animals **(iv)** Excessive levels of NO3- if drank in water lowers the oxygen carrying capacity of blood and kill unborn children and infants ("blue baby syndrome").
2. Sediment	(i) Soil (ii) Silt	*Land erosion*	Can **(i)** cause turbidity / cloudiness in water; light penetration is reduced therefore reduce photosynthesis, **(ii)** settle and destroy feeding and spawning grounds of fish, **(iii)** clog and fill water bodies, shortening their lifespan **(iv)** disrupt aquatic ecosystems **(v)** carry pesticides, bacteria and other harmful substances into water.
3. Inorganic chemical	(i) acids, (ii) compounds of toxic metals like lead (Pb), mercury(Hg), arsenic (As) and selenium (Se) and (iii) salts e.g. NaCl in ocean water	Surface runoff, industrial effluents and household wastes	(i)Drinking water becomes unusable for drinking and irrigation (ii) Lead and Arsenic damage the nervous system, liver and kidneys(iii) they harm fish and other aquatic life (iv) they lower crop yields (v) they accelerate corrosion of metals exposed to such water.

EUTROPHICATION

How eutrophication occurs and its effects

Eutrophication occurs when nutrients accumulate in water bodies.
This can be as a result of *fertilizers being washed from fields into the water* by running rain water. This brings an excess of nutrients into water bodies. The nutrients cause plants to grow rapidly and there is an algae bloom across the water surface. This (algae bloom) covers the surface of the water, preventing sunlight from passing through. Hence, aquatic plants cannot photosynthesize, less oxygen is released into the water.
The dead plants are broken down by decomposers which use up the remaining oxygen from the water. As a result other aquatic organisms e.g. fish, frogs begin to die and decompose.
This contaminates the water, making it murky and smelly.

