BIODIVERSITY

Describing biodiversity

- biodiversity includes the diversity of genes, species and ecosystems; measures of biodiversity rely on classification and are used to make comparisons across spatial and temporal scales
- biological classification is hierarchical and based on molecular sequences, different levels of similarity of physical features and methods of reproduction
- biological classification systems reflect evolutionary relatedness between groups of organisms
- most common definitions of species rely on morphological or genetic similarity or the ability to interbreed to produce fertile offspring in natural conditions – but in all cases, exceptions are found
- ecosystems are diverse, composed of varied habitats, consisting of a range of biotic and abiotic factors, and can be described in terms of their component species, species interactions and the abiotic factors that make up the environment
- relationships and interactions within a species and between species in ecosystems include predation, competition, symbiosis (mutualism, commensalism and parasitism), collaboration and disease
- in addition to biotic factors, abiotic factors, including climate and substrate, can be used to describe and classify environments
- model is determined by the representativeness of the sampling

Ecosystem dynamics

- the biotic components of an ecosystem transfer and transform energy, originating primarily from the sun, and matter to produce biomass; and interact with abiotic components to facilitate biogeochemical cycling, including carbon and nitrogen cycling; these interactions can be represented using food webs and biomass pyramids
- species or populations, including those of microorganisms, fill specific ecological niches; the competitive exclusion principle postulates that no two species can occupy the same niche in the same environment for an extended period of time
- the dynamic nature of populations influence population size, density, composition and distribution
- keystone species play a critical role in maintaining the structure of the community; the impact of a reduction in numbers or the disappearance of keystone species on an ecosystem is greater than would be expected, based on their relative abundance or total biomass
- fire is a dynamic factor in Australian ecosystems and has different effects on biodiversity
- ecosystems have carrying capacities that limit the number of organisms (within populations) they support, and can be impacted by changes to abiotic and biotic factors, including climatic events
- ecological succession involves changes in the populations of species present in a habitat; these changes impact the abiotic and biotic interactions in the community, which in turn influence further changes in the species present and their population size 12 Biology | ATAR | Year 11 syllabus

- human activities that can affect biodiversity and can impact on the magnitude, duration and speed of ecosystem change include examples of
    - habitat destruction, fragmentation or degradation, including erosion and dryland salinity
    - the introduction of invasive species
    - unsustainable use of natural resources
    - the impact of pollutants, including biomagnification and eutrophication
    - emissions contributing to the enhanced greenhouse effect which impact climate change
- conservation strategies used to maintain biodiversity are
    - genetic strategies, including gene/seed banks and captive breeding programs
    - environmental strategies, including revegetation and control of introduced species
    - management strategies, including protected areas and restricted commercial and recreational access
- models of ecosystem interactions (food webs, successional models) can be used to predict the impact of change and are based on interpretation of and extrapolation from sample data (data derived from ecosystem surveying techniques); the reliability of the

BIODIVERSITY

What is biodiversity?

Biodiversity comes from two words Bio meaning life and diversity meaning variability.
Biodiversity is the variety of all living things.
-The more biodiverse our planet is, the more secure all our lives are.

Importance of biodiversity:

Our planet's biodiversity provides all the things we need to survive FOR FREE
-we need towering forests across one-third of the land to **block away carbon** and **keep the climate stable**
-we need millions of pollinators and billions of soil organisms and megatons of plankton to keep the **food we eat in supply**
-we need strange plants deep in our jungles to create **medicine**
-we need coral reefs and mangroves to **protect the coast**
-we need rivers and lakes to control water sources and **reduce floods**
-we need waterfalls to **purify and clean water**

The three main types of biodiversity

Genetic diversity

the variety of genes within a species (diversity at the DNA level)
eg. Different dog breeds
-populations that are genetically diverse are well equipped to handle change.
-this means if there is a deadly disease that strikes a high genetic diverse population, some animals can handle the disease better than others, preventing the species from going extinct.

Species diversity

the variety of species within a habitat or a region
Some habitats, such as rainforests and coral reefs, have many species. Others, such as salt flats or a polluted stream, have fewer.
Eg. woodland forests comprising 4-5 different species of trees
-is also relevant to the roles each species plays in the community
-if there is only one predator species in a community to a specific prey. When the predator's population levels are healthy, its prey's population numbers remain at a level the community can handle.
-if the predator's numbers suddenly drop the prey may become too much and explode.
-However, if there are more predator species the prey will remain handled.

Ecosystem diversity

the variety of ecosystems in a given place
-considers both biotic and abiotic factors such as sunlight and temperature.
-Areas high in ecosystem diversity create a geographic mosaic of communities that help protect an entire area from drastic changes.

Biodiversity hotspot

The places on our planet that we need to provide special attention because they are important and threatened by human habitation.
There are currently 36 hotspots on our earth
A scientist named Norman Myers wrote a paper that analysed different criteria which are considered a hotspot.

Why are we concerned with the health of ecosystems worldwide?

Healthy ecosystems clean our water, purify our air, maintain our soil, regulate the climate, recycle nutrients and provide us with food. They provide raw materials and resources for medicines and other purposes. They are at the foundation of all civilisations and sustain our economies.

Species diversity

Species richness

The number of different species in an area. The higher number the richer.
Calculated by $D = s/ \sqrt{N}$
s is number of different species
N equals the total number of individuals in the sample

Species evenness

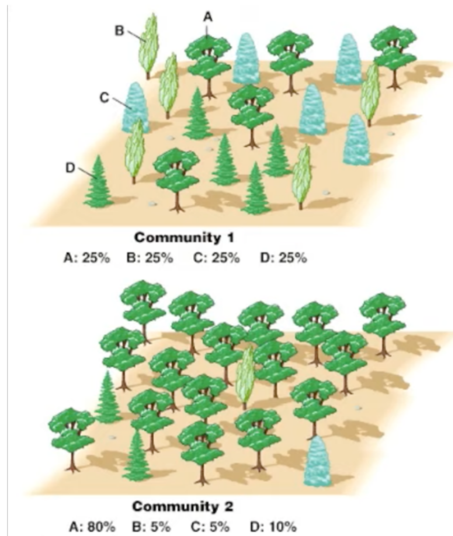
The measure of the relative abundance of different species makes up the richness of an area.
When the relative abundance is similar for each species the more evenness vs if the relative abundance has large differences for each species the less evenness.
High evenness: many or most species are common

Low evenness: one or a few species are more common and the rest are rare.

Relative abundance

how common each species is in an area. To calculate you must find the percentage of each species in the community.
Species number/ total number x 100

In these 2 communities, the richness is the same since they both have 4 different species, but the evenness is different. Community 1 is more even than community 2.



Simpsons index of biodiversity

-introduced in 1949 by Edward Simpson
Formula:

$$D = \frac{\Sigma n(n-1)}{N(N-1)}$$

n- represents the number of organisms of a particular species.
N- the total number of all organisms

In this index when D is 0 represents a higher species diversity and 1 is lower species diversity (the bigger the value of D (between 0-1) the lower the diversity)

Simpsons index of diversity: 1-D

-the value of D also ranges from 0-1 but, 0 represents a lower diversity and 1 represents a higher diversity

Simpsons reciprocal index: 1/D

-when the maximum number is number is the number of species.
-the higher the value the greater the diversity
-e.g. If there are 5 species in the sample, the maximum number is 5

ENVIRONMENTS

Terminology:

Ecosystems: an ecosystem is a community of organisms and their physical environment interacting with each other.
-summarised: the abiotic and biotic organisms that interact with each other in a common physical environment.

