CHAPTER 9.1 – COMMUNITY AND ECOSYSTEM

Community and ecosystem

HABITAT

- Habitat is the natural surrounding or the living place of an organism

SPECIES

❖ A species is a group of similar organisms, able to interbreed and produce offsprings

POPULATION

A population is a group of organisms of the same species which live in the same habitat

COMMUNITY

→ A community is the populations of all organisms from different species living in the same habitat whilst interacting with each other

ECOSYSTEM

» An ecosystem is a few communities that live together in a habitat and interact with each other including non-living components (water, air and soil)

NICHE

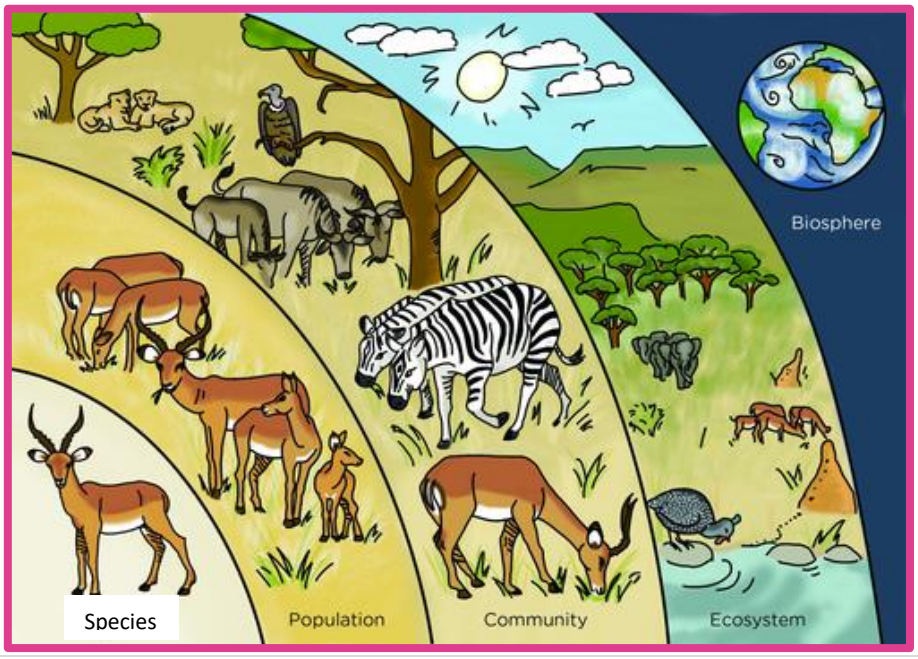
❑ A niche is the role of an organism in an ecosystem which includes its behaviour and interactions with biotic and abiotic components in the surrounding of its habitat

❑ Ecological niche

⊕ The role of a species in its surroundings

❑ Species niche

▪ The way in which a species interacts with biotic and abiotic components within its surroundings



Biotic and abiotic components in an ecosystem

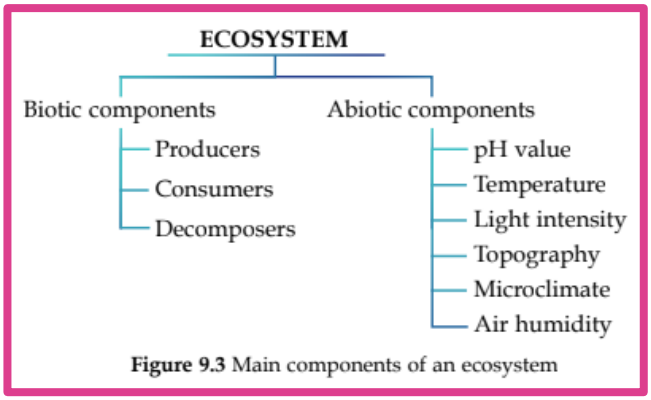


Figure 9.3 Main components of an ecosystem

Abiotic components

pH VALUE

- ⌂ pH value of soil strongly influences the distribution of living organisms in a habitat
- ⌂ Most organisms are capable of living adequately in a condition in which the pH value is either neutral or almost neutral
- ⌂ Soil is a habitat for hundred million of worms and microorganisms (bacteria, fungi and protozoa)

TEMPERATURE

- ↘ Surrounding temperature affects the psychological activities of plants and animals
- ↘ A little change in temperature causes a reduction in the metabolic rate of organisms as all the enzymes that catalyse physiological responses are sensitive towards temperature changes
- ↘ Although most organisms can live within the temperature range of 20°C to 40°C, there are also organisms which can live in extreme temperatures
- ↘ Polar bears can live in Tundra, a habitat with a temperature of -14°C whereas foxes can live in the desert where the temperature can reach up to 45°C during the day

LIGHT INTENSITY

- ♥ Light intensity and duration of sunlight received by a certain region can strongly influence the distribution of organisms especially for plants that carry our photosynthesis
- ♥ Taller plants in tropical rainforests that are exposed to high light intensity form a canopy providing low light intensity underneath
- ♥ Only small plants (ferns) can grow under the canopy
- ♥ Coniferous forests in regions with temperate climate have lower density of plants due to low light intensity
- ♥ Plants in coniferous are shorter as well as smaller in size

TOPOGRAPHY

- Δ Topography is the physical characteristics on the surface of the Earth which include altitude, gradient and aspect
- Δ Topography determines humidity, temperature and light intensity in an ecosystem
- Δ Altitude
  - ➢ The higher the altitude, the lower the relative humidity,

atmospheric pressure and oxygen content
  - ➢ Plants at different levels of altitudes are different in types, sizes and density
  - ➢ For example, pine trees that grow at higher altitudes are smaller in size compared to *meranti* trees which can be found in tropical rainforests
- Δ Gradient
  - ➢ Steeper mountain slopes are easily eroded due to swift water movement
  - ➢ The soil layer becomes thinner and drier
  - ➢ This area has less growth of plants except for some short, thorny shrubs with small and pointed leaves
- Δ Aspect
  - ➢ Aspect refers to the direction in which wind blows and the rays of sunlight
  - ➢ A mountain slope which faces the sea has denser plants compared to the one facing towards the land
  - ➢ This slope also gains more rainfall distribution
  - ➢ The slope that receives more sunlight is denser with plants

