

✓ **ECOLOGY**

- ✓ This term ecology is derived from the Greek word oikos which means a house or a place to live hence ecology is a branch of biology that deals with the study of relationships between organisms and their environment.

Concepts of ecology

- ✓ **Autecology** – it's the study which involves a single species.
- ✓ **Synecology** – it's the study of many species.
- ✓ **Biosphere** – it's the part of earth and atmosphere inhabited by living organisms. Also called ecosphere.
- ✓ **Habitat** – this is the particular place in the environment where an organism is found. Habitats are categorized into terrestrial (land)

habitats, aquatic (water) habitats.

- ✓ **Ecological niche**- it's the position that an organism occupies in a habitat.
- ✓ **Population** – refers to all members of a given species in a particular time e.g. population of lions in Tsavo national park., in 2007
- ✓ **Community** – refers to all organisms belonging to different species that interact in the same habitat e.g. pond, forest communities.
- ✓ **Ecosystem**- it's a natural unit composed of living and non- living components whose interactions result in a self sustaining system hence ecosystem is made up of communities.
- ✓ **Biomass**- it's the total dry weight of living organisms at a particular trophic

level (feeding level)
or per unit area e.g.
total weight of maize
crop per hectare.

- ✓ **Carrying capacity**-
it's the maximum
number of organisms
an area can
comfortably support
without depletion of
the available
resources.

- ✓ **Factors in an
ecosystem**

They are divided into
biotic and abiotic
factors

- (a) Abiotic factors**

- ✓ They are non living
environmental factors
which affect the
distribution of
organisms e.g.

- Light**

- ✓ Affect living
organisms in terms of
intensity, quality
(wave length/ colour)
and duration.
- ✓ Light intensity and
quality affect the rate
of photosynthesis,
flowering and
germination in plants.

- ✓ In animals affects
migration,
hibernation and
reproduction e.g. lion
hunts at dawn or
dusk to avoid being
seen by their prey.

- ✓ A photographic light
meter is used to
measure intensity

- ✓ Secchi disc measures
light penetration in
water.

N.B (i) at the top of
the forest the trees
form a continuous
thick cover of leaves
and branches called
canopy. This canopy
filters the light
allowing only little
light to pass through
to the bottom of the
forest. Some plants
such as ferns, mosses
and liverworts are
found at the bottom
of the forest.

(ii) Some types of
plants grow on trees
where they get
enough light for
photosynthesis. They

are called epiphytes
e.g. orchids.

Temperature

- ✓ Biochemical processes of most animals function efficiently within a narrow range of temperatures.
- ✓ Very low temperatures may inactivate enzymes
- ✓ Very high temperature denatures enzymes.

Atmospheric pressure

- ✓ It's the mass exerted by air on the surface of earth.
- ✓ Atmospheric pressure affects the amount of oxygen in the air.
- ✓ At sea level the air pressure is high hence more oxygen available.
- ✓ In high attitude areas the air pressure is low hence less oxygen available.

Humidity

- ✓ This is the amount of water vapour in the atmosphere
- ✓ At low humidity plants and animals lose a lot of water through transpiration and sweating respectively and the opposite is true at high humidity.

✓ Wind

- ✓ It increases the rate of water loss from organism.
- ✓ In desert areas winds aid in formation of sand dunes which becomes the habitats for growth of desert plants.
- ✓ Wind causes wave formation in lakes, ocean which enhances aeration of water.
- ✓ It also disperses spores, seeds and influences dispersal and migration of flying animals.

✓ Salinity

- ✓ It's the degree of salt concentration in water. Aquatic habitats are divided into three i.e.
- ✓ **-Fresh water habitat**- has very little or almost no salt e.g. fresh rivers, lakes etc
- ✓ **-Marine**- have high salt concentration e.g. ocean, seas etc
- ✓ **-Estuarine**- found at the point where fresh water rivers join salt water lakes. Salt concentration depends on tides.
- ✓ Salinity determines the type of organisms found in an ecosystem e.g. tilapia fish is found in fresh water habitats only while shark is found in salty water habitat like oceans.
- ✓ **PH**
- ✓ This is the degree of acidity or alkalinity. It influences the distribution of plants and animals in soil and fresh water ponds
- ✓ Some plants thrive well in acidic conditions while others in alkaline or neutral conditions
- ✓ **Biotic factors**
- ✓ They are all the living organisms in an environment and their effects on each other.
- ✓ **Biotic interrelationships**
- ✓ **Competition**
- ✓ This is where two different species require a common resource whose availability is limited. These resources include nutrients, space, light or mates
- ✓ Competition between individuals of the same species is known as **intraspecific** while that between individuals of different species is

known as
**interspecific
competition.**

- ✓ In such competition for a limited resource, organisms with suitable structural and behavioural adaptations survive while others without such adaptations may die or migrate.
- ✓ Competition is only found in organisms in the same ecological niche e.g. there may not be any competition between an elephant and a rabbit because they don't depend on the same food.
- ✓ **Predation**
- ✓ This is the food relationship in which one organism kills another for food and feeds on it either wholly or in part.
- ✓ Organism that kills another for food is a predator while the

one killed is the prey.

- ✓ **Adaptations of predators**

- ✓ **Structural adaptations**

- ✓ Rattle snakes locate their prey with special heat sensitive organs located near their eyes and they kill small birds and mammals by injecting them with toxins through their fangs.
- ✓ Praying mantis has enlarged forelimbs with spikes for capturing its prey. It feeds on small insects such as grasshoppers.
- ✓ Birds e.g. eagles, hawks, kites have sharp eyesight, fast flight, modified beaks and talons.
- ✓ Lion which preys on the antelopes has strong jaws with carnassial teeth, large claws on strong forelimbs and it is fast in movement.

✓ **Behavioural adaptations**

- ✓ Lion moves against the wind while stalking the prey.

Colour Camouflage

- ✓ This involves the body colour of the organism blending well with the background environment to conceal the organism to a great extent e.g. the spotted pattern of the leopard blends well with the background colour of the bushes and trees concealing the leopard from the prey.

✓ **Adaptations of prey**

✓ **Structural adaptations**

- ✓ Herbivores e.g. zebra have large eyes on the sides of the head which gives them a wide field of vision. This enables them to keep track of their enemies from far and

therefore take precautions.

- ✓ Antelopes and gazelles have swift movement to escape from predators

Behavioural adaptations

- ✓ A stick insect mimics a dry stick.

- ✓ Confrontational display in porcupine.

Colour Camouflage

- ✓ The stripes of zebra and the spotted pattern of giraffe.

- ✓ Predation brings about biological control e.g. if there were too many locusts destroying crops then several bird species that prey on them can be introduced into the habitat to reduce the locusts.