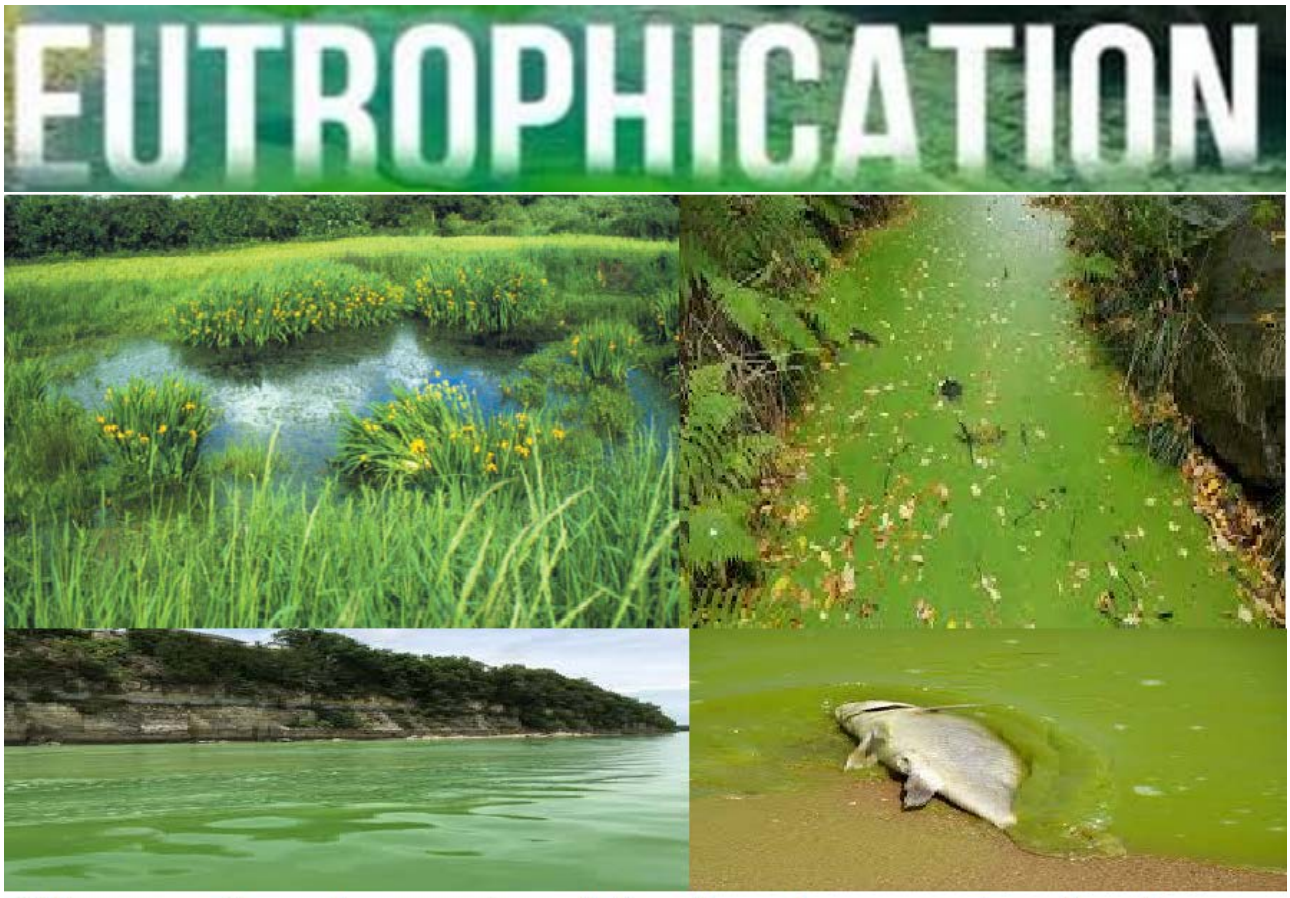


Figure showing eutrophication in a water body

Eutrophication effects on human health

A lot of diseases result from drinking or being in contact with contaminated water, such as diarrhea, cholera, typhoid, dysentery or skin infections. In zones where there is no available drinking water, the main risk is dehydration.

(3) LAND (SOIL) POLLUTION

Soil pollution can occur due to various direct and indirect ways which include:

- Dumping of industrial wastes.
- Excess use of agrochemicals in the form of pesticides and fertilizers.
- Dumping of discarded wastes like paper, food and plastics.
- By air pollution like acid rain.
- By water pollution like pollutants finding their way to soil.

Soil pollutants and their effects

The majority of soil pollutants include; pesticides, herbicides and inorganic fertilizers used for Agricultural purposes.
Below is a summary of soil pollutants and effects

Table showing common soil pollutants and their effects

Pollutants	Effects
Pesticides, herbicides and fertilizers	• Cause death of microorganisms, animals and certain plants • Affect soil fertility • Several non-biodegradable by-products find their way to animals and man through food chain and have serious long term damaging effects. Some may be cancerous.
Excretory products of organisms and digested sewage sludge used as manure	Number of pathogens present in the wastes contaminate the soil. Cause health hazards for man and domestic animals.
Salts of iron, lead, copper, mercury, arsenic etc.	Toxic to both plants and animals.
Discarded food, paper, carcasses, Aluminium and plastics.	

Control of soil pollution

i) Construction of transfer stations at different points in a city for bulk transfer of refuse to discharge sites to speed up removal.
ii) Materials like paper, glass and plastics should be recycled to decrease the volume of refuse and to conserve the natural resources.
iii) Use of chemical fertilizers should be reduced. Bio fertilizers and manure should be used in their place.
iv) Instead of pesticides, biological control of pests be used where possible.

Environment conservation

It is important to reduce the negative impacts that humans have on the environment to conserve the biodiversity of eco systems.
This means increasing the sustainability of resources and manufacturing.

Sustainable resources are those which can be taken from the environment without the risk of them running out. They can be produced naturally as quickly as they are harvested.
Resources such as coal and oil are not sustainable as fossil fuels are non-renewable while others such as wood and fish can be harvested sustainably.

WAYS OF CONSERVING THE NATURAL ENVIRONMENT.

- Cutting down an 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 greenhouse 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 than 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 IN UGANDA

Solid waste management is one of the major environmental problems faced especially in urban areas in Uganda today.

In Kampala city, like other urban centers and in most developing countries, this important service is based on the local government's centralized collection, transportation and disposal strategy. For example KCCA in Kampala faced a serious waste management at Kiteezi that collapsed killing many Ugandans.

How Different Categories of Garbage Can Be Reused Or Recycled In Uganda.