MICROCLIMATE

- ◊ Microclimate refers to the climate condition of a small area which is different from the surrounding area
- ◊ Microclimate can take place under the rocks, or beneath the shades of bigger plants of the forest canopy
- ◊ Microclimate depends on temperature, humidity, light intensity, heat balance, atmospheric pressure, water evaporation and ability of soil to retain water around an area in order to maintain humidity

AIR HUMIDITY

- ✓ Air humidity is the quantity of water vapour in the air which affects the distribution of organisms in a habitat
- ✓ There are more organisms occupying areas of high humidity than in dry areas
- ✓ Low air humidity increases water loss in a stoma through transpiration
- ✓ This situation enhances the absorption of water and mineral salts from the soil
- ✓ Transpiration also provides a cooling effect; therefore, plants can maintain optimum temperature for enzyme action

Biotic components

PRODUCERS

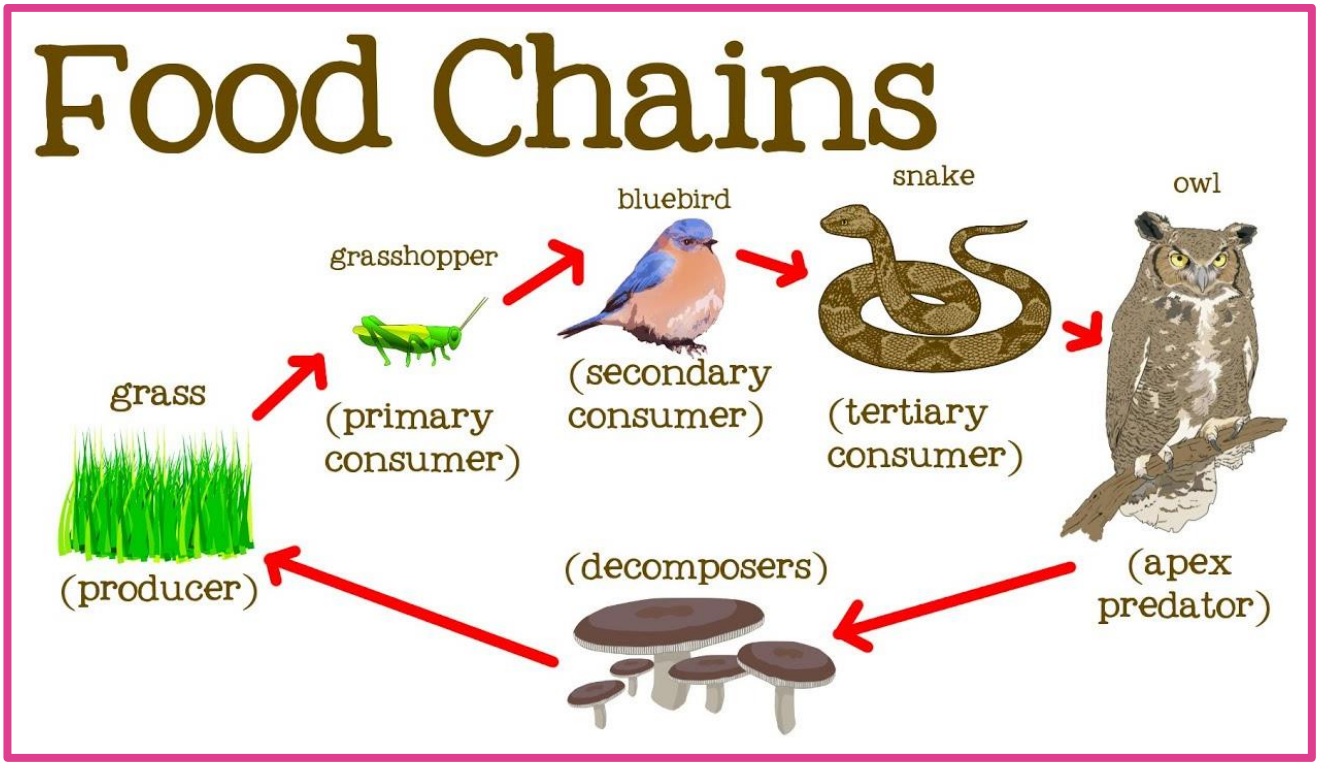
- Autotrophs synthesise organic substances from inorganic substances
- Producers consist of green plants which synthesise glucose from water and carbon dioxide with the help of energy from sunlight

CONSUMERS

- ⊕ Primary consumers
  - → Herbivores which gain energy by feeding on producers
- ⊕ Secondary consumers
  - ☖ Carnivores which feed on primary consumers or omnivores which feed on primary consumers and producers
- ⊕ Tertiary consumers
  - ✓ Carnivores which feed on secondary consumers

DECOMPOSERS

- ◊ Microorganisms decompose waste substances as well as dead or decaying organisms into simpler organic substances (carbon dioxide, ammonia)



Autotrophic and heterotrophic nutrition

- » Nutrition is a way for an organism to obtain nutrients and energy from the food for its life processes
- » There are two types of nutrition
  - I. Autotrophic
  - II. Heterotrophic

Autotrophic

PHOTOAUTOTROPHIC

- Δ Photoautotrophic refers to an organism that synthesises complex organic compounds from carbon dioxide together with light energy
- Δ Photoautotrophs synthesise their own food via the process of photosynthesis
- Δ Example: green plants

CHEMOAUTOTROPHIC

- Chemoautotrophs include a few types of bacteria which synthesise organic compounds without using light
- Chemoautotrophs gain energy from the oxidation of inorganic substances (hydrogen sulphide and ammonia) through chemosynthesis
- Example: *Nitrobacter* sp.