✓ **Parasitism**

- ✓ It's the relationship in which an organism obtains nutrients from another live organism without killing it.

- ✓ This organism which lives on or in another

organism is called a parasite while the one from which nutrients are obtained is called the host.

- ✓ When a parasite lives inside the body of the host it is called **endoparasite** e.g. tapeworms.
- ✓ When the parasite lives on the outside of the host it is called **ecto-parasite** e.g. ticks
- ✓ Parasites weaken their hosts, cause or transmit diseases which may kill their host.
- ✓ **Symbiosis**
- ✓ This is association between organisms of different species in which both organisms benefit. e.g.
 - Rhizobium bacteria which lives in the root nodules of leguminous plants.

- ✓ The plants benefit from the nitrates fixed by rhizobium bacteria while bacteria benefit from shelter and carbohydrates provided by the plants.
- ✓ -A lichen is an association between blue - green algae and a fungus. The algae carries out photosynthesis which provides the fungus with carbohydrates. The fungus provides the moisture and a place for attachment to the algae.

▪ **Saprophytism**

- ✓ This is a type of nutrition where organisms obtain nutrients from dead organic matter hence causing

- decomposition e.g. fungi and bacteria.
- ✓ Decomposition releases nutrients into the ecosystem which are then made available to other living organisms.
 - ✓ **Nitrogen cycle**
 - ✓ It refers to the cycling of nitrogen and its compounds in nature.
 - ✓ Nitrogen is essential in the manufacture of proteins by organisms. Plants absorb nitrogen in the form of nitrates and assimilate it into plant proteins either by eating plants or other animals.
 - ✓ Nitrogen fixation is the process by which atmospheric nitrogen is converted into a form that can be utilized by plant by:

Biological nitrogen - fixation

- ✓ It's done by nitrogen fixing micro- organisms. These are ;
- ✓ (i) Symbiotic nitrogen fixing- bacteria known as Rhizobium bacteria found in the root nodules of the leguminous plants.
- ✓ (ii) Non- symbiotic (free living) bacteria found in the soil such as *Azotobacter* and *Clostridium*
- ✓ (iii) Some algae e.g. *Anabaena chlorella* and *Nostoc*. These organisms fix nitrogen into ammonia which is then converted to nitrates.
- ✓ **Non- biological nitrogen fixation** - it's achieved by lightening.

- ✓ -During thunder storms lightning energy combines atmospheric nitrogen with O_2 to form nitrous acid and nitric acid. These are later converted to nitrates.

✓ **Nitrification**

- ✓ It's the process of oxidizing ammonia formed from nitrogenous wastes contained in the decaying tissues. This is done by several nitrifying bacteria e.g.
- ✓ Nitrosomonas and Nitrococcus – oxidize ammonia to nitrites (NO_2)
- ✓ Nitrobacter bacteria which converts Nitrites (NO_2) into Nitrates (NO_3)
- ✓ **Denitrification**
- ✓ It's the chemical process in which the nitrate in the soil are reduced to free nitrogen and released

to the atmosphere. The organisms involved are Bacteria such as Thiobacillus, Pseudomonas and fungi.

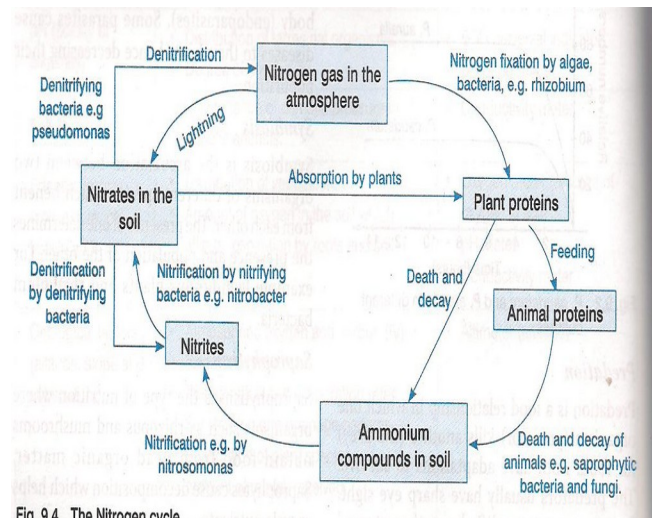


Fig. 9.4 The Nitrogen cycle

Energy flow in an ecosystem

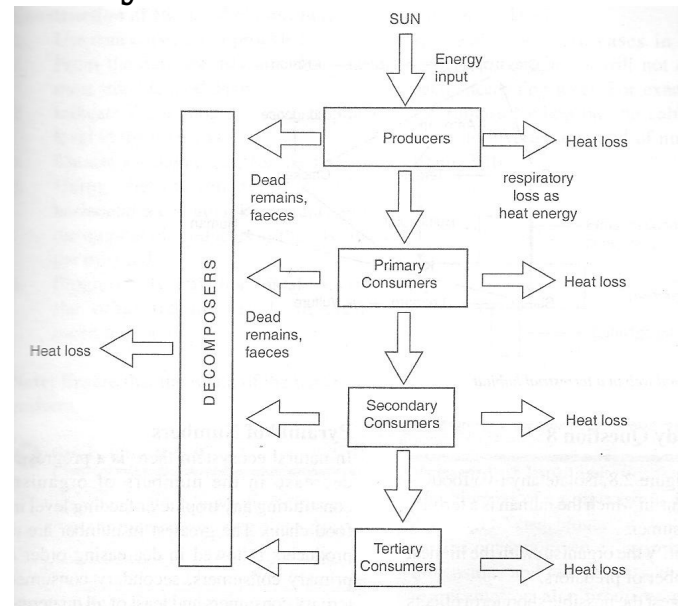
- ✓ The energy from the sun is trapped by green plants for photosynthesis. Green plants are known as producers in an ecosystem.
- ✓ Green plants are eaten by animals (herbivores) called primary consumers because they obtain chemical energy directly from the plants.