Environment: everything that is around us, which includes both living and nonliving things such as soil, water, animals, and plants, which adapt themselves to their surroundings.
-summarised: all the biotic and abiotic features around us

Community: an interacting group of various organisms that share a common habitat.

Niche: an organism's role within its environment.

Habitat: the place or environment where a plant or animal naturally or normally lives and grows

abiotic factors: non-living chemical and physical parts of the environment that affect living organisms and the functioning of ecosystems. E.g.

biotic factors: A biotic factor is a living organism that shapes its environment. E.g. Animals and plants

biomes: A major life zone, is an area that includes communities of plants and animals that have a common adaptation to that environment.

Aquatic environments:

Physical characteristics of all aquatic environments:

- **Viscosity** (the stickiness of a fluid: its power to resist fluid)
- Water is more viscous than air.

- **Buoyance** (the ability for something to float in water)
- organisms that live in water experience an upward force (upthrust)
- Water is dense
- Water helps support organisms.

- **Temperature variation:**
- Temperature fluctuations are mush less in water than on land
- Most stable in seawater
- The temperature fluctuates most in small ponds
- Temperature decreases as depth increases

- **Availability of gasses:**
- Oxygen availability is lower in water
- The solubility of oxygen is 0.5% (5 cubic centimetres per litre of water) in seawater and slightly higher in freshwater
- Diffusion of oxygen is slower in water
- Carbon dioxide availability is higher than oxygen
- CO_2 dissolves in water to form carbonate and bicarbonate ions.

- **Availability of water and ions:**
- Organisms that live in water are surrounded by water in which ions are dissolved
- Salt content is lower in freshwater than in seawater.

- **Light penetration:**
- Decreases as depth increases.
- Light intensity is lower in water than in air.

- **Pressure variation:**
- Water pressure increases with depth

Some problems faced in aquatic environments:

- Water must be pushed aside
- The density of water increases with depth (organisms need mechanisms to help overcome the tendency to float, other organisms need mechanisms to help them float)
- Aquatic organisms have problems obtaining oxygen
- Water absorbs light (photosynthesis can only take place in the first few metres)

Adaptations to an aquatic existence:

- **Gaseous exchange:** animals can not perform gaseous exchange through their surface fast enough so they have gills
- **Reproduction:** animals and plants release their gametes into the water and fertilization happens outside but sometimes eggs can drift away and die so the produce large numbers of eggs.
- **Nutrition:** Plants need sunlight for photosynthesis so they are normally near the top of aquatic environments

Marine: Are aquatic environments with high levels of dissolved salt. These include the open ocean, the deep-sea ocean, and coastal marine ecosystems.

- The organisms fall into 3 major groups.
- **The Benthos:** plants such as kelp and animals such as brittle stars that live or depend on the bottom.
- **The nekton:** swimming animals such as fish and whales
- **The plankton:** various small to microscopic organisms that are carried along by currents.
- Plankton is the dominant life and food source of the ocean.

Freshwater: Freshwater environments include rivers, lakes, wetlands, streams, and underground aquifers. They store and clean the water.

- 2 major types:
- Lentic/ still water (ponds and lakes)
    - Lower levels of oxygen and carbon dioxide
    - **Shallow zone** of water along the shore
    - Is dominated by submerge, floating and emergent vegetation.
    - Have an upper **open water zone** that extents to the depth at which light is available for photosynthesis
    - Plankton and filamentous green algae supply most of the energy for the ecosystem
    - The **deep zone** is warmer and less dense
    - At the bottom water is soft mud and silt where decomposition takes place
    - Is influenced by temperature and the amount of dissolved oxygen
    - In cold lakes oxygen is sufficient so lake trout and plankton can inhabit deep water
    - In the bottom zone mud and overlaying water lack oxygen due to decomposing organic matter

- Lotic/ running water (rivers, streams)
    - Higher levels of oxygen and carbon dioxide
    - Organisms in this habitiat posses adaptations to enable them to maintain their position in the water
    - Most streams depend apon adjoining terrestrial ecosystems for their primary energy source
- Both conditions influence the life inside them

Estuary: Semi closed coastal area, were seawater mixes with freshwater from rivers. Also the tidal area of the lower part of a river

- Three overlapping zones
    - An open connection with the sea where marine water preponderates.
    - A middle area where strong salt water and freshwater mix
    - A tidal river zone where freshwater preponderates (to exceed in weight)

- 4 main groups of estuaries:
- Coastal plain estuaries:
    - Resemble a V shaped river channel
    - Less than 20 cm deep

- Salt march estuaries:
    - Part of coastal plain
    - Well defined drainage network
    - Not usually fed by rivers so they contain mostly salt water

- Lagoons:
  - Have a less defined drainage system
  - Larger open areas
  - Shallow (less than 2m deep)
  - Raised edge
- Fjords:
  - Major type of estuaries in northern and southern temperate latitudes above 45°C
  - Where formed when continental glaciers scoured out river valleys
  - Have U shaped cross sectional form.
  - Water can be 500m deep.

Mangrove: A group of trees and shrubs that live in the coastal intertidal zone.

Terrestrial environments:

Physical characteristics of all terrestrial environments:

- **Viscosity:**
- Air is less viscous than water

- **Buoyancy:**
- Organisms that live in air do not experience an upthrust

- **Temperature variation:**
- Is extreme on land
- Air temperature in the dessert may reach 45 °C in day but 2 °C at night.

- **Availability of gasses:**
- The concentration of oxygen in air is 21% (210 cubic centimeters per litre of air)
- Diffusion of oxygen is 3000000 times faster in air than in water

- **Availability of wate and ions:**
- Water availability varies, in deserts rainfall is lower vs in rainforests rainfall is higher
- Ions are not as readily available.
- Ions are dissolved in soil water

- **Light penetration:**
- Light intensity is high

- **Pressure variation:**
- Air pressure increases with height

Problems faced with terrestrial environments:

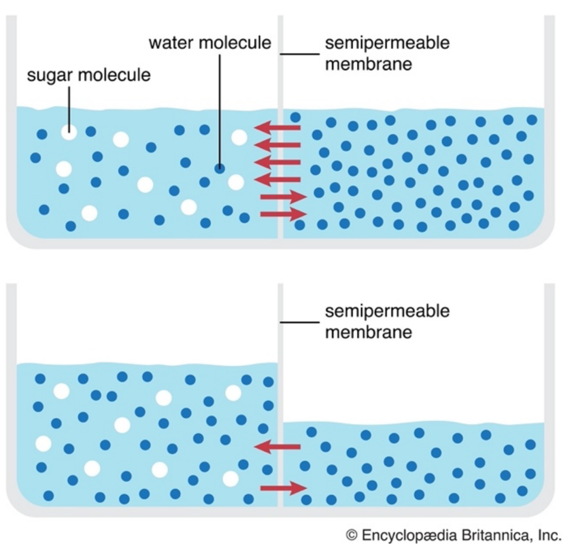
- Not as much support from air than water (animals can be bigger in water than on land)
- Movement on land creates friction (organisms must have mechanisms to provide support and reduce friction)
- Temperature vary more on land (organisms must have mechanisms to cope with high and low temperature)
- Wet surfaces on land will evaporate and loose the water

Adaptations to a terrestrial existence:

- **Gaseous exchange:** terrestrial organisms are covered with a waterproof coat to prevent dying out so diffusion is not possible. Therefore plants have spores so they can get oxygen and animals have internal structure called lungs so we can breath
- **Reproduction:** terrestrial organisms need to protect their gametes so some organisms have internal fertilisation. And some organisms lay eggs to protect their embryos.
- **Nutrition:** terrestrial plant photosynthesis and absorb water and minerals from soil.
- **Support and movement:** plants must either remain small or develop supporting tissues. Land animals may have hydrostatic skeleton or exoskeletons to support them

Osmosis:

is the diffusion of solvents over a semipermeable membrane from a region of high concentration to a region of low concentration.
Osmosis helps regulate the flow of water in and out of a cell.
Osmosis also helps regulate salt concentration for fish that live in marine environments.