Heterotrophic

SAPROTROPHIC

- Saprotrophs are saprophytic organisms which gain their nutrients from dead and decaying organic substances
- Digestion occurs outside the body of an organism before the nutrients are absorbed into its body
- Example: Fungi

HOLOZOIC

- An organism that survives by eating solid organic substances which are then digested and absorbed into the body
- Most animals including human beings are holozoic
- Example: squirrel

PARASITIC

- Parasites are organisms that absorb nutrients from the hosts
- Example:
  1) Ticks
  2) Fleas
  3) Tapeworms

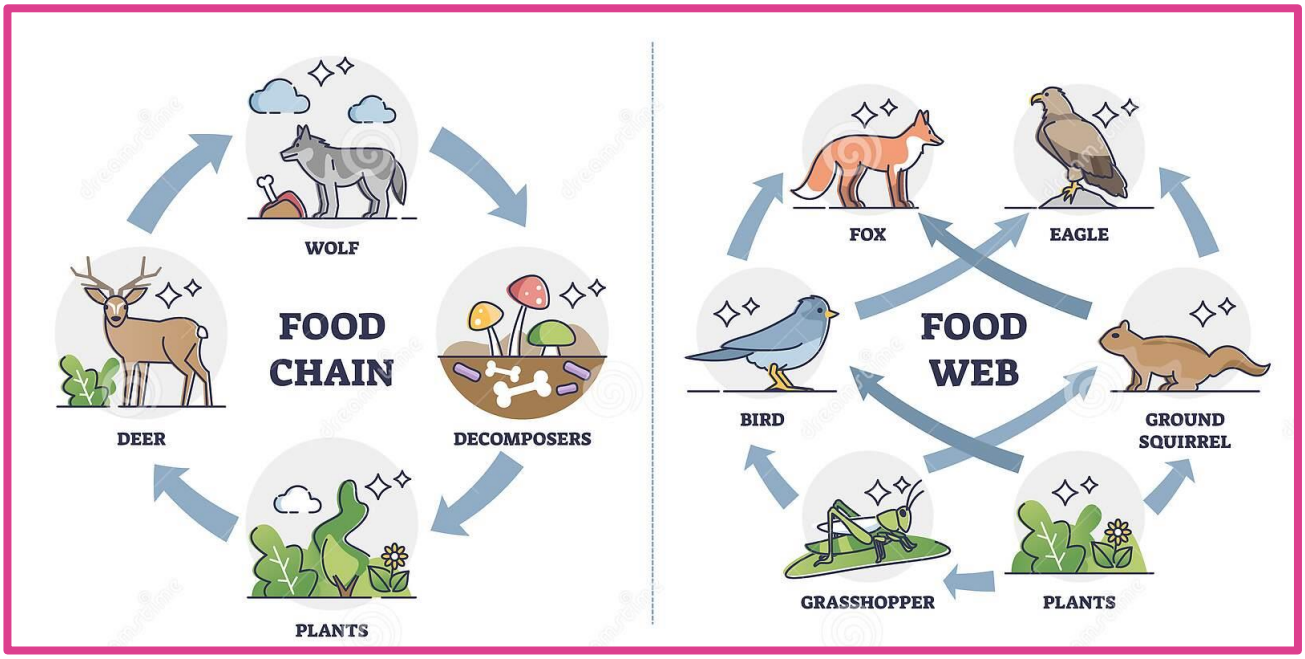
Energy flow in the food chains

FOOD CHAIN

- A food chain is the sequence of energy transfer from one trophic level to another trophic level, beginning with producers
- In a food chain, it starts with the producer and ends with either a secondary consumer or a tertiary consumer
- Organisms feed on organisms from the previous trophic level
- Energy is transferred from the consumed organisms to the feeding organisms
- Energy is transferred between trophic levels when an organism eats other organisms from which it gains its energy
- This energy is transferred to the organism after it has digested and assimilated the food to form new substances in the body

FOOD WEB

- ◊ Food web formed when there is a several food chain that is connected
- ◊ Most of the animals feed on more than one type of organisms
- ◊ An animal can form a few food chains and occupy different trophic levels
- ◊ For example, bird can be a primary consumer (at the second trophic level) by feeding on paddy
- ◊ Bird can also be a secondary consumer (at the third trophic level) by feeding on grasshoppers
- ◊ In a food web, it shows the feeding relationships in a community
- ◊ It consists of several food chains
- ◊ Organisms in all food chains rely on each other in feeding aspects
- ◊ It starts with photosynthetic producers which convert light energy from the sun into chemical energy in the form of food stored in organs (roots, fruits, stems or leaves)



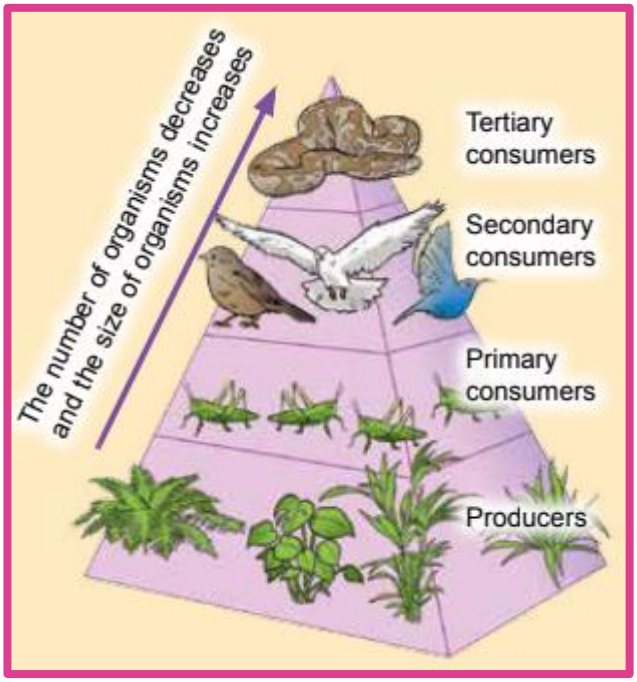
Ecological pyramids

- Food chains and food webs show the feeding relationships among organisms
- Energy transfer occurs when an organism feeds on another organism
- In a feeding interaction, when a trophic level increases, the number of individuals, biomass and total energy contained in each individual for each trophic level will change