- ✓ Herbivores are in turn eaten by carnivores (secondary consumers) e.g. dog.
- ✓ The secondary consumers are eaten by tertiary consumers e.g. leopard.
- ✓ When the leopard dies it is eaten by the vulture (quaternary consumer). These feeding levels i.e. producers and consumer levels are referred to as **trophic levels**.
- ✓ When living organisms die, they are decomposed by bacteria and fungi which are referred to as **decomposers**.
- ✓ **Food chains**
- ✓ It's the flow of energy from producers to consumers in an ecosystem. It's a linear representation of energy flow from a producer to other organisms.
- ✓ There are three main levels that the energy must pass through in a food chain. They are referred to as trophic levels.
- ✓ Trophic means nourishment hence they are also called nutritional levels. They are:
 - ✓ **Producers** – they are capable of making their own food by trapping energy from the sun.
 - ✓ **Consumers** – they depend on the producers for their food directly or indirectly e.g.
 - Primary consumer – these are plant eating organisms e.g. filter feeders in water, herbivores and omnivores.
 - Secondary consumers – small carnivores e.g. insects, spiders, lizards e.t.c.
 - Tertiary consumers – large carnivores like lions, leopards, sharks e.t.c
 - ✓ **Decomposers** – it's made of saprophytic organisms. They act on dead remains of

organisms in all the other levels. When they are included in a food chain they are usually placed at the end.

N.B The amount of energy passed on by a trophic level to another is always less than the amount of energy that the trophic level received. This is due to the loss and usage of energy e.g. some energy in animals is lost as heat energy in breath, urine and faeces

Energy flow in an ecosystem



NB The arrow in the food chain and food web shows the direction of energy flow.

Examples of food chains

Grass → Grasshopper → Bird

Grass → Grasshopper → Bird →

Mongoose → Wild dog →

(Producer) (Primary consumer) (Secondary consumer) (Tertiary consumer) (Quaternary consumer)

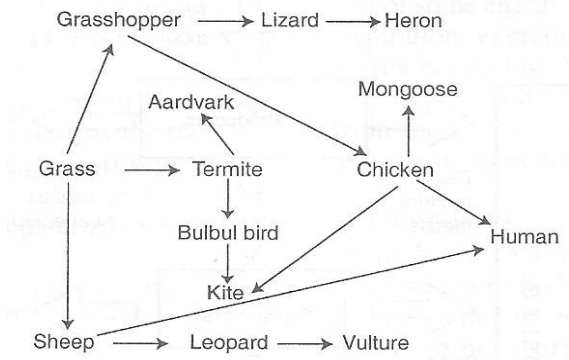
Bacteria and Fungi (Decomposers)

Food webs

✓ It's composed of all possible food chains in a given ecosystem

i.e. it's made of several interconnecting food chains

- ✓ System of food chains that are linked to one another



NB In every ecosystem there are consumers that feed on dead organisms e.g. scavengers and detritivores.

- ✓ Scavengers are carnivores that feed on dead bodies e.g. vultures, hyenas
- ✓ Detritivores are organisms that feed on dead plant material which is undergoing decomposition e.g. termites, cockroaches, earthworms e.t.c
- ✓ **Ecological pyramids**
- ✓ They are diagrammatic

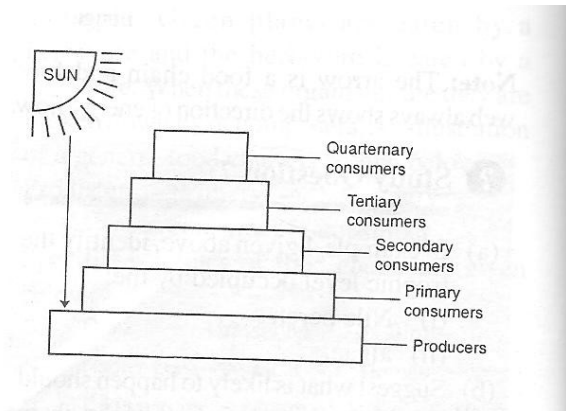
representations that show the number of organisms, the amount of matter and energy at each trophic level in a food chain.

- ✓ The producers are found at the base of pyramid followed by the primary, secondary, tertiary and quaternary consumers.
- ✓ Ecological pyramids are important because they can be used to show the efficient use of energy in a community.

These pyramids are:

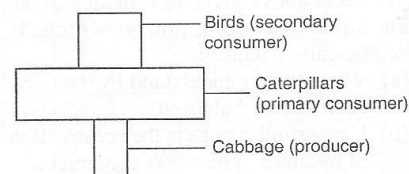
(a) **Pyramid of numbers**

- ✓ This shows the relationship between the numbers of the organisms that occupying the trophic level e.g.



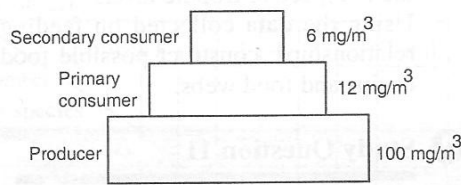
- ✓ In this way it is possible to know the number of organisms that are capable of transferring energy to the next level
- ✓ The pyramid indicates that the organisms transferring energy to the next energy levels decrease as we rise up
- ✓ The body size of organisms increases at each level from the base to the apex of the pyramid as their number decreases
- ✓ At each trophic level much of the energy obtained is lost in respiration and thus fewer organisms can be supported at the succeeding level.

- ✓ In some cases the number of organisms will not increase at each succeeding level e.g. many caterpillars feeding on one cabbage. It gives an inverted pyramid of numbers e.g.



Pyramid of biomass

- ✓ The biomass of an organism is its constant dry weight
- ✓ The producers have the highest biomass per unit area in decreasing order followed by primary consumers , secondary consumers, tertiary and quaternary consumers



Population

- ✓ It is a group of organisms belonging to the same species in a particular habitat e.g. population of people in Utumishi academy
- ✓ **Characteristic of population**
 - Density** – refers to the number of individuals per unit area e.g. 50 antelopes/km²
 - Dispersion** – this is the spread or distribution of organisms in a habitat.
 - Population growth** – refers to the rate of increase in numbers.
- ✓ Population growth rate may be influenced by food availability, space,

diseases, pests and predators

Population estimation methods

- ✓ In order to find out the number of organisms in an ecosystem all organisms can be counted. But this is difficult and time consuming because:
 - (i) Some organisms are very too small or too many
 - (ii) Some organisms move from one place to another.
 - (iii) Some organisms may be poisonous or dangerous.
- ✓ This problem is solved by taking representative samples from within the habitat.
- ✓ A sample is a small number of individuals taken from a habitat that is representative of the whole population. Samples are used where the

area to be studied is too big.

- ✓ Sampling can be carried out using the following methods:

(1) Sampling methods

a) Quadrat method

- ✓ A quadrat is a square frame of known area made of wood or metal. The standard quadrat is a square meter (m^2) but small quadrats can be used if only a small area is being studied.
- ✓ The quadrat can further be sub-divided into smaller squares by lengths of string or wire.
- ✓ X
- ✓ **Procedure**

(i) Select a suitable study area

(ii) Mark the study area and measure its size.

(iii) Stand in the middle of the study area, hold the quadrat aloft and throw it at random within the study area.