CLASSIFICATION

Linnaean system

Terminology:

Systematics: The study of organism identification, classification, and nomenclature.

Classification: the arrangement of animals and plants in taxonomic groups according to their observed similarities

Taxonomy: the science of naming, describing and classifying organisms

Phylogeny: the history of the evolution of a species or group, especially in reference to lines of descent and relationships among broad groups of organisms.

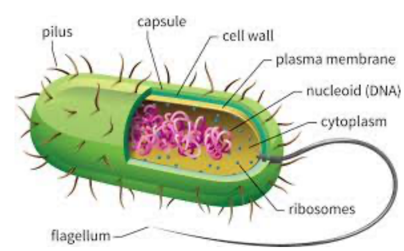
Hierarchy: the systemic organisation of organisms into levels, such as the Linnaean taxonomy

Holotype: When a species is first described scientifically one specimen and has a unique remarkably important role. Holotype is a representation of a new species.

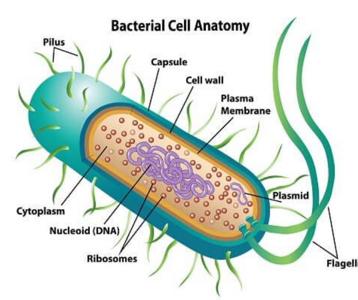
Domain:

- The highest level of classification (least specific)
- Humans fall into the Eucarya Domain
- There are 3 domains of life.

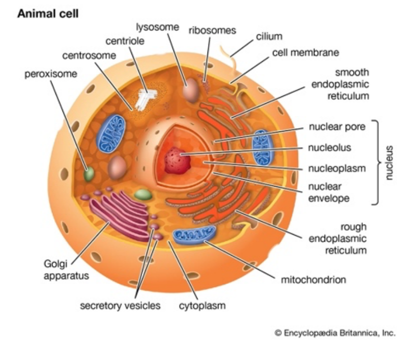
  - Archaea:
  - Small single-celled organisms
  - Prokaryote (no membrane-bound nucleus)
  - Reproduce asexually
  - Surrounded by cell wall
  - Presence of flagella or pilus
  - Often live in extreme environments
  - No membrane-bound organelles



  - Bacteria:
  - Small single-celled organisms
  - Prokaryote (no membrane-bound nucleus)
  - Reproduce asexually
  - Surrounded by a cell wall (contains peptidoglycan)
  - No membrane-bound organelles
  - Presence of flagella or pilus



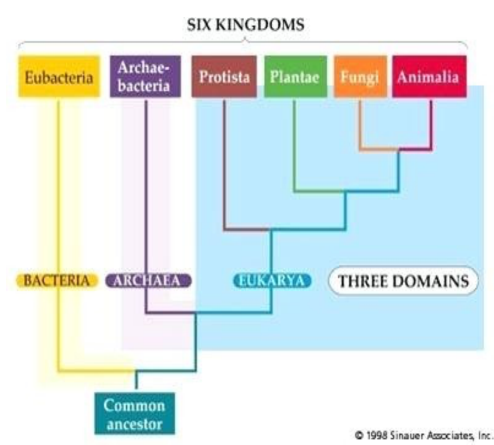
- Eucarya:
- Multicellular
- Has membrane-bound nucleus
- Has membrane-bound organelles



Kingdom:

- 2nd highest level of classification
- Humans are in the Animalia domain
- 5 main kingdoms
    - Animalia:
    - Can be divided into vertebrates and non-vertebrates
    - Are multicellular.
    - Eukaryotic nature (membrane-bound organelles)
    - Heterotrophic eukaryotes (An organism that eats animals or plants to get energy)
    - Aerobic perspiration (where oxygen is used to make energy) anaerobic respiration (uses glucose to make energy)
    - Sexual reproduction
    - Mobile
    - MRS GREN
    - Movement, respiration, sensitivity, growth, reproduction, excretion, nutrition
    - E.g., Human, Whale

    - Plantae:
    - Immobile
    - Multicellular
    - Eukaryotic nature (membrane-bound organelles)
    - Have cell wall (cellulose)
    - Autotrophic (can produce its own food with light, water, C02,.. for energy)
    - Has chloroplast (photosynthesis)
    - $6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$
    - Has vacuole .
    - E.g., Rose, Potato



    - Fungi:
    - Multicellular
    - Reproduce through spores
    - Feed on other living things (heterotrophic)
    - Eukaryotes
    - Have cell wall (chitin)
    - E.g., Oyster mushroom

- Protista:
- Eukaryote
- Mobile
- Both sexual and asexual reproduction
- Get energy through ingestion, absorption or photosynthesis.
- E.g., Amoebas

- Monera:
- In 5 kingdom classification, Monera is made up of Eubacteria and Archaea bacteria combine.

- Eubacteria:
- Both autotroph and heterotroph
- prokaryotes
- Unicellular
- Cell walls made of peptidoglycan.
- Has flagella and pilus
- E.g. E coli

- Archaea bacteria:
- Single-celled
- Cell membranes made of various polysaccharides and glycoconjugates
- Capable of methanogenesis (a form of aerobic respiration)

Phylum:

- An attempt to find physical similarities among organisms within a kingdom
- Humans are in the Phylum Chordata
- Chordata species all share 4 key features that appear in some stage of development.
    - A notochord
    - A dorsal hollow nerve cord
    - Pharyngeal slits
    - Post-Anal tail
- Sub Phylum
- The rank below phylum:
- Humans are a part of the Vertebrata subphylum
    - Backbone
    - Bilateral symmetry
    - 4 appendages
    - Red blood
    - Ventral heart
    - Developed nervous system.

Class:

- Further division of organisms of a phylum (organisms in a class have even more in common with each other)
- Humans are in the class Mammalia
    - Hair/fur
    - Milk glands

Order:

- Organisms in a class are broken down further into orders
- Humans are in the primate order
- Primates are divided into 2 major groups
- Strepsirrhines (e.g. lemurs and bushbabies) and haplorrhines (monkeys, apes)
- Primate characteristics
    - Large brains
    - Hands adapted for grasping
    - Vision more important than smell
    - Long life spans
    - Complex social groups
    - Few offspring
    - Opposable thumbs

Family:

- Order further divides into families
- Families have a lot in common
- Humans are in the Hominidae family
    - Communication through language
    - No tail
    - Erect posture

Genus:

- Way to describe the generic name of organism
- Organisms are very specific to each other
- Humans are in the Homo genus.