PYRAMID OF NUMBER

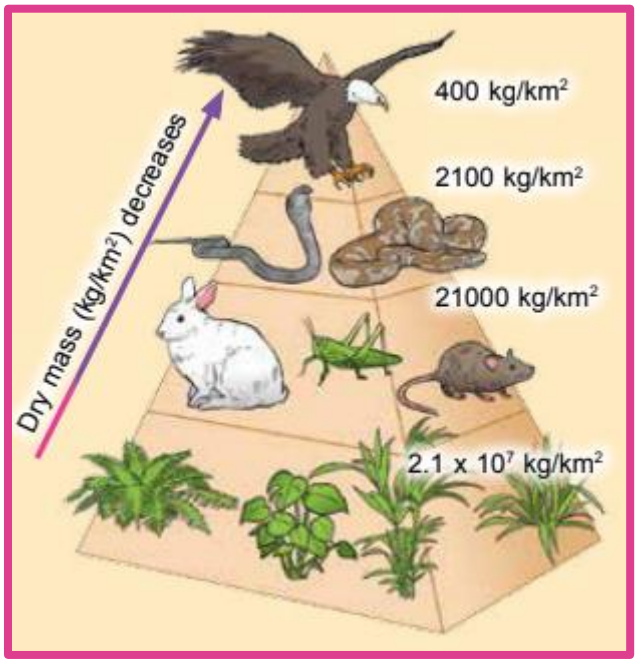
- » Pyramid of number is a diagram which shows the number of organisms at every trophic level in a food chain
- » The base of the pyramid is the largest part which accommodates the first trophic level, representing the number of producers

- The next tiers of the pyramid are the sections for the second, third and fourth trophic levels which represents the number of primary consumers, secondary consumers and tertiary consumers
- Ascending the pyramid, the number of the organisms decreases whereas the size of organisms at each level gets bigger



PYRAMID OF BIOMASS

- Pyramid of biomass is a diagram which shows the total biomass per unit area of all organisms in every trophic level
- Biomass is measured by using dry mass
- This pyramid shows the biomass that can be supplied to the organisms in the next trophic level
- For example, the total biomass of producers that can be eaten by primary consumers is higher than the total biomass of primary consumers in the ecosystem
- The total biomass of secondary consumers is lower than primary consumers
- Ascending the pyramid, the total amount of biomass per unit area decreases

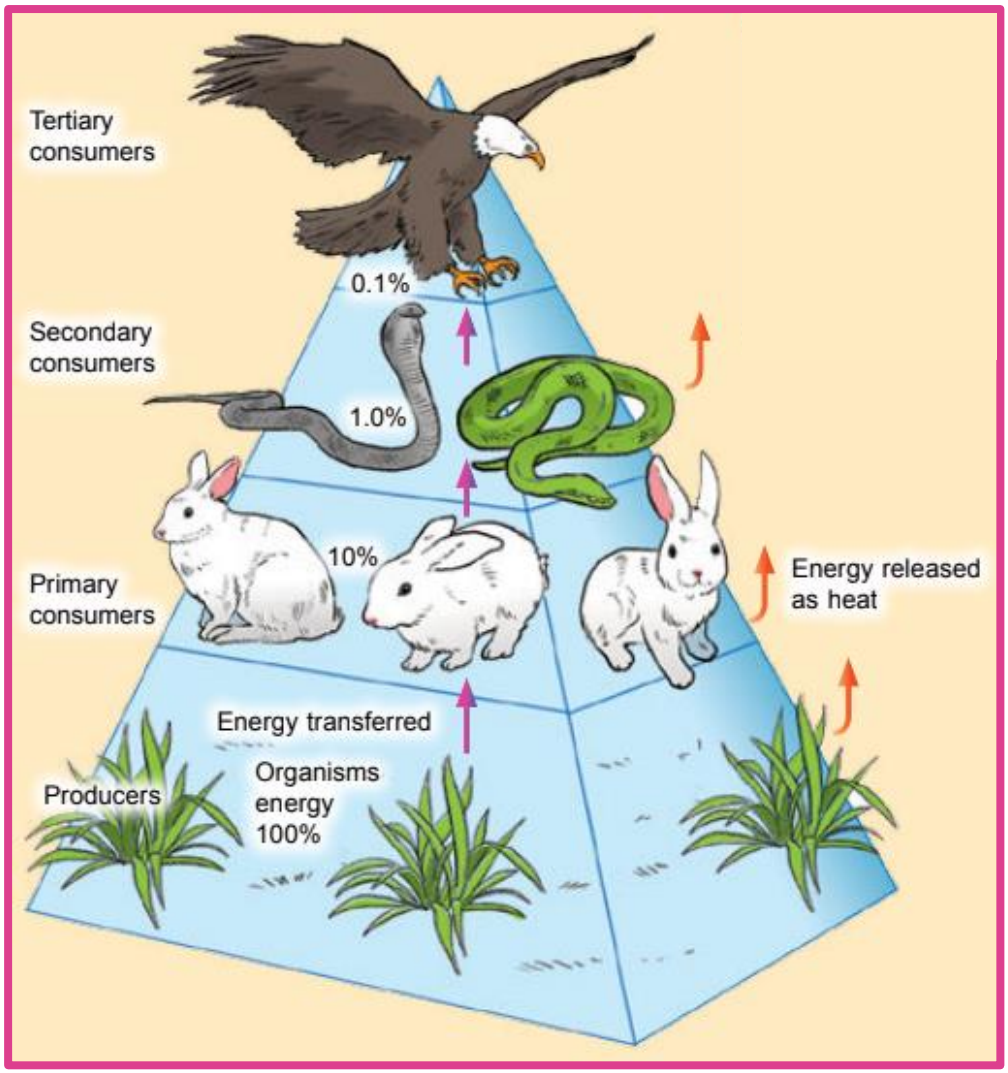


PYRAMID OF ENERGY

- Pyramid of energy demonstrate the total energy which is present in an ecosystem
- The energy source in an ecosystem is light energy from the sun which is absorbed by green plants to carry out photosynthesis and convert it into chemical energy
- The energy will be transferred to the next trophic level when a primary consumer feeds on a producer
- The energy contained inside the food molecules may be stored in the body tissues, or transferred into the environment in the form of excrement (faeces or urine)
- When food molecules are decomposed for respiration or other reactions,

some energy is released into the environment through heat

- Only a small part of the energy in food is converted into energy stored in body tissues as a supplement to the organism's biomass
- Only 10% of the energy is transferred to the next trophic level
- 90% of the energy is dissipated into the environment through heat, living processes and excretion
- Hence, organisms that belong to lower trophic levels have greater energy if compared to organisms at higher trophic levels