(iv) Where the quadrat lands identify and count all the living organisms enclosed within the boundaries of the quadrat and record the number of each species identified.

(v) Make several throws of the quadrats and repeat step (iv) for each quadrat thrown. Record your result in the table below.

X

(vi) Work out the average for each species from the total throws
$$\text{Specimen A} = \frac{\text{Total species}}{\text{No. of throws}}$$

$$= \frac{20+2+100+0+50+68}{6} = 40$$

6

i.e. average number of specimen A in cm^2 is 40

(vii) Calculate the total population in the study area.

Example

a. Supposing that the area of the playing field is $5000m^2$ and the average number of star grass per m^2 is 30. Calculate the

number of star grass
in the field.

If $1\text{m}^2 = 30$

$5000\text{m}^2 = 5000 \times 30$

1

= 15,000 star
grass

(b) Line transect method

- ✓ It may be used to find out the distribution of species of plants in an area
- ✓ A line transect is taken by running a rope across the plot and marking off equidistant points. Outs are made at each point (station). Only those plant along the line are identified counted and recorded
- ✓ A line transect is particularly useful when studying transition in habitats and population through an area.
- ✓ X

(c) Belt transect

- ✓ A belt transect is taken by running two ropes parallel to each other and about 1m apart along the length of a plot. Counts are made between the two ropes at marked points

(d) Capture - recapture method

- ✓ This method is suitable for highly mobile animals like insects, birds, small mammals and fish.

Procedure

- (i) Catch and mark as many organisms under study and record them as first marked (FM)
- (ii) The animals are given time to disperse and mix with the remaining population for 24hrs. After 24hrs return to the habitat and capture as many organisms as possible.
- (iii) Record the number of organisms collected

as second capture (SC) and the number of those that were marked with paint i.e. marked recapture (MR)

$$P = \frac{FM \times SC}{MR}$$

Whereas

P – Total population

SC – second capture

FM – first marked

MR – marked

recaptured

NB – the marking technique should not harm the animal or alter its behavior

- ✓ Marking technique includes light coloured paint that is quick drying e.g. cellulose paint or coloured nail varnish.
- ✓ For water animals the paint should be waterproof
- ✓ Other methods include use of tags.

Assumptions made

- ✓ No organisms move in or out of the area

between the two counts.

- ✓ The released animals mix freely with the remaining population.
- ✓ The mark does not alter the animal's behavior.
- ✓ The marked animals will have enough time to mix with the rest.
- ✓ The population number does not vary during the study period.

Example

- (i) To estimate the population size of mosquitoes in ASTU village, KEMRI researchers caught 400 mosquitoes which they marked and released. After 24hrs, 200 mosquitoes were caught out of which 80 had the marks. Estimate the population size of mosquitoes in the village.

$$P = \frac{FM}{MR} \times SC = \frac{400 \times 200}{80} = 1000$$

mosqui

- (ii) The initial number of organisms captured is 75. The second captured is 200. The number of organisms recaptured is 50.
- $$P = \frac{FM}{MR} \times SC = \frac{75 \times 200}{50} = 300$$

(2) Aerial photography count

- ✓ It involves photographing organisms from the air and counting them
- ✓ The method is suitable for large animals that congregate in open spaces
- ✓ **(3) Census /direct counting/head count**

- ✓ This involves the direct count of members of a species in a given area
- ✓ The method is suitable for large organisms in open areas like savannah grassland
- ✓ **Adaptations of plants to various habitats**
- ✓ Adaptation is change in an organism that increases its chances of survival in a specific environment.
- ✓ These changes may be structural, behavioural or physiological.
- ✓ Based on adaptations, there are 4 main groups of plants i.e.
 - Xerophytes
 - Helophytes
 - Hydrophytes
 - Halophytes
- ✓ **Xerophytes**
- ✓ They are plants adapted to withstand a dry habitat or to endure condition of prolonged drought as

in arid and semi-arid areas.

✓ **Characteristics of dry habitats**

- ✓ Unpredictable and poorly distributed, rainfall – less than 250mm
- ✓ Very high day temperatures but very low night temperatures resulting in high diurnal temperature range.

✓ They are very windy

✓ **Adaptations of xerophytes to their habitats**

- ✓ High ability to absorb water from the soil.
 - Some plants have deep roots to absorb water from deep in the soil e.g. acacia tree.
 - Other plants have superficial roots which grow horizontally close to the soil surface to absorb water after a short or

light shower of rain.

- ✓ Many xerophytes have water storage tissues.

- Some xerophytes such as Bryophyllum have succulent stems to store water. Other plants are Eurphobia, sisal, opuntia, aloe

- ✓ Some xerophytes have a very short life cycle to evade drought hence some survive as seeds or underground perenating organs e.g. corms and bulbs.

- ✓ The plants reduce their rate of transpiration by:
 - Some leaves have thick waxy cuticle to minimize the rate of cuticular transpiration e.g. sisal and aloe.
 - Some have hairs covering the surface of leaves hence trapping

- moisture e.g. Sodom apple
- Some leaves are reduced in size such as scale like leaves of whistling pine (*casuarina spp*) or modified into spines as in cactus. This reduces the surface area over which transpiration occurs.
 - Shedding of leaves during drought to reduce surface exposed to transpiration.
 - Some leaves are folded or rolled up to ensure stomata are not exposed to environmental factors.
 - Most xerophytes show reduced number of stomata which are located on the lower epidermis that lowers the rate of transpiration.
 - Some have sunken stomata which accumulate moisture in sub-stomatal air spaces leading to low diffusion gradient thus reducing transpiration rate e.g. Nerium oleander.
 - Some xerophytes experience reversed stomatal rhythm (opening at night and closing them by day) to prevent excessive loss of water by transpiration.
- (b)**
- Mesophytes**
- ✓ These are plants growing under normal conditions of water supply or in well watered soils. They are found in savannah, rainforests e.t.c.
 - ✓ The habitats of Mesophytes have the

following characteristics

- Adequate rainfall i.e. 950mm - 1800mm that is well distributed throughout the year.
- Relatively high humidity
- Moderate to high temperatures with low diurnal range
- Shallow water table.

Adaptations of Mesophytes to their habitat

- ✓ Depending on where they grow in these habitats, they show various adaptations e.g.

(i) In forest ecosystem

- Trees grow tall due to competition for light
- Climbers such as lianas have vines which twine on trees to reach the source of light while epiphytes

support themselves on the branches of taller trees.