Species:

- As specific as it gets
- Most strict level of classification
- Organisims from the same species can breed together
- Humans are in the sapiens species

Binominal Nomenclature

- Is the formal way of naming all species in the world that is used by scientists
- It gives every species a two part name consisting of the genus first and the the species
- E.g. lady bugs are named Harmonia axyridis because they are in the genus Harmonia and they are in the species Axyridis.

Species concept- features and weakness

- It is easy to tell some species apart, for example a hippopotamus is recognizably a different species from a cheetah .But what is the difference between a cheetah and a leopard? They are also different species, but a leopard looks very similar to a cheetah. Both live in Africa, are carnivores, cats, and both even have spots.
- The most commonly used rules to divide organisms into species are called the Biological Species Concept .
- These rules consider animals to be different species **if they cannot breed together or if they breed together and produce infertile offspring, meaning offspring that cannot have their own babies.**
- Because a cheetah and a leopard cannot breed together, we consider them two different species.
- Other rules are controversial e.g. some scientists looka t physical feature like bood shape, behaviour or habitat while others look at gene pool. Within a species, there will be small differences within genes called mutations.
- Such mutations are what cause slight differences within a species, like different eye colours in humans.

Exclusion of species

- Hybrids are crosses between two difference species, so they contain 50% of genes from each parent species
- the mule, a cross between a donkey and a horse. Fifty percentage of a mule's genes are from a horse and 50% from a donkey. Because of this mixing, mules have features of each parent species and are strong, like donkeys, as well as intelligent, like horses. Farmers breed mules because the combination is very helpful.
- Most hybrids are infertile like the mule
- Some hybrids can be fertile which breaks the species concept that only animals from the same species can have fertile offspring.
- E.g. Lions and tigers create Ligers which are fertile (meaning they can have babies)
- Hybridization can occur in the natural environment too.

POPULATIONS

Terminology:

Populations: a group of individuals of the same species living and interbreeding within a given area
population dynamics: the analysis of the factors that affect the increase, stability, and decrease of populations over time.

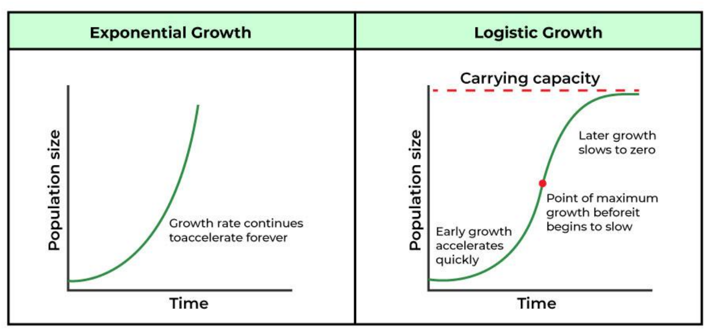
population size: the number is individuals present in a population.

population density: concentration of individuals within a population in a specific geographic area.
- Number of individuals of a population per unit of total land area
- Can be found using different methods such as quadrat sampling and capture-recapture methods.

population distribution: describes how the individuals are distributed or spread throughout their habitat

population ecology: the study of how populations of plants, animals, protists and other organisms change over time and how these living things interact with their environment.

Population growth curves:



(a) (b)

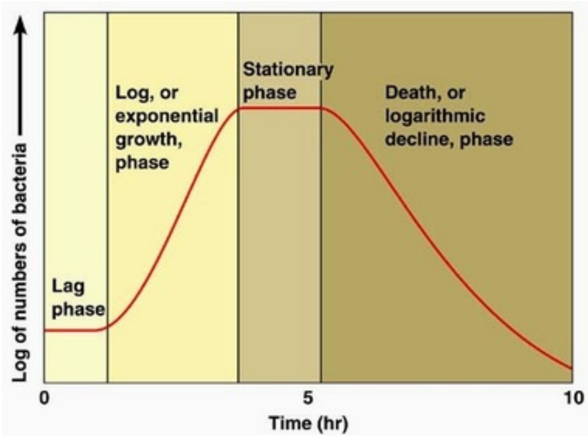
Biotic potential
Unrestricted reproductive capacity of any population
- Exponential graph

Environmental resistance
The effect of essential factor/s which reduce a populations growth rate, when in short supply
- The exponential curve flattens off (shaded area)
- E.g. food, water, shelter, space – density dependant and independent factors

Carrying capacity
The limit of biotic potential set by environmental resistance (point of stable population – some oscillation)

Population crash
When a population drastically exceeds carrying capacity, causing a severe depletion

Stages on the population graph:



Population size limiting factors:

- Species do not reproduce to their maximum.
  - E.g. Humans could have a child a year from 13-45 but most females only have a couple in their lifetime
- Resources of food and space affect population density
  - E.g. sessile organisms heavily restricted by space
  - Mobile organisms more affected by other factors like food
- Emigration decreases population size (emigration means leaving a community)
- Immigration increases population size (meaning coming into a community)
- Predation regulates the population size of both predator and prey
- Parasitism can be a limiting factor and is limited by the number of parasites in the host
- Diseases are very effective in regulating populations.
- Inter-specific (between species) and intra-specific (within species) competition
  - E.g. (inter-specific) sharks and dolphins both feed of the same fish
  - E.g. (For intra-specific) two male birds of the same species compete for the same female.
- Temperature
- oxygen

Density factors:

dependent factors:

- effects on these factors are influenced by the population density.
- e.g. food, disease, competition
- these factors have a bigger impact when the population is denser.

Independent factors:

- regardless of the population density, these factors are the same for all individuals.
- E.g. temp, rainfall, fire, droughts, …
- These factors affect the whole population no matter the size or density.

Methods of assessing population size and variety

Quadrants

For immobile organisms (plants, flowers, trees)
- Randomly through a square and count the organisms inside each square
- ESTIMATE the population using pop = total area x avg. per quadrant/quadrant area
- calculate the ACCURACY using acc% = estimate/actual x 100

Transects

For immobile organism
Line transects:
-measure the gradient of the hill by using a rise-over run where the run will always be the same distance (1m)
-measure where the plants start and finish and the hight
-plot on graph paper
Belt transect:
-measure the start and finish, hight and width from the middle on both right and left sides of the plant
-then plot it on a graph

Capture/recapture

For mobile organisms (animals that move fast)
- Tag when captured (n1)
- Grab another handful and if tagged count how many (m) and those who aren't tagged (n2), tag them
- ESTIMATE the population using pop = initial no. tagged x number recaptured/number recaptured with tag

ECOLOGICAL SUCCESSIONS

Definition: The process of how a biological community's structure gradually changes over time.
5 Stages:

Primary Succession	Secondary Succession
Begins with no life	Follows removal of existing biota
No soil present	Soil already present
New area (e.g. volcanic island)	Old area (e.g. following a bush fire)
Lichen and moss come first	Seeds and roots already present
Biomass is low	Biomass is higher

Nutation: Nutation is the development of a bare area (an area without any life form)

Invasion: Invasion is the successful establishment of a species in a bare area.