Types of interactive among biotic components

Saprophytism

- Saprophytism is an in which an organism gets its food from dead organic materials
- For example, mushrooms that live on dead tree trunk

Symbiosis

- Symbiosis occurs when different species that live together, interact with each other

MUTUALISM

- Mutualism is an interaction that gives benefits to both organisms
- For example, a myna gets its food (lice) from the body of a buffalo whereas the buffalo is free from the lice

COMMENSALISM

- ♥ Commensalism is an interaction that provides benefits to only one organism without causing any harm to the other organism
- ♥ For example, a shark does not gain any benefit but the remora fish gets scraps of the shark's food

PARASITISM

- ❖ Parasitism is an interaction that benefits one organism but harms the other organism
- ❖ For example, a tapeworm becomes a parasite in the intestines of a human being by absorbing nutrients and causes the human (host) to lack in nutrients

Predation

- ◊ It is an interaction involving an organism (predator) that eats another organism (prey)
- ◊ For example, an owl (predator) catches and eats rats (prey)

Competition

- ❑ Competition occurs when organisms in a habitat compete in order to get basic needs (food, water, light and mates)

INTERSPECIFIC COMPETITION

- ✓ For example, competition among different species of plants to get sunlight

INTRASPECIFIC COMPETITION

- ▪ For example, competition among of the same species to get mates

Mangrove ecosystem

Abiotic components

Abiotic components of mangrove ecosystem:

- → Germination of seedlings in tidal area
- → Exposed to very strong light intensities
- → Soil with high salt content as well as very low content of dissolved oxygen in water
- → Exposed to strong wind blows
- → Soft, silted and muddy soil that lacks aeration
- → Exposed to waves and water tides

Biotic components

Biotic components of mangrove ecosystem:

- Δ Stork
- Δ Mushroom
- Δ Mangrove trees
- Δ Crab
- Δ Horseshoe crab
- Δ Mudskipper
- Δ Snake

- Proboscis monkey
- Silvered leaf monkey

Adaptation features of the mangrove trees

- Mangrove trees are tropical plants which are usually found in estuaries
- Estuaries is a place where the sea and river meet

LEAVES

- Mangrove leaves have thick cuticles and sunken stomata which can reduce the rate of transpiration
- These leaves have succulent leaves that can store water and special structure known as hydathode to eliminate excess salt
- Mature leaves can store salt, which will fall off when the concentration of salt stored is too high

PNEUMATOPHORE ROOTS

- Pneumatophore roots are short root projections from the soil surface for aeration in water-submerged areas
- The root allows the gas exchange between the submerged root and atmosphere through lenticels
- Example: *Avicennia* sp.

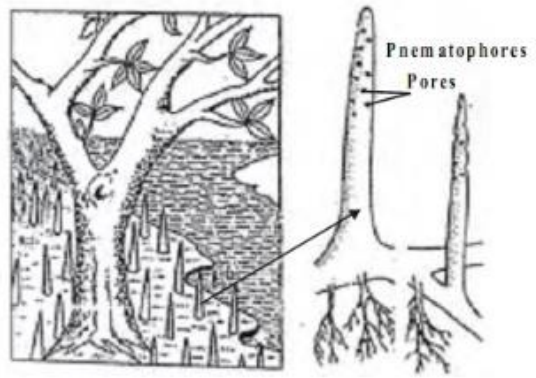
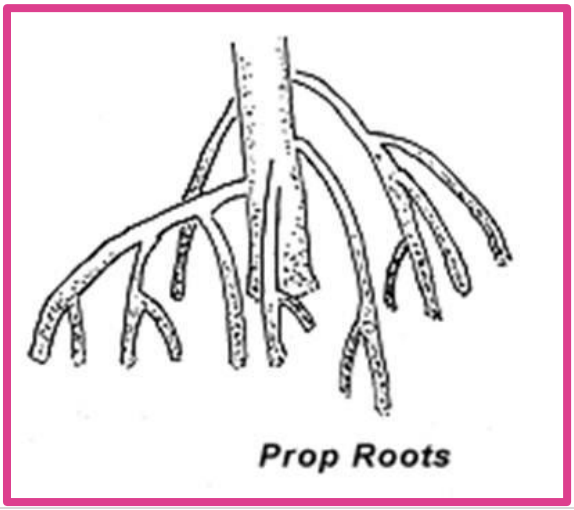


Figure: Respiratory Roots (Avicennia)

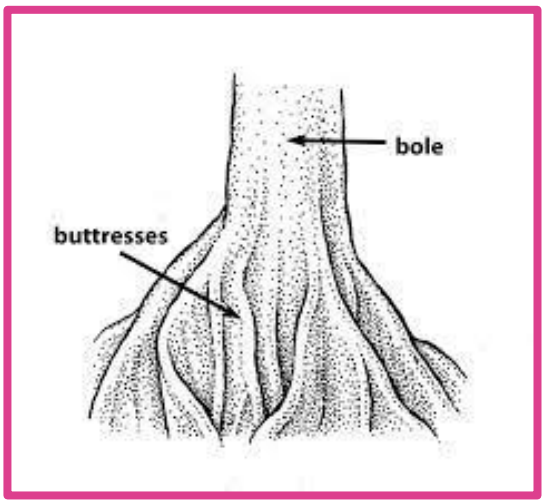
PROP ROOTS

- Prop roots branch out from the lower part of the stem of a mangrove tree
- The roots are firmly planted in the soil to support the tree to overcome strong winds and waves
- Example: *Rhizophora* sp.