- Others that cannot compete for light are adapted to photosynthesise under low light intensities by having numerous chloroplasts.
- Majority show leaf mosaic that minimizes overlapping and over shadowing of leaves so that all leaves are exposed to light for photosynthesis.
- Have broad leaves with thin cuticles and many stomata on both leaf surfaces to encourage high rate of transpiration.
- Some have waxy and glossy surfaces to reflect the strong light rays and drip off rain water respectively.

(ii) **Grassland**

- Long tap root system to reach the water table
- Extensive fibrous root system to absorb rain water. Some are shallow rooted and thus develop buttress roots or prop roots for extra support e.g. *Ficus natalensis*
- Needle like leaves to reduce the rate of transpiration
- Fewer stomata on the upper leaf surface to reduce the rate of transpiration.
- Shedding of leaves during the dry season.

(c) Hydrophytes

- ✓ These are plants which grow wholly or partly in fresh water.
- ✓ Their habitats are characterized by:
 - Low concentration of dissolved gases such as oxygen

- Waves and currents are common

- Less light under the water

There are 3 types of hydrophytes i.e.

(i) Floating types

- They include *pista*, *salvinia molestus* (water lettuce), *duckweed*, *hyacinth* and *algae*.

(ii) Emergent types

- They have roots for anchorage but their stem and leaves are extended to float on the water surface e.g. water Lilly

(iii) Sub merged types

- They may be suspended in water or anchored at the bottom of the aquatic habitat e.g. *ceratophyllum*, *elodea*, *spirogyra* e.t.c.

Adaptations

- ✓ Most emergent and floating types have broad leaves with maximum number of stomata on the upper surface. This provides a large surface area for gaseous exchange. The exposed stomata allow for quick loss of water through transpiration
- ✓ Some sub merged hydrophytes have leaves which are deeply dissected into thread like straws in order to provide a large surface area for absorption of maximum light for photosynthesis.
- ✓ Their leaves have numerous and sensitive chloroplasts that photosynthesize under low light intensities.
- ✓ Have large air filled tissues (aerenchyma). The air gives buoyancy to the plants and also assist in gaseous exchange.
- ✓ They have poorly developed roots that lack root hairs to reduce absorption of water.
- ✓ Flowers are raised above the water to allow for pollination.
- ✓ **(d) Halophytes**
- ✓ These are plants which are able to tolerate very salty conditions in soil and marine water.
- ✓ These habitats are characterized by:
 - Low concentration of dissolved gases especially in marine water.
 - Light intensity is low in marine water

-High
concentration of
mineral salts

Adaptations

- ✓ Seaweeds grow close to the water surface where there is sufficient light for photosynthesis.
- ✓ Submerged plants are able to carry out photosynthesis at low light intensity
- ✓ Root cells concentrate a lot of salt to enable the roots absorb water by osmosis.
- ✓ Mangroves have well developed prop and stilt roots for support.
- ✓ Mangroves growing in mud flats have buttress roots for support.
- ✓ Some like mangroves have pneumatophores (breathing roots) which emerge above water to obtain atmospheric oxygen for respiration.

- ✓ The reproductive adaptations include floating fruits. The fruits have got large aerenchymatous tissue for air storage that makes them buoyant.

POLLUTION

- ✓ Pollution is the addition of substances to the environment in quantities that are harmful to the organisms and distribute to an ecosystem.
- ✓ Pollutants are substances that cause pollution. There are 3 main categories of pollution i.e air, water and soil pollution.

1.AIR POLLUTION

- ✓ It refers to the contamination of air. The causes of air pollution include:
Sulphur based chemicals e.g. sulphur IV oxide

(SO₂) and Hydrogen sulphide (H₂S).

- ✓ They are produced by food preserving industries, manufacture of sulphuric acid and burning of sulphur based petroleum fuels.
- ✓ Hydrogen sulphide is produced from mineral extraction, mine and also from geothermal power stations like Olkaria.
- ✓ Volcanic activities also release hydrogen sulphide, carbon IV oxide and carbon II oxide (CO) into the atmosphere.
- ✓ **Effects**
- ✓ High concentrations of sulphur IV oxide leads to bronchitis, pneumonia and heart failure.
- ✓ It also causes irritation and interfere with gaseous exchange.
- ✓ Sulphur IV oxide also dissolves in rain

water and falls as acid rain which lowers the soil PH thus lowering the crop production.

- ✓ Also acid rain corrodes metals such as iron and aluminium in buildings.
 - ✓ Acid rain also causes leaching of magnesium and calcium ions from the soils.
 - ✓ Hydrogen Sulphide poisons the organisms. It contaminates blood and suffocates victims when inhaled.
- Oxides of nitrogen
e.g. Nitrogen II
Oxide (NO) and
Nitrogen IV Oxide
(NO₂)**
- ✓ These are produced from burning of petroleum fuels in industries and emissions of exhaust fumes in motor vehicles.
 - ✓ **Effects**

- ✓ Nitrogen oxides dissolve in rain water forming acid rain.
- ✓ They are also poisonous to animals affecting respiratory systems when inhaled
- ✓ Nitrogen IV Oxide is carcinogenic
- ✓ When trapped near the ground these gases seriously diminish visibility on roads.
- ✓ **Smoke and fumes**
- ✓ These contain carbon II Oxide (CO), carbon IV Oxide (CO₂) and carbon particles. These are produced from industries which burn coal and petroleum fuels and from the burning of natural gases and charcoal.
- ✓ **Effects**
- ✓ Smoke and fumes affect the visibility due to “smog” on roads
- ✓ When they settle on leaves they block the stomata hence hinder photosynthesis.
- ✓ Smog also causes intense eye irritation, headaches and breathing difficulties
- ✓ Carbon IV Oxide causes respiratory poisoning since it readily combines with haemoglobin forming carboxyhaemoglobin leading to O₂ deficiency.
- ✓ CO₂ prevents layers of warm air from escaping into the upper atmosphere causing green house effect that leads to global warming.
- ✓ Global warming leads to generally high temperatures that have caused the melting of snow on the peak of

mountains such as Kenya and Kilimanjaro.

✓ **Dust**

- ✓ Its composed of small particles emitted from cement lime producing industries such as:
 - Cement works
 - Quarries
 - Road constructions
 - Dusty dry weather roads

NB A “wet method” of cement manufacture which does not result into the release of dust has been adopted by East African Portland cement Bamburi cement limited.

✓ **Effects**

- ✓ Dust settles on plants leaves hence limiting photosynthesis
- ✓ It clogs the respiratory surfaces of organisms resulting in breathing difficulties and respiratory diseases.

- ✓ Dust reduces visibility and irritates the eyes.

Lead

- ✓ This is mainly from consumption of leaded petrol by motor vehicles. Lead is normally added to petrol to serve as anti-knock compound in vehicle engines so as to improve the engine combustion.