Competition and co-action: Aggregation results in the increase of the number of species within a limited space. This results in competition between individuals for food and space. Individuals of a species affect each other's life in various ways and this is called co-action.

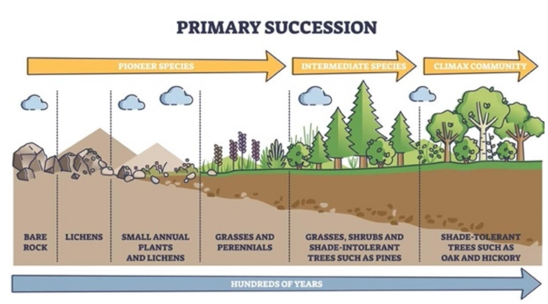
Reaction: It is the modification of the environment through the influence of living organism present on it.

Stabilisation: The final or terminal community becomes more or less stabilized for longer period of time.

Primary successions:

- is initiated when a new area that has never previously supported an ecological community is colonized by plants and animals. This could be on newly exposed rock surfaces from landslides or lava flows.
- happens when a new patch of land is created or exposed for the first time.
- **stages:**

1. Pioneer species (mosses, lichen, algae, fungi)
    - These species are more tolerant and eventually contribute to soil formation by breaking down rocks into smaller particles. They also provide organic matter to the area.
    - Eventually, the land with soil becomes favourable for the growth of a higher form of species.
    - Generally, have shallow roots.
    - Hardy leaves
2. Intermediate species
    - As the habitat improves, a wider range of vegetation and small animals can occupy the area.
    - They are primarily grasses and shrubs that can thrive in thin soils.

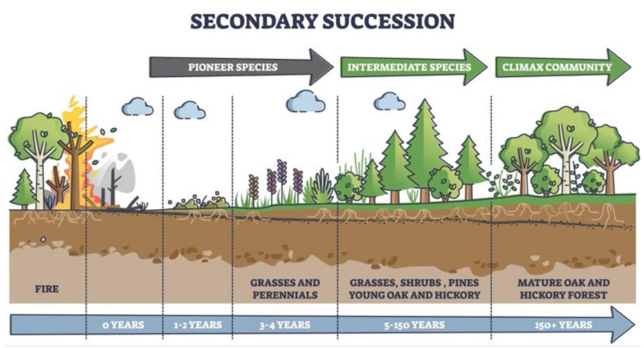


3. Climax species
    - as the soil becomes richer, more plant species can grow

- a climax occurs with the appearance of the most complex plant species. These climax species include taller trees such as oaks, pines, and spruces.

Secondary succession:

- occurs in areas where a biological community has already existed but some or all of that community has been removed by small-scale disturbances that did not eliminate all life and nutrients from the environment.
- fire, flooding, and other disturbances may drive out many plants and animals and set back the biological community to an earlier stage, the community does not start from scratch.



- **Stages:**
- Secondary has the same steps as primary succession, but it happens a lot quicker because there is already soil and nutrients In the soil that allow plants to grow quicker.

1. Pioneer species
2. Intermediate species
3. Climax species

Climax community:

- A climax community is the “endpoint” of succession within the context of a particular climate and geography.
- The climax community in succession shows the following characteristics:
    - The vegetation of the climax community will have high ecological amplitude.
    - They possess high tolerance towards environmental conditions.
    - They show rich diversity in species composition.
    - The species composition remains constant for many years.
    - The community possesses a complex food chain system.
    - The ecosystem will be balanced and self-sustainable.
    - The energy used from the sunlight and energy released after decomposition will be balanced.
    - The uptake of nutrients from the soil and the release of nutrients back to the soil by decomposition will be in equilibrium.
    - The individuals of the community lost by its death are replaced by the individuals of the same species.

Fire ecology:

Terminology:

Crown fire: a tree fire that spreads through canopy or from tree top to tree top
Surface fire: burning in surface fuels such as leaf litter, woody debris and low level lining plants
Spot fire: a fire started by flying sparks or embers at a distance from the main fire
Prescribed burn: the controlled application of fire by a team of fire experts under specified weather conditions to restore health to ecosystems that depend on fire.
Wildfire: a fire that starts, usually by itself, in a wild area such as a forest, and spreads rapidly, causing great damage.
Fire intensity: Fire intensity is the amount of energy or heat given off by a forest fire at a specific point in time
Fire frequency: the number of times that fires occur within a defined area and time period
Fire severity: a quantitative measure of the effects of a fire on the environment, typically considering both the damage to vegetation and the impacts on the soil
Mosaic/ patch burn: applying planned fire at varying intensities, scales and times within a broader landscape to create patches (a mosaic) of burnt and unburnt areas that change over time.

Factors affecting the spread of wildfires:

- Wind strength
    - the stronger the wind, the faster a fire will spread
- Fuel availability
    - the more leaf litter and vegetation (fuel) the hotter the fire will burn.
    - E.g., there is more fuel to burn in a forest than a grass paddock
- The slope
    - Fire travels faster up a slope (the steeper the slope the faster the fire will travel)
    - Flames moving up the slope preheat the fuel causing it to ignite rapidly
    - Flames moving down a hill are angled away from the fire and there is little preheating of the fuel
    - For every 10 degree increase slope the fire speed doubles
- Weather
    - Fires are more likely to start and spread when temperatures are high and humidity is low and it is windy
    - E.g. in summer forest fuel is drier and will cause the fire to travel faster and burn hotter
- Spreading patterns (the pattern that a fire spreads depends on ..)
    - The wind direction, If there is an easterly wind the fire will spread to the west
    - The topography
    - The barriers, e.g., roads, rivers, and areas without vegetation.

Effects of fire on animals:

- Where the animals lives:
    - Ground-dwelling animals may be affected by all types of fires
    - Tree dwellers habitat may be unscathed apart from very intense fires

  - Animals that can hide in burrows may survive a fire versus those that seek shelter is logs
- What it eats:
  - Animals that have varied diets can switch to other foods if one becomes scarce vs animals that have specialist feeders
  - Carnivorous diets become more visible after a fire vs herbivorous where their diet may be burnt
- Size of animal
  - Larger and faster animals such as kangaroos can escape a fire
  - Tiny slow animals such as honey possums cannot escape an intense fire
- The intensity of the fire
  - Hot summer fires will do more damage than autumn or spring fires
  - Fires that cover large areas are more damaging than small fires that animals can escape
  - It will take longer for animals to recolonise after a high-intensity fire vs a low-intensity fire there will be patches of vegetation left over where animals can refuge to.

Adaptations and community changes to dealing with fire:

- Plant species have a range of adaptations that help them to persist through fire. These may either involve populations re-colonising after fire through dispersal, populations regenerating from seed banks that survive fire, or individuals resprouting from buds and tissues that survive the fire.
- Resprouters (more than one stem) survive fires as individuals.
- Reseeders (one stem) are killed by fire and must re-establish through germination and the establishment of seedlings.