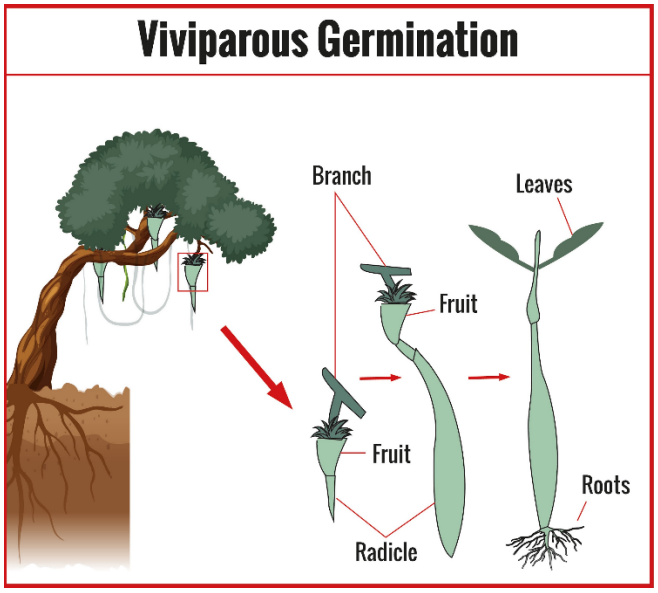
BUTTRESS ROOT

- Buttress roots are type of roots with a thick structure that can add in widening the base of a tree
- The roots provide support to the tree that grows on soft soil which borders with solid land
- Example: *Bruguiera* sp.



SEEDS

- Viviparous seeds germinate and grow when they are still on the parent plant
- This feature enables fallen seedlings to stick into the muddy soil and will not be uprooted by waves



Colonisation and succession

- An ecosystem can change due to natural phenomena (a volcano eruption, earthquakes, draughts and human activities
- Human activities (mining) can cause organisms to die or migrate to other habitats
- However, after a long period of time, this deserted area starts to have inhabitants known as pioneer species
- Pioneer species is a species that begins to colonise an area where there are no other living things
- Colonisation
  - Plants start to conquer an uninhabited area, breed and form colonies in that area
- Succession
  - A few species of dominant plants in a habitat are gradually being replaced by other species called successor

COASTAL ZONE

- Coastal zone is the area that is most exposed to big waves
- This zone is dominated by pioneer species, which are *Avicennia* sp. (*Api-api* tree) and *Sonneratia* sp. (mangrove apple)
- An enlarged root system and pneumatophores help the trees to trap mud and organic substances which are brought by high tides

- ◊ Mud accumulation slowly begins and as a result, the soil becomes higher and denser
- ◊ *Rhizophora* sp. succeeds and replaces the pioneer species

MIDDLE ZONE

- ❑ Middle zone is situated along the river, closer to the estuaries
- ❑ An area inhabited by *Rhizophora* sp. plants (*bakau minyak* tree) that have tangled prop roots
- ❑ These roots can trap twigs and mud which are washed away and block the flow and water
- ❑ The trapped mud causes sedimentation to occur much faster
- ❑ The river bank becomes higher and drier because less seawater overflows during high tides
- ❑ The soil becomes less suitable for the growth of *Rhizophora* sp.
- ❑ Instead, it is more suitable for *Bruguiera* sp.
- ❑ *Bruguiera* sp. succeeds and replaces *Rhizophora* sp.

INLAND ZONE

- → Inland zone is situated further into the land
- → The soil becomes higher, harder and only flows with seawater during high tides
- → The area inhabited by *Bruguiera* sp. (*tumu merah* tree) which have buttress roots to trap more mud and slit
- → Sedimentation process forms a new swamp that projects out towards the sea
- → The one-time shore gets further away from the sea and the ground changes into a land which is suitable for land trees (*Nypa fruticans* and *Pandanus* sp.)
- → The land trees succeed and replace *Bruguiera* sp.

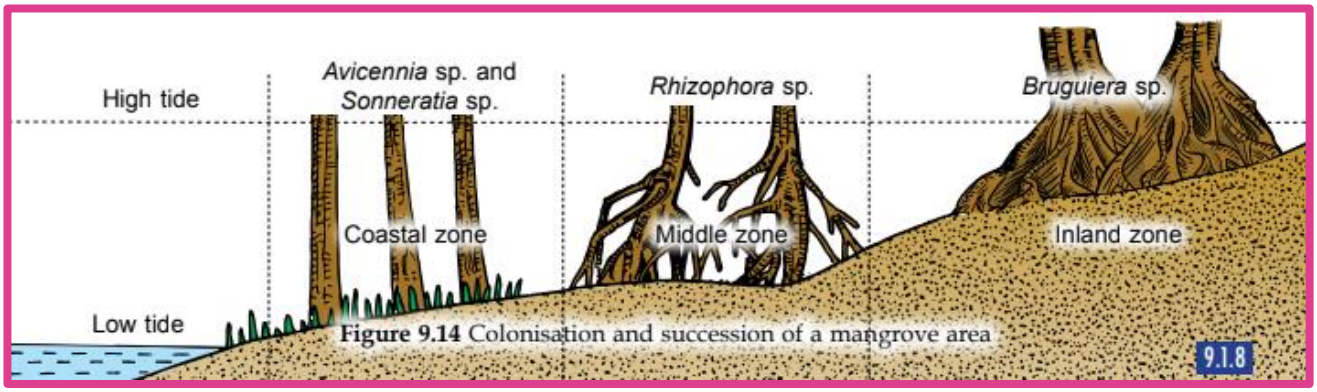


Figure 9.14 Colonisation and succession of a mangrove area

The importance of the mangrove ecosystem

PROTECTION ZONE

- ✓ Mangrove forests become a natural barrier to lessen the impact of strong waves and wind that reach the seashore area
- ✓ Mangrove forests offer a protected site for small fish, shrimps and crabs from predators as well as swift movements of currents and waves
- ✓ Mangrove forests can become preserved areas where various species of migratory birds can search for food

FISHERY RESOURCES

- ♥ Sea products (fish, shrimps, crabs and sea snails) become a source of income for fishermen living near the mangrove areas
- ♥ The wetlands in mangrove areas are conducive for fish rearing in floating cages and also for breeding commercial species