Effects

- ✓ When inhaled it is absorbed into the blood stream and accumulates in the liver, kidneys and bones of animals affecting physiological functioning of these organs.
Leads is also thought to interfere with mental development of children.
- ✓ In plants it leads to the blocking of stomatal pores making it difficult for the plants to carry

out gaseous exchange
hence no
photosynthesis

(vi) Aerosols

- ✓ An aerosol is a substance that consists of very fine particles of liquid or solid suspended in a gas e.g. pesticides, insecticides, fungicides, perfumes, air fresheners or spray paints.
- ✓ The main pollutants in these aerosols are copper, lead and chlorofluorocarbon (CFC) compounds
- ✓ **Effects**
- ✓ When copper based aerosols are inhaled they cause irritation of respiratory organs of animals.
- ✓ Copper also causes poisoning of water plants and fish.
- ✓ Copper based chemicals are non-biodegradable hence tend to accumulate in the ecosystem.

- ✓ CFCs are used in refrigerators and as propellants in aerosol cans such as perfume.

- ✓ The main effect of CFCs is the depletion of the ozone layer leading to increased penetration of U.V radiation which causes skin cancer and affects crops

(vii) Noise

- ✓ It's the presence of undesirable sound in the atmosphere. It's produced by machines in factories, heavy vehicles, aeroplanes, music players, loud speakers and juakali workshops.

Effects

- ✓ **Affects** hearing in animals. Human beings become insensitive to low pitched sounds.
- ✓ It's an irritant and causes stress in animals.

Control of air pollution

✓ Legislation-

- government needs to enforce the relevant legislative acts on environmental pollution.
- ✓ Automobile should be fitted with filters and catalytic converters in their exhaust pipes to reduce emission of oxides of nitrogen, sulphur and carbon.
- ✓ Industries manufacturing sulphuric acid and nitric acids should have long chimneys fitted with scrubbers e.g. solar and wind energy
- ✓ Use CFC free aerosols and appliances
- ✓ Use of biological control methods to control pests, diseases and weeds. This reduces reliance on biodegradable chemicals.

- ✓ Encourage use of public means of transport as much as possible other than private cars, this minimizes consumption of fossil fuels and emission of gas pollutants.
- ✓ Smoking in public should be abolished.
- ✓ Ear muffs should be used in factories and juakali workshops that generate loud noises.
- ✓ The masses should be educated on the need for sustainable environmental management.
- ✓ The government should be signatory to global treaties on environmental conservation

2. WATER POLLUTION

- ✓ It is the addition of substances into the water bodies in quantities that are harmful to the living organisms'

dependent on that water.

Sources of water pollution

Domestic effluents-

untreated sewage from urban centers gets discharged into rivers used for water supply for domestic purposes.

- ✓ This sewage contains disease causing micro-organisms such as bacteria, viruses and protozoa. It's also full of faecal material and urine which encourage bacterial growth. Kitchen wastes also contain detergents that have a lot of phosphates.

Effects

- ✓ Water pollution may cause epidemics of water -borne diseases e.g. cholera, typhoid and amoebic dysentery.
- ✓ The faecal material is broken down by saprophytic bacteria

and fungi which lead to depletion of dissolved oxygen in water. This in turn affects aquatic organisms such as fish and aquatic plants.

- ✓ Decomposition of wastes also releases nutrients into the water which causes rapid growth of water hyacinth e.g. L.victoria. This enrichment of the lake with nutrients and its effects is called eutrophication.

Industrial effluents

- ✓ Industries discharge various effluents into rivers, dams e.t.c.. The effluents contain toxic metallic compounds of mercury, arsenic and cadmium in addition to acids and other chemicals.

Effects

- ✓ The poisonous compounds directly

kill aquatic organisms such as fish.

- ✓ This compound enter the food chain and accumulate to lethal levels in organisms higher up the trophic levels

- ✓ **Heat**

- ✓ Industries discharge hot water directly into the water bodies. Some of the effluents may react among themselves releasing heat into the water

Effects

- ✓ Heat reduces the amount of dissolved gases in water e.g. oxygen and carbon dioxide thus organisms may die from oxygen deficiency.
- ✓ The hot water may even kill the living organisms directly due to the high temperatures.

Oil Spillage

- ✓ Oil spillage occur in oceans from oil tankers accidents,

- ✓ **Marine organisms such as fish** are

killed by clogging on their respiratory surfaces.

- ✓ Marine birds get their feathers clogged hence have difficulty in flight.
- ✓ Oil coats photosynthetic phytoplankton's till they die.
- ✓ There is reduced light penetration into the water hence photosynthesis of submerged plants is hindered

Agrochemicals

- ✓ They include_ inorganic fertilizers, herbicides, and pesticides.
- ✓ The inorganic fertilizers contains phosphates and nitrates
- ✓ Pesticides may contain heavy metals e.g. mercury and copper. other pesticides such as DDT contains CFC

which are not easily broken down biologically(non-biodegradable)

Effects

Most of these chemicals contain heavy metals such as copper and mercury which affect respiratory activities of aquatic organisms.

- ✓ These chemicals accumulate in the body over a long time and reach toxic levels leading to death

- ✓ Nitrates and phosphates in fertilizers cause eutrophication

Lead

- ✓ This is water pollutant mainly from pipes and tanks in domestic water supply system. through run-off it finds its way into water bodies like rivers, lakes and oceans

Mercury

- ✓ It's a pollutant released by industries that manufacture chlorine, sodium hydroxide oves and vinyl plastics.

- ✓ Also released during combustion of coal and petroleum oils

- ✓ Fungicides and some cosmetics also contain mercury
- Effects

- ✓ Methyl mercury is volatile and very toxic it is absorbed by aquatic organisms or though leaves hence entering the food web involving human beings animals eating plants will mercury are poisoned and killed

- ✓ Mercury poisoning_in people results in accumulation of mercury in liver, kidney and brain affecting the physiological functioning and eventually causes death.

- ✓ Mercury also interferes with the process of melanin formation leading to skin lightening , blindness paralysis and even death
- ✓ **SOIL EROSION**
- ✓ Silt is transported into water bodies
- Effects
- ✓ It makes water unclean and unfit for human consumption
- ✓ The silt reduces light penetration hence hindering photosynthetic activities.
- ✓ It clog the respiratory surfaces of aquatic organisms e.g. gills in fish stomata in plants. This interferes with gaseous exchange.

Control of water pollution

- ✓ Legislation- relevant legislation should be enforced and provide for heavy penalties.
- ✓ Industries should control or treat the industries effluents

before discharging into water bodies.