- **Reseeders vs resprouters:**
  - Reseeder seedlings tend to grow faster than do resprouter seedlings
  - Reseeding species most commonly have a shallow, fibrous root system. Resprouters have a massive, deeply penetrating root system
  - reseeders tend to conserve nutrients to a greater extent through leaf retention.
  - Reseeders tend to produce greater numbers of flowers and greater amounts of floral rewards

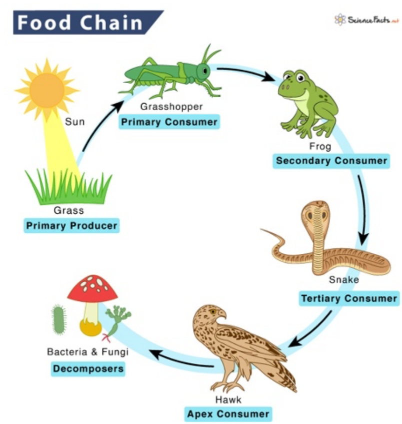
- **Resprouting (resprouters):**
  - individuals can survive fire to regrow new leaves and branches, and some to flower and produce seeds, quickly after fire
  - It requires a 'bank' of dormant buds that are insulated from fire, and stored energy to enable growth.
  - Buds are protected under soil or thick bark.
  - Resprouting enables plants to have longevity greater than the fire interval and some to grow to large sizes.

    - Trees of northern savannahs, Banksia woodlands and **Jarrah forests** have these traits.

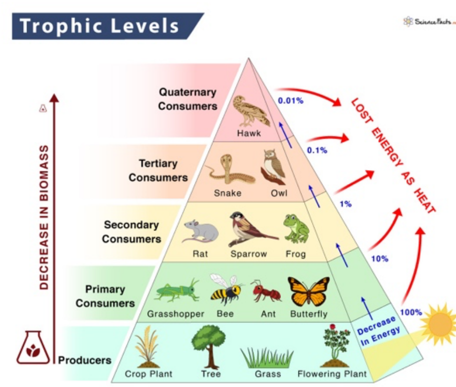
- **Seed banks (reseeders):**
    - long-lived seedbanks is a common feature of many Australian plants
    - seedbanks can be stored in the soil or stored in the plant's canopy in woody fruits, e.g. gum nuts
    - The heat from fire promotes the opening of these woody fruits in the canopy, releasing seeds to enable dispersal and germination.
    - Heat, or chemicals in smoke, also trigger dormancy release, and cue germination of soil-stored seeds

ENERGY TRANSFERS

The ultimate source of energy for organisms in an ecosystem is sunlight. Which is converted to chemical energy with photosynthesis.
The primary producers harvest their energy through photosynthesis
($6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$) or chemosynthesis.
majority of autotrophs are photoautotrophs that get energy from the sun to make biomass.
The energy is then passed on to consumers through feeding pathways.
The energy contained within the producers and consumers is then passed to decomposers.



A **food chain** is a linear series of feeding relationships in which there is a transfer of food from one organism to the next.
A food chain shows how energy is passed through a series of animals. The arrows in a food chain show the flow of energy. As an organism is eaten, energy is transferred to the organism that ate it.

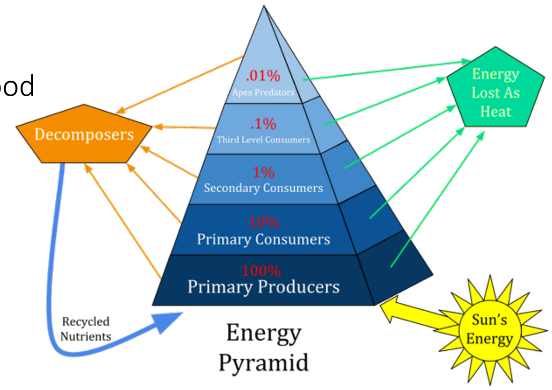


Trophic levels are position in a <u>food chain</u> or <u>ecological pyramid</u> occupied by a group of <u>organisms</u> with similar feeding modes.

A **food web** is a complex network of interrelated food chains.
They consist of all the food chains in a single ecosystem. Each living thing in an ecosystem is part of multiple food chains.

ECOLOGICAL PYRAMIDS

Niche: an organism's role in its environment:
Biomass: renewable organic material that comes from plants and animals



Producer (plants, autotroph):

Definition: an organism that is able to make its own food via photosynthesis or chemosynthesis.
An example of a produce is an Eucalyptus tree
Niche: to provide energy for 1^{st} order consumers

Consumer:

Definition: organism on the food chain that depends on autotrophs (producers) or other consumers for food, nutrition, and energy.
Herbivore: an organism that eats and depends on plants for food. They are the 1^{st} order consumers on an ecological pyramid or in a food chain.
An example of a herbivore is Panda
Carnivore: An organism that eats and depends on the meat and flesh of other animals. They are 2^{nd} , 3^{rd}, 4^{th} and sometimes 5th-order consumers on an ecological pyramid and food chain.
Predication niche
Detritivore niche
Scavenger niche
Omnivore: an organism that regularly consumes a variety of material, including plants, animals, algae, and fungi. These organisms cannot be identified on food chains and ecological pyramids as in a food chain each organism can eat one other organism to keep it as a food chain. However they can be identified on a food web because each organism can be shown to eat more than one food source, for an omnivore this can be meat and plants.
and example of an omnivore is a human

Decomposer:

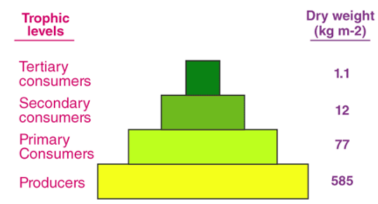
Definition: an organism that decomposes, or breaks down, organic material such as the remains of dead organisms. E.g. fungi and bacteria
Niche: Decomposers in ecosystems act as environmental cleaners by decaying dead plants and animals. They also aid in the recycling of nutrients and make room for a new life in the biosphere by decaying the dead.

The Pyramid of Biomass:

- the representation of total living biomass or organic matter present at different trophic levels in an ecosystem.
- There is roughly only 10% biomass that is transferred and therefore there is a 10% rule.
- The reason only 10% is transferred is:
  - 1. Organisms don't usually eat every part of the other organsims e.g. Their teeth or skeleton
  - 2. Some parts that are eaten are not absorbed and instead are ejected as faeces
  - 3. Most nutrients that animals absorb is used to release energy through respiration and is then released as waste products (CO_2 and Urea). When the organisms ends up being eaten it doesn't pass on all the biomass it has consumed in its entire life.

In terrestrial ecosystems:

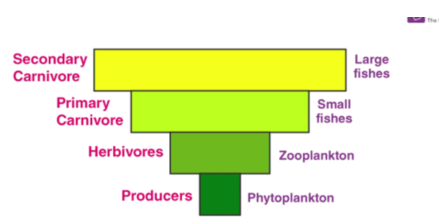
- In terrestrial settings the pyramid of biomass will be upright (the bottom is bigger than the top)
- The biomass of each trophic level gets smaller going up.
- This is because the biomass of producers must be greater than the biomass of herbivores, must be greater than that of carnivores.



Pyramid of biomass for grassland ecosystem

In Aquatic ecosystem:

- In aquatic ecosystems, the pyramid of biomass is sometimes inverted (the bottom is smaller than the top)
- The biomass of each trophic level gets bigger going up.
- This is because the common producer Phytoplankton has short lifespans and higher reproducibility meaning if at any time the biomass is low, they frequently replenish and cater to more zooplankton and larger fish.