FORESTRY RESOURCES

- Mangrove woods can be used to build boats, fish traps and building frames
- Mangrove woods can also be used to make handicrafts
- Mangrove wood is burnt in the furnace to produce a type of fuel called charcoal

FOOD AND MEDICINE RESOURCES

- Δ The fruit *Avicennia* sp. can be consumed as a vegetable
- Δ The nut can be boiled and eaten whereas its flower produces honey
- Δ The fruit of *Sonneratia* sp. is used in the production of drinks
- Δ The fruit of *Nypa* sp. can be eaten and water from the fruit can be used in the production of vinegar and *nira*
- Δ The bark of *Bruguiera* sp. tree can be used to treat diarrhoea

CHAPTER 9.2 – POPULATION ECOLOGY

Factors affecting population distribution

The effects towards plants

TEMPERATURE

- The optimum temperature for plant growth is between 25°C to 30°C
- High temperatures can cause enzymes to denature
- Biochemical processes in plants are disrupted
- After disrupted, biochemical processes will
  I. Stunt the growth of plants
  II. Increase the rate of water evaporation by transpiration
  III. Slow the rate of photosynthesis
- Low temperatures reduce the activities of enzymes which slow down the biochemical reactions

WATER

- Water is needed for enzyme activities, photosynthesis, transport and support in herbaceous plants
- Dry regions (the desert) and tundra area (at the poles) have low population distribution and also low density of plants

LIGHT

- Light is very important for the process of photosynthesis in plants
- Areas which receive little light have a lower number of plants

pH OF SOIL

- The pH of soil is important for nutrient absorption by the roots
- Soil in which the pH is either too acidic or too alkaline will cause lower absorption of nutrients by plant
- The growth of plants will be disrupted due to lack of nutrients

MINERAL SALTS CONTENT

- Salt content affects the absorption of water through osmosis by the roots
- High salt content in soil will cause plants to lose water through osmosis
- Minerals are needed for the production of proteins, enzymes, nucleotides, vitamins and other compounds
- For example, phosphorus is used to form phospholipids (in the formation of cell membrane)

The effects towards animals

TEMPERATURE

- Areas which are exposed to high temperatures in a habitat are less inhabited by certain animals (worms and snails)

WATER

- Animals are concentrated in areas that have enough water resources for drinking and cooling the body

BREEDING SITE

- A safe and suitable breeding site is needed by animals to raise their offsprings

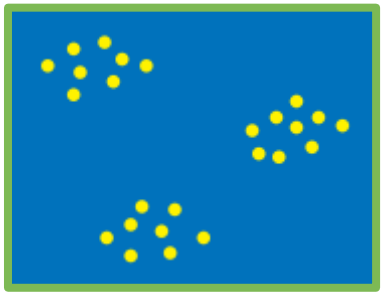
FOOD SUPPLY

- Food is important for survival because animals are heterotrophs which depend on plants and other animals for food

Patterns for population distribution

CLUMPED

- Clumped organisms form separated groups
- This condition is caused by uneven distribution of resources in an area

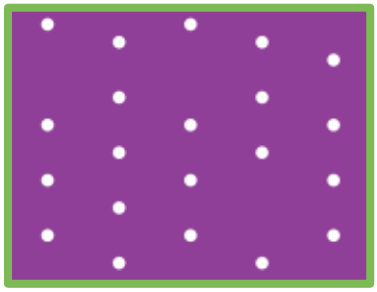


RANDOM

- Organisms are distributed in a free pattern in an area
- This distribution involves species that have little interaction among individuals

UNIFORM

- Organisms are distributed all over an inhabited area
- This distribution involves species in which every individual competes for limited resources in an area



Estimation of organism population size

- Two important factors for studying population ecology
  - → Population size: The number of organisms present in a population
  - → Population density: The number of individuals of a species per unit area of a habitat
- The population size in an area can be estimated by a random sampling technique when the studied area is large and difficult to obtain data
- A sample which represents the area is taken to give an estimation of the abundance and the distribution pattern of certain organisms that inhabit the area

Quadrat sampling technique

- A quadrat sampling technique can estimate the population size of land plants or animals which are inactive or more slowly
- The number of organisms in the quadrat areas is the sample which represents the whole area of study
- The data obtained from all quadrats can be used to estimate the population in the area of study
- A quadrat is a square-framed structure which is made of wood, iron or plastic
- Normally, a quadrat is subdivided into a few parts of the same size to estimate the coverage percentage of any species
- The size of the quadrat depends on the types and size of organisms, the area of study as well as the distribution and density of the plants being studied
- For example, a one-metre-squared quadrat is suitable to estimate the population of plants in a school field
- Quadrat sampling technique can estimate the frequency, density and coverage of any plant species which is being studied in the area of study

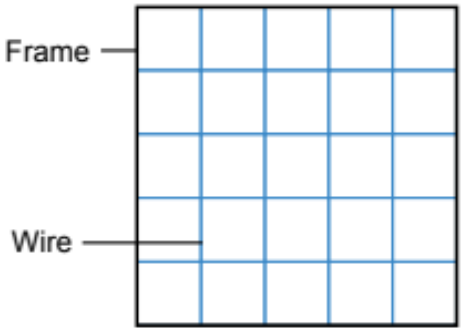


Figure 9.17 A quadrat

FREQUENCY

» Frequency is the probability to get an individual of any plant species in every quadrat

$$Frequency = \frac{The\ number\ of\ quadrats\ containing\ studied\ species}{Total\ number\ of\ quadrats\ used} \times 100\%$$

DENSITY

↘ Density is the average number of individuals in any species per unit area of study

$$Density = \frac{Total\ number\ of\ individual\ species\ studied\ in\ all\ quadrats}{Total\ number\ of\ quadrats\ used\ \times Area\ of\ a\ quadrat}$$

COVERAGE

⌂ Coverage is the surface area of the soil which is covered by the shoots of the plant species