- ✓ Proper treatment and disposal of sewage there should be separate systems for disposal of sewage and drinking water.
- ✓ Latrines should be constructed and properly used in addition to proper personal hygiene to control diseases causing agent.
- ✓ Encourage use of unleaded fuels
- ✓ The public should be educated on correct use of inorganic fertilizers and pesticide to be used and should offshore oil wells and refineries.

Effects

- ✓ **Oil** layer on the water surface reduces oxygen supply to the water and this may lead to death of aquatic life forms.

- ✓ be encourage using organic farming which biologically control pest.
- ✓ Appropriate soil control methods to be put in place such as building of gabions.

3.SOIL POLLUTION

- ✓ This is where chemicals are discharged into the soil and accumulate to levels that cause harm to soil organisms
- ✓ **Sources of soil erosion**
Oxides of sulphur – e.g. sulphur IV oxide enter the soil through precipitation as acid rainfall acid rain alters the soil pH therefore affecting plants and animals that cannot tolerate acid soil
- Aerosols**
- ✓ Most aerosols sprayed to control pest and disease in plants and animals contain heavy

metals e.g. copper and mercury

- ✓ The chemicals fall on the soil and are taken up by plants where their concentration increases and lead to the death of animals.
- ✓ **Petroleum products**
- ✓ They are spilled on land e.g. oil tankers. Some organisms fail to obtain oxygen in soil saturated soil and therefore die
- Inorganic fertilizers**
- ✓ Contain phosphate and nitrates which increase soil acidity so that the soil micro organism cannot inhabit such soils
- Solid waste**
- ✓ Community household waste and industrial wastes.

- ✓ Some are biodegradable e.g. food residue, oil clothing and papers. Others are non- biodegradable e.g. rubber plastic containers scrap metals and glass bottles
 - ✓ Solid wastes are a nuisance and may also be injurious e.g. glass bottles.
 - ✓ They destroy the aesthetic state of the environment
 - ✓ They offer breeding grounds for pests rodents and insects vectors which pose a health hazard to human beings
 - ✓ The non-biodegradable solid wastes limit soil aeration thus inhabiting micro-organisms activities
- Control of soil pollution**
- ✓ Recycle solid waste e.g. polythene paper and plastic

- containers, glass bottles paper and scrap metal.
 - ✓ Household wastes that are biodegradable can be disposed in a compost pit to form compost manure for organic farming.
 - ✓ Combustible soil waste e.g. oil cloths sanitary towels hair should be burned in incinerators
 - ✓ encourage pipeline transportation of petrol and petrol products to minimize risk of spillage
 - ✓ discourage the excessive use of agrochemicals
 - ✓ biological control of pests and diseases to be encouraged
 - ✓ enforce appropriate legislation on proper solid waste management
- 4. RADIOACTIVE EMISSION**

- ✓ Nuclear energy is based on the destruction of atom of matter to release energy. The form in which this energy is released when atoms are broken down is generally called radiation. such radiations have great power and it is very destructive if it leaks accidentally
 - ✓ The industries in which this energy is produced are called radioactive or nuclear reactors. Some of the common substances broken down to release nuclear energy are uranium, radium, germanium, plutonium, Hydrosonium (heavy water)
- HUMAN DISEASES**
- ✓ A disease is a disorder state of a tissues, organ

system or organism during which its function is not carried out normally.

a. Bacterial diseases

- ✓ They are caused by bacterias e.g.

Cholera

- ✓ Cause *Vibrio cholerae*

Mode of transmission

- ✓ It's a waterborne disease. Epidemic of cholera are common during floods.
- ✓ It's transmitted through contaminated human faeces and food.
- ✓ Its spread by houseflies which feed on both contaminated faeces and human food.
- ✓ Incubation period is spread few hours to 6 days.

Symptoms

- ✓ The bacteria reach the intestine and multiply rapidly.
- ✓ They secrete an enzyme called mucinase which digests the inner lining of the intestines. The exposed intestinal wall becomes irritated and damaged by the produced by the bacteria and this causes violent diarrhoea and vomiting accompanied by severe abdominal pains.
- ✓ Leads to general body dehydration occurring to the high frequency of defecation accompanied by loss of large quantities of water.
- ✓ Death can occur within 24 hours of infection in extreme cases.

✓ **Adaptive characteristics**

- ✓ Adaptive characteristics are the structural and functional mechanisms which make a parasite be better suited to its environment.
- ✓ They form cysts that remain dormant for sometime.
- ✓ They can survive outside the body of the host.
- ✓ Can survive in areas of low oxygen concentration like that in the small intestines.

Prevention and control

- ✓ Treating patients using antibodies.
- ✓ Isolating the patient especially during an outbreak.
- ✓ Disposing faeces properly in toilets

and latrines discouraging the practice of “flying toilets”(deface in plastic bags which are then thrown into water dumps or rooftops).

- ✓ The toilets and latrines should be cleaned daily with disinfectants. The latrines should be located far from water sources such as wells and boreholes.
- ✓ Boiling drinking water.
- ✓ Cooking food properly before it is eaten
- ✓ Washing fruits and vegetables properly before eating.
- ✓ Killing houseflies using insecticides. Covering food properly before storing it.
- ✓ Vaccinating people against the disease in areas prone to

cholera. The vaccine is effective for 6 months only.

- ✓ Proper treatment and disposal of sewage.

✓ **Typhoid**

- ✓ **Cause:** *Salmonella typhi*

✓ **Mode of transmission**

- ✓ It's a food and water-borne disease.
- ✓ It can also be transmitted through sweat and saliva droplets.
- ✓ Its spread by houseflies and cockroaches and salmonella bacteria is found in the intestines, lymph nodes.

✓ **Symptoms**

- ✓ Fever
- ✓ Flu
- ✓ Headache
- ✓ Abdominal pains
- ✓ Vomiting
- ✓ Throat infections
- ✓ Dry cough
- ✓ Diarrhea
- ✓ Dehydration

Adaptive characteristics

- ✓ They survive in contaminated water for a long time.
 - ✓ They have many alternative hosts such as pigs, cattle and poultry hence the chance of infecting human beings is high.
- Prevention and Control
- ✓ To treat patients with antibiotics
 - ✓ Proper disposal of feces and urine in toilets and latrines.
 - ✓ Boil drinking water.
 - ✓ Cook food properly before serving it.
 - ✓ Wash vegetables and fruits in treated water before eating them.
 - ✓ Kill houseflies and cockroaches

using insecticides.