The Pyramid of numbers:

- The representation of the number of each organism on each trophic level in the pyramid.
- This pyramid type was made by Charles Elton in 1927 who pointed out the huge difference in the number of organisms involved in each level of the food chain.
-

Upright pyramid of numbers:

- Found in grassland ecosystems.
- Where there are numerous autotrophs that support lesser herbivores. And with every higher trophic level the numbers of organisms deacrease.

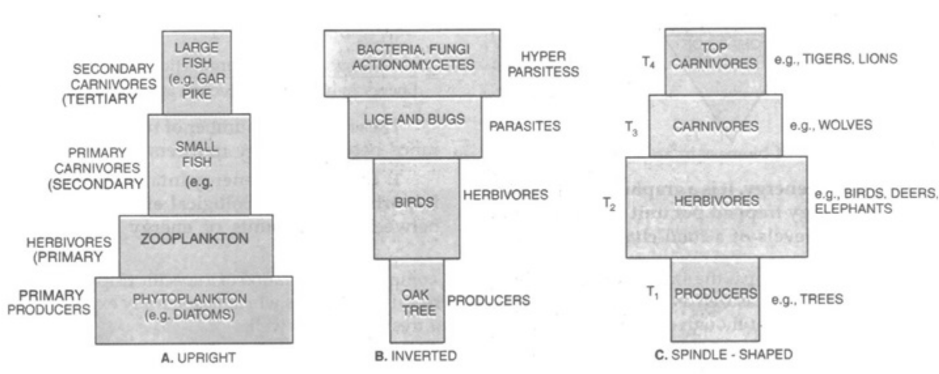
- For example in terrestrial ecosystems:
    - o Grass is the lowest trophic level
    - o Grasshoppers are the herbivore who are the 1st order consumers and have a smaller quantity than the grass
    - o The rats are the carnivores who are the 2nd order consumers and are at a lesser number than grasshoppers
    - o The Snakes are carnivores who are the 3rd order consumers and are at a lesser number than rats
    - o And Finally, Hawks are the tertiary consumers who are at a lesser number than the snakes
- A pond ecosystem also depicts the same upright pyramid:
    - o Phytoplankton
    - o The smaller herbivores fish
    - o The Larger carnivores fish who is the apex consumer
    - o

Partially upright pyramid of numbers:

- Typical in Forrest ecosystems
- The producers are normally large-sized trees where there a few of them
- The 1st order consumers (herbivores) like fruit-eating birds are at a larger number than the producers
- The rest of the pyramid then returns to the upright pyramid where each higher trophic level has fewer organisms than the one before it.

The inverted pyramid of numbers:

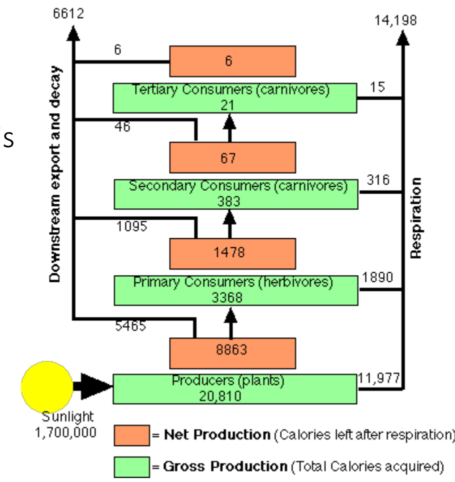
- Where each level is increased from lowest to highest.
- Found in parasitic food chains
- In these food chains, there is usually one producer supporting many parasites
- The parasites then support more hyperparasites.



Pyramids of numbers : **A.** In pond ecosystem; **B.** In parasitic food chain; **C.** Tree ecosystem.

The Pyramid of Energy:

- Is always upright as the flow of energy in a food chain is unidirectional.
- Represents the amount of energy at each trophic level on a food chain.
- The 10% rule (each level should pass on 10% of their energy to the next level)
- The reason only 10% is transferred:
    - Energy is released as heat from each level.
    - Some of the energy is undigested from the lower level.
    - A lot of the energy that organisms consume is used to carry out their own functions and growth. (respiration)



- Gross energy: is the total amount of energy the organism starts of with and has before respiration.
- Net energy: the energy that is left after respiration and is used to pass on to the next organism.

THE CARBON CYCLE

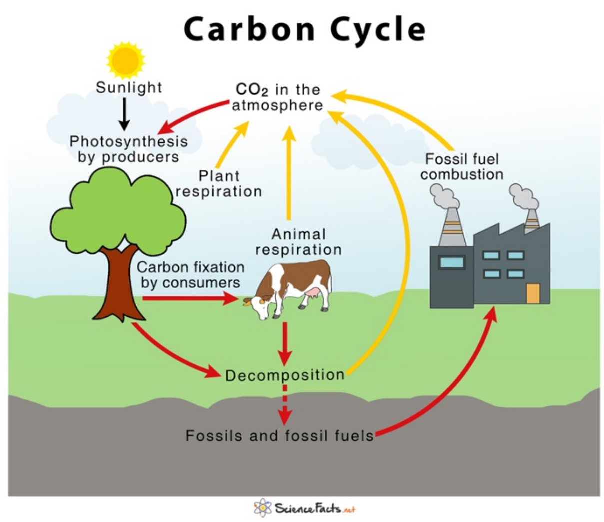
Definition: The carbon cycle is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere geosphere, hydrosphere, and atmosphere of Earth.

Steps:

1. Carbon present in the atmosphere is absorbed by plants for photosynthesis.
2. These plants are then consumed by animals and carbon gets bioaccumulated into their bodies.
3. These animals and plants eventually die, and carbon is released back into the atmosphere upon decomposing.
4. Some carbon not released into the atmosphere eventually becomes fossil fuels.
5. These fossil fuels are then used for man-made activities, which pump more carbon back into the atmosphere.

Photosynthesis: the process by which green plants and some other organisms use sunlight to synthesize nutrients from carbon dioxide and water

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$



Animal/ cellular respiration: A chemical process in which oxygen and glucose is used to make energy for organisms. (by-product being carbon dioxide)

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

Plant respiration: the process of plants using up the sugars made through photosynthesis and turning them into energy for growth, reproduction, and other life processes. It involves taking in oxygen and releasing it as carbon dioxide into the atmosphere.

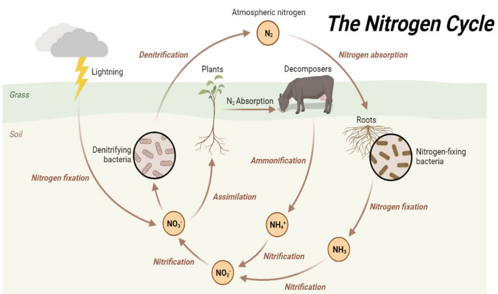
Carbon Fixation: the process by which inorganic carbon (particularly in the form of carbon dioxide) is converted to organic compounds by living organisms.

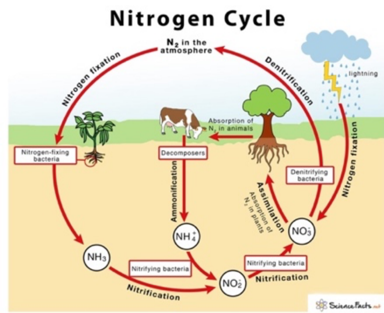
Decomposition: Decomposition or rot is the process by which dead organic substances are broken down into simpler organic or inorganic matter such as carbon dioxide, water, simple sugars and mineral salts.