Reusable waste can be used by recycling them which reduces the pollution caused by them.

Under solid waste management, plastic , paper, cardboard, metals, and glass get recycled by melting or grinding, after that it's molded in another form which makes it reusable.

Explain How Effectively Recycling Of Garbage 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

RECYCLING BASED PRACTICES

Separate biodegradable from non-biodegradable materials.

- Recycle bottles, cans, paper and cardboard.
- Keep food and liquid out of your recycling.
- No loose plastic bags and no bagged recyclables. Grocery bags dissolve into potentially harmful micro plastics and in the case of ingestion or entanglement, hurt and kill animals.
- 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 cannot be separated.
- Avoid wish-cycling, which is the act of putting items that cannot be recycled in recycling bins.
- Compelling manufacturers print recycling guides in local languages.

4. HEAT (THERMAL) POLLUTION

Main human sources

Use of water as a coolant in industrial processes e.g. electricity generating plants

Harmful effects

1) Lowers dissolved oxygen levels since solubility of most gases reduces with temperature.
2) Make aquatic organisms more vulnerable to disease, parasites, and toxic chemicals.
3) When a power plant shuts down for repair or opens, fish and other aquatic organisms adopted to a particular temperature range can be killed by the abrupt change in water temperature. This is known as thermal shock.
4) Some aquatic animals may migrate to water with favorable temperature.

Note: The Effects of eutrophication are more severe in water bodies where thermal pollution occurs because of;

1) Increased decomposition of organic matter and metabolism, which raise the demand for oxygen by higher organisms.
2) Reduced dissolved oxygen levels in water

1. What are advantages and disadvantages of biological methods used to control eutrophication rather than chemical control of eutrophication?

Organisms live in their environment all the time; their presence (or absence) reflects the suitability of that environment for their living requirements at all times. A short-lived but severe pollution incident occurring at night would be reflected by the absence of sensitive organisms long after visible and chemical evidence of the pollution incident had disappeared. Biological indicators can therefore be a more sensitive and representative reflection of environmental conditions. Chemical monitoring all the time can only be done for small water courses e.g small rivers , streams and remote areas. It also requires much time-consuming and, in the long term, expensive laboratory analysis Biological control requires reasonable expertise at identification and is also affected by seasonal factors.

ACTIVITY 10

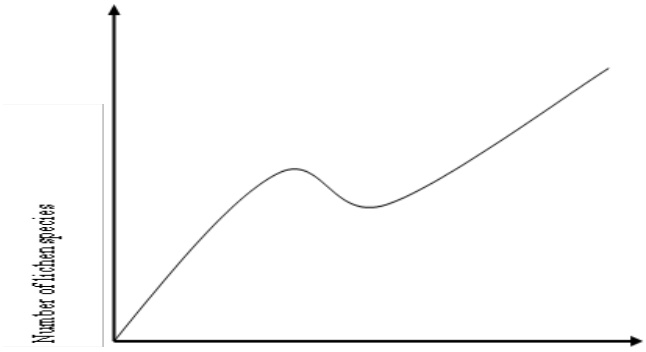
Local people near the waste fill at kiteezi had built their homes close to the waste dumping Centre without precautions. Recently there was an accident at kiteezi involving the collapse of a waste on people's homes, leading to loss of lives and properties.

(a) State three ecological problems which arise from accumulation of domestic waste in urban communities like kiteezi.

(b) Give two ways of reducing domestic waste in urban communities

(c.) A team of Botany students from Makerere University carried out an investigation on the level of sulphur dioxide pollution within an urban Centre and about 20km away from urban Centre. They counted the number of lichens present in a transect strip for every 5km intervals using passive method from urban further into the forested areas. The results were plotted as shown in the graph. Lichens are indicator species for sulphur dioxide pollution. The presence of many lichen species indicates low level of sulphur dioxide

The figure below shows the lichen species along 20km transect from the urban centre.



Distance from urban areas to forest

(i) Explain the trend in the lichen species with distance from the urban centre.

(ii) Suggest an explanation for the observed number of lichen species at a distance of 10km from the urban centre.

(iii) Suggest possible remedies to mitigate air pollution in big cities like kampala

END