⌂ The coverage percentage is the percentage of soil surface covered by the plants

$$Coverage\ percentage = \frac{Area\ covered\ by\ studied\ species\ in\ all\ quadrat}{Total\ number\ of\ quadrats\ used\ \times Area\ of\ a\ quadrat} \times 100\%$$

Capture-mark-release-recapture technique

- Capture-mark-release-recapture technique can estimate the population size of organisms (foxes, sharks, snails, millipedes, insects and butterflies) which can move freely in the studied area

THE STEPS FOR CAPTURE-MARK-RELEASE-RECAPTURE TECHNIQUE

◊ Animals under study are captured randomly in the area of study (natural habitat)

◊ The number of animals captured is recorded

◊ Every animal captured is marked by using nail polish, paint or Indian ink

◊ The mark animals are then released into the same area of study

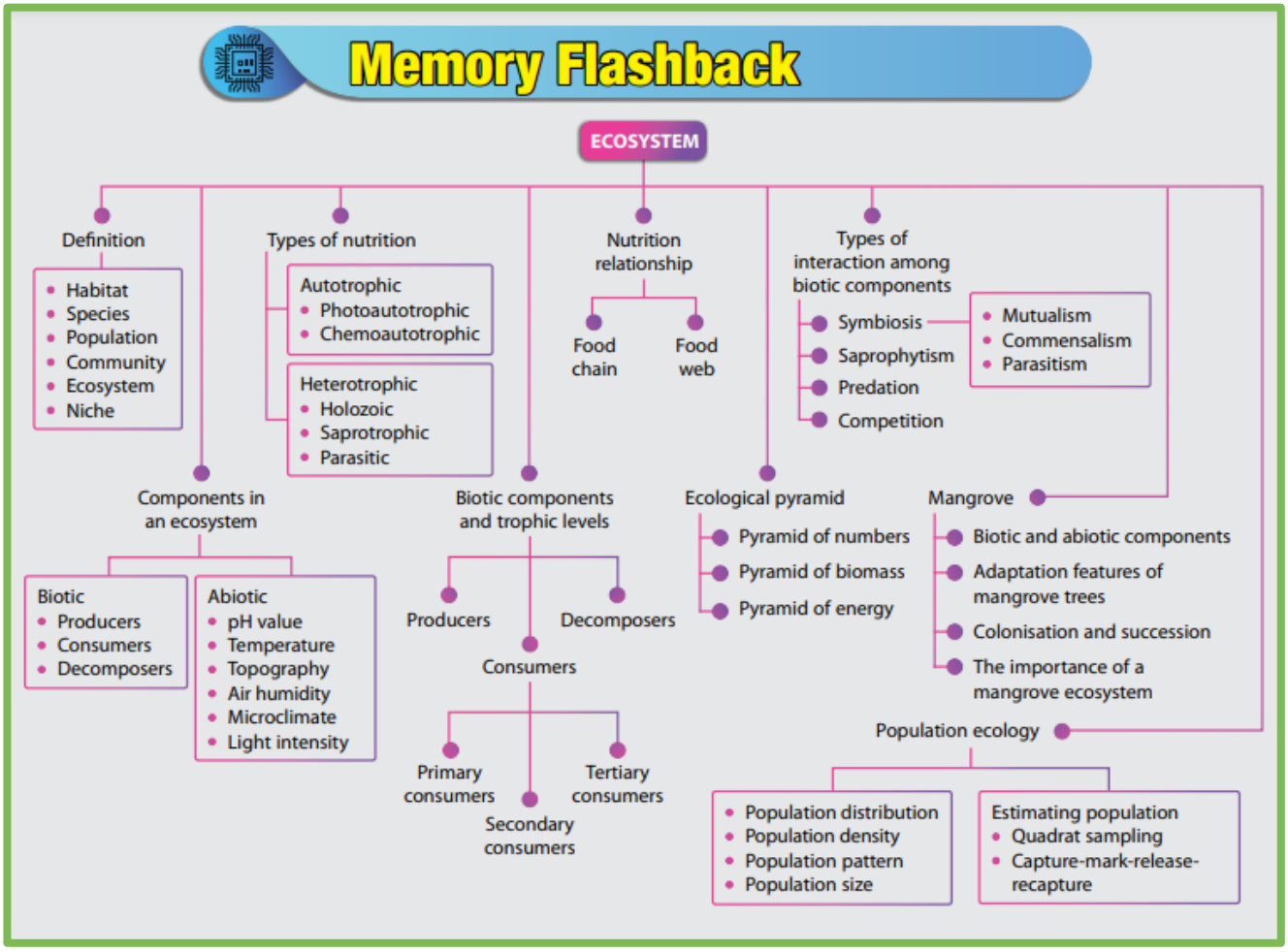
◊ After a certain period of time, second capture is done randomly in the same area of study

◊ The total number of animals captured the second time, both marked and unmarked is recorded

◊ Population size estimation formula

$$Population\ size = \frac{P \times Q}{R}$$

KEYS
P: the number of animals in the first capture Q: the number of animals in the second capture R: the number of marked animals in the second capture


Memory Flashback
ECOSYSTEM
Definition
Habitat
Species
Population
Community
Ecosystem
Niche
Types of nutrition
Autotrophic
Photoautotrophic
Chemoautotrophic
Heterotrophic
Holozoic
Saprotrophic
Parasitic
Nutrition relationship
Food chain
Food web
Types of interaction among biotic components
Symbiosis
Mutualism
Commensalism
Parasitism
Saprophytism
Predation
Competition
Components in an ecosystem
Biotic
Producers
Consumers
Decomposers
Abiotic
pH value
Temperature
Topography
Air humidity
Microclimate
Light intensity
Biotic components and trophic levels
Producers
Decomposers
Consumers
Primary consumers
Secondary consumers
Tertiary consumers
Ecological pyramid
Pyramid of numbers
Pyramid of biomass
Pyramid of energy
Mangrove
Biotic and abiotic components
Adaptation features of mangrove trees
Colonisation and succession
The importance of a mangrove ecosystem
Population ecology
Population distribution
Population density
Population pattern
Population size
Estimating population
Quadrat sampling
Capture-mark-release-recapture