Combustion: When fossil fuels are burned, they release large amounts of carbon dioxide, a greenhouse gas, into the air.

NITROGEN CYCLE

Definition: a repeating cycle of processes during which nitrogen moves through both living and non-living things





Fixation - Fixation is the first step in the process of making nitrogen usable by plants. Here bacteria change nitrogen into ammonium.
Nitrification - This is the process by which ammonium gets changed into nitrates by bacteria. Nitrates are what the plants can then absorb.
Assimilation - This is how plants get nitrogen. They absorb nitrates from the soil into their roots. Then the nitrogen gets used in amino acids, nucleic acids, and chlorophyll.
Ammonification - This is part of the decaying process. When a plant or animal dies or excretes waste, decomposers like fungi and bacteria turn the nitrogen back into ammonium so it can renter the nitrogen cycle.
Denitrification - Extra nitrogen in the soil gets put back out into the air. There are special bacteria that perform this task as well. Converts from NO3- -> N2
Steps:

1. Nitrogen (N2) in the atmosphere is unusable for plants because it is very unreactive. Nitrogen-fixing bacteria “eats” the nitrogen and turns it into ammonia (NH3) in a process called **fixation**. Nitrogen-fixing bacteria can be held in nodules in plant roots.
2. The ammonia is “eaten” by nitrifying bacteria that turn it into Nitrite (NO2-) in a process called **nitrification.**
3. The Nitrate is eaten by more nitrifying bacteria that turn it into Nitrate (NO3-) in the nitrification process.
4. Lightning also fixes nitrogen from the high temperatures of the bolt and converts nitrogen into nitrates. N2 -> NO3-.
5. The Nitrate is absorbed into the plants through the process of **assimilation.**
6. Animals eat plants and get nitrogen in their system.
7. Animals and plants die, and decomposers **decompose** the plants and animals and, in a process, called **ammonification**, release ammonium (NH4+) into the soil.
8. The ammonium goes through nitrification and turns back into Nitrate.
9. Denitrifying bacteria convert Nitrates (NO3-) back into gaseous nitrogen (N2) that can be released into the atmosphere in a process called **Denitrification.**

ECOLOGICAL INTERACTIONS

Predation: an interaction in which one animal typically kills and consumes another animal.
e.g. lions eating gazelles

Competition: When two or more organisms in the same community compete for the same resource. Intra-specific (members of the same species) and interspecific (members from different species)
e.g. two male birds of the same species might compete for mates in the same area

Disease: the interaction of the behavior and ecology of hosts with the biology of pathogens as relating to the impact of diseases on populations
e.g. Examples include Cholera, chickenpox, malaria

Collaboration: When 2 animals work together to achieve a common goal.
e.g. orcas hunting in a pack to feed

Amensalism: an interaction where one species suffers, and the other interacting species experience no effect.
e.g. When cattle trample on grass, the grass is crushed. However, the cattle do not benefit from this action nor is harmed in the process. (the grass is harmed but the cattle are neither benefited or harmed)

Symbiotic relationships:

Symbiosis is defined as a close, prolonged association between two or more different biological species. Mutualism, commensalism and parasitism are the 3 types of symbiotic relationships.

Mutualism: When two interacting species benefit each other by mutually increasing both species' chances of survival or reproduction
e.g. Oxpecker birds gain a safe habitat on rhinoceros' backs and in exchange eat parasites and insects that would harm rhinos. (the bird benefits and the rhino benefits)

Commensalism: a relationship between two organisms in which one benefits and the other is neither benefited nor harmed.
e.g. a bird making a nest in a tree (the bird benefits and the tree is neither benefited or harmed)

Parasitism: an interaction in which one organism (the parasite) lives on or in another organism (the host), where one organism benefits at the expense of the other.
e.g. tapeworms, bacteria, **pathogens** (parasites that cause disease)

KEYSTONE SPECIES

Definition: A keystone species is an organism that helps define an entire ecosystem.

- Without its keystone species, the ecosystem would be dramatically different or cease to exist altogether.
- Keystone species have low **functional redundancy.** This means that if the species were to disappear from the ecosystem, no other species would be able to fill its ecological niche.
- Any organism, from plants to fungi, may be a keystone species
- They are not always the largest or most abundant species in an ecosystem. However, almost all examples of keystone species are animals that have a huge influence on food webs.

Predator:

- Keystone species are often predators.
- Predator species such as wolves, orcas and sea otters help maintain the population sizes of prey species, and sometimes even other predators, in an ecosystem. If a keystone predator is removed, other species may explode in number, potentially outcompeting and displacing other species.
- E.g. sharks are keystone predators that have a top-down impact on marine ecosystems worldwide. By preying on the sickest, weakest, and slowest animals, they control the spread of disease and keep prey populations in check

Herbivore:

- Their consumption of plants helps control the physical and biological aspects of an ecosystem
- European wild rabbits are a 'keystone species' that hold together entire ecosystems – according to researchers at the University of East Anglia. Their grazing and digging activity keeps the ground in a condition that is perfect for sustaining other species that would otherwise move on – or die out

Umbrella species

- a species whose conservation is expected to confer protection to a large number of naturally co-occurring species.
- Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.
- E.g. The spotted owl is a species of true owls. They are currently “near threatened” due to their habitat loss because of excessive timber harvesting. Spotted owls depend on tall and old trees as they nest in tree holes. When that's not available they nest in abandoned nests of other birds or younger trees. Conserving this species implies protecting their habitat: ancient forests, growing trees and other species that thrive in the same habitat.

Foundation species

- Foundation species play a major role in creating or maintaining a habitat and have a strong role in structuring a community.
- Corals are a key example of a foundation species across many islands in the South Pacific Ocean. These tiny animals grow as a colony of thousands and even millions of individual polyps

Ecosystem engineers

- ecosystem engineers contribute to the physical geography of their habitat. Ecosystem engineers modify, create, and maintain habitats.
- Ecosystem engineers modify their habitats through their own biology or by physically changing biotic and abiotic factors in the environment.
- E.g. Beavers are among the most prominent ecosystem engineers. Their dam-building activities divert and stagnate streamflows, flooding adjacent areas, and forming new wetlands that provide habitat for other aquatic organisms, from tiny zooplankton to amphibians

Indicator species

- An indicator species describes an organism that is very sensitive to environmental changes in its ecosystem. Indicator species are almost immediately affected by changes to the ecosystem and can give early warning that a habitat is suffering.
- Indicator species can signal a change in the biological condition of a particular ecosystem
- Scientists monitor factors like the size, age structure, density, growth, and reproduction rate of populations of indicator species to look for patterns over time. These patterns may be able to show stress on the species from influences like pollution, habitat loss, or climate change.
- E.g. Mayflies are a type of macroinvertebrate insect that is especially sensitive to water pollution. These insects are used by researchers as indicators of the health of aquatic ecosystems because of their dependence on water and their pollution intolerance

Flagship species

- A flagship species acts as a symbol for an environmental habitat, movement, campaign, or issue. They can be mascots for entire ecosystems.
- E.g. tiger, panda, snow leopard, gorilla, they are used as icons of their habitats as they attract public attention, and hence funding for research and conservation.