ECOLOGY

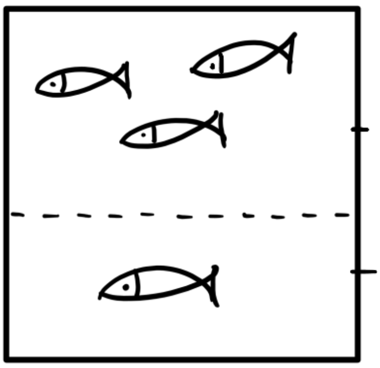
The study of how living and non-living interacts with each other.

According to odum ecology : Abiotic components + Biotic comp. → "Interacts" = Ecosystem

Ecosystem

1. Abiotic factors
   - light, Temperature, air, soil, etc.
2. Biotic factors
   - plants and animals
3. Nature ecosystem
   - Grassland ecosystems, forest ecosystems, marine ecosystems, etc.
4. Artifical ecosystem
   - ecosystem made by mankind

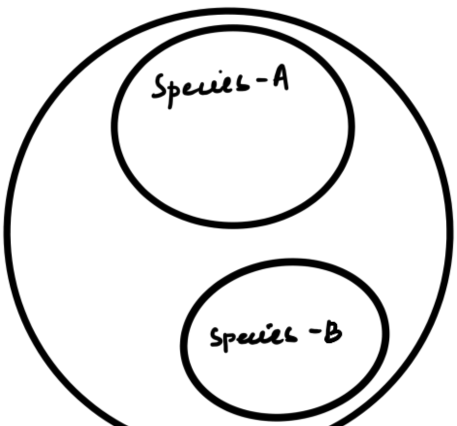
- <u>Ecological levels of organisms</u>



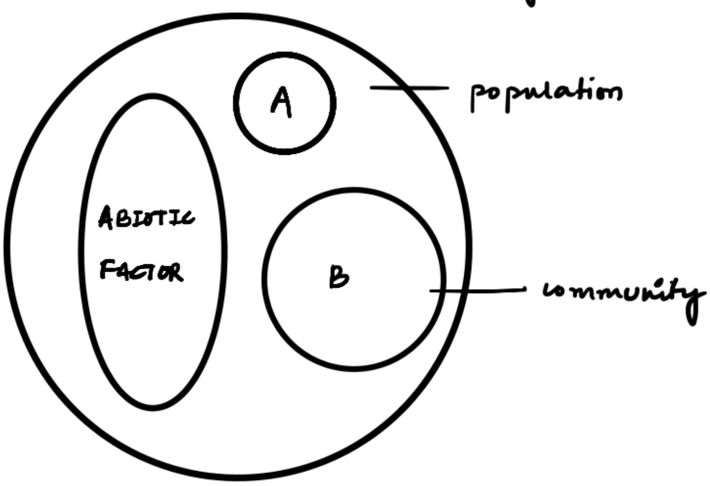
population : sum of all individuals belong to one species at a particular area.

Individual / species

* Species (Mayer, 1942) : Species is a group of organisms which can interbreed and can produce fertile offspring.



COMMUNITY



ECOSYSTEM

Landscape : Large region formed by interaction of two or more ecosystem

Biome : A biome is a large area characterized by its vegetation soil climate and wildlife. It is formed in response to physical environment.

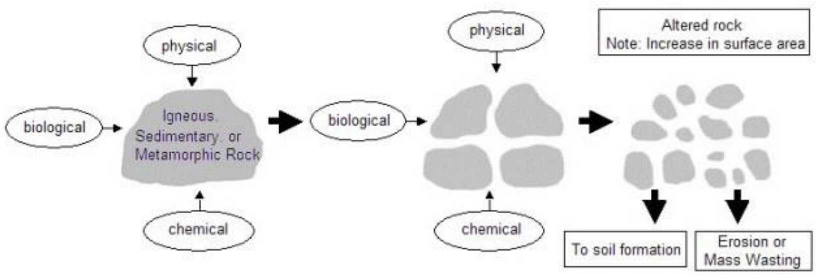
Biosphere : The region above and below on the earth's surface where life exists.

- <u>Soil Biology</u>

The soil is an living organism. The soil is an complex of living cells in an organic and mineral matrix.

⇒ Soil formation (pedogenesis) : 1. weathering