- ✓ Food should be properly covered before storage.
- ✓ Proper treatment and disposal of sewage.
- ✓ People can be vaccinated against typhoid [effective for 3 yrs]

b. Protozoan diseases

i. Malaria

- ✓ It's caused by a plasmodium. The four types of plasmodium are : Plasmodium malariae
- ✓ Plasmodium vivax
- ✓ Plasmodium ovale
- ✓ Plasmodium falciparum
- ✓ **Mode of transmission**
- ✓ Plasmodium parasites live in a female anopheles mosquito and in human beings.

The male anopheles mosquito feeds on the sap of plants.

- ✓ Female anopheles mosquito transmits malaria by biting an infected person then biting a healthy person. The parasites are transmitted from the infected to the healthy person through the bite.

- ✓ Plasmodium attack RBC and the liver of humans. Incubation period 8-10 days.

Symptoms

- ✓ Fever and shivering
- ✓ Headaches
- ✓ Pain in the joints and sometimes all over the body.
- ✓ Enlarged spleen and liver.
- ✓ Vomiting.
- ✓ Anaemia

- ✓ Loss of appetite
- ✓ Profuse sweating punctuated by chills and shivers. NB sometimes plasmodia parasites cause a more severe and fatal form of malaria by entering the brain cells. This causes cerebral malaria which causes mental disorders.

Adaptive characteristics

- ✓ The parasites are not digested in the stomach of the mosquito.
- ✓ Plasmodium is able to enter the RBC and reproduce within haemoglobin.
- ✓ Some parasites mutate and become resistant to some of the drugs used for treating malaria.

Prevention and control

- ✓ Take preventive anti-malaria drugs especially when travelling to malaria-prone areas.
- ✓ Treat patients using anti-malaria drugs.
- ✓ Sleep under mosquito net which has been treated using anti-malaria medicine.
- ✓ Apply mosquito repellent cream to the body.
- ✓ Control the vector by:
 - Spraying insecticides to kill mosquitoes.
 - Draining mosquito breeding places such as pools, broken pots and tins.
 - Introducing fish into the ponds to feed on mosquito larvae.

- Spraying oil onto the surface of stagnant water in order to kill mosquito larvae.
- Clearing bushes around homesteads.

Amoebic dysentery

- ✓ Cause: Entamoeba histolytica
- ✓ **Mode of transmission**
- ✓ Transmitted through contaminated water and food hence termed as water-borne disease.
- ✓ The protozoa are spread by houseflies. The protozoa live in the human intestines causing damage to them. They cause traces of blood to appear in the faeces.
- ✓ Incubation period is 21-28 days.

Symptoms

- ✓ Diarrhoea
- ✓ Faeces have traces of blood.
- ✓ Abdominal pains
- ✓ vomiting
- ✓ fever

Adaptive characteristics

- ✓ the parasites is able to feed on the digested food of the host;
- ✓ it resist digestion by the enzymes of the host.
- ✓ They form a cyst

Prevention and control

- ✓ Treat patient using anti-protozoa drugs.
- ✓ Destroy vectors using insecticides.
- ✓ Proper treatment and disposal of sewage.
- ✓ Boil drinking water.
- ✓ Cook food properly
- ✓ Proper food storage
- ✓ Clean vegetables and fruits in

treated water before eating them

• Parasitic worms

a) Schistosomiasis (bilharzia)

- ✓ It's caused by a blood fluke referred to as schistosome. there are various species of schistosome i.e.
 - Schistosoma mansoni*
 - Schistosoma japonicum*
 - Schistosoma haematobium*

Mode of transmission

- ✓ Schistosoma eggs are passed from an infected person to a healthy person through urine or faeces which are discharged into the water.
- ✓ The eggs hatch into larvae which enter an intermediate host.e.g snail

- ✓ The larvae live the snail and live into the water where they penetrate the human being through the skin.

Effects of the parasite on the host

- ✓ Presence of blood in urine.
- ✓ General body weakness.
- ✓ Pain in the lower abdomen.
- ✓ Itchy skin.
- ✓ Damage of liver and kidney

Adaptive characteristics

- ✓ Ability to tolerate low oxygen concentration in the tissues of the urinary bladder.
- ✓ The parasite has suckers for attachment so that they are not dislodged
- ✓ The parasite has 2 host i.e. primary host(human being) and secondary

host(snail) thereby increasing their chances of transfer to several host

- ✓ The cercariae larvae and eggs of the parasite has glands that secrete lytic enzymes which soften tissues to allow more penetration into the host
- ✓ Some larval forms e.g. cercariae are encysted and can remain dormant and viable until they come into contact with the human being
- ✓ The adult worm in blood produces chemical substances which protect it against the host defense mechanism
- ✓ They worm are of separate sexes. The male forms a gynecophoric canal in which it carries the female.

This ensures that eggs produced by the female are fertilized before they are shed into the blood vessels

✓ **Prevention and control**

- ✓ People should wear protective shoes and clothes and avoid walking barefooted in swampy areas.
- ✓ Treatment using anti-schistosomiasis drugs
- ✓ Use molluscicides to eradicate snails
- ✓ Do not bath or stand in stagnant water
- ✓ Boil water used for domestic purposes
- ✓ Proper treatment and disposal of sewage

b) Ascaris lumbricoides

- ✓ It's a parasitic roundworm which belongs to the

phylum nematode (roundworms)

- ✓ Its characterized by a brownish yellow colour with mouth parts having three lips

Mode of transmission

- ✓ Its transmitted through contaminated food and water

Effects of parasite on host

- ✓ General nourishment and tendencies to have a large appetite because the digested food is consumed by the parasite in the intestine
- ✓ The worms block the intestines thus interfering with digestion, also due to intestinal blockage victims develop large round stomachs.
- ✓ The worms my move towards the

nasal passages and interfere with breathing

- ✓ Pneumonia may develop due to weakened lungs
- ✓ Abdominal discomforts
- ✓ The parasite produces toxic substance in a host's body

Adaptive characteristic

- ✓ It has a hard outer pellicle that resists the digestive enzymes of the host
- ✓ The worms tolerate low oxygen concentration in the ileum
- ✓ They lay many eggs to ensure survival of the species
- ✓ Eggs are covered by a cyst which resists the enzymes of the host
- ✓ The worm uses its lips to suck

digested food from the host

- ✓ The worm produces an anti-enzyme to counter the enzymes of the host
- ✓ It has 2 hosts; human beings and pigs. This ensures that it always has a ready host for survival
- ✓ It has a muscular pharynx through which it sucks digested food from the host's intestine into its own gut

Prevention and control

- ✓ Drugs can be used to kill worms
- ✓ Boil drinking water
- ✓ Proper use of toilets and latrines
- ✓ Proper treatment and disposal of human waste
- ✓ Cook food thoroughly before eating it
- ✓ Practice personal hygiene

✓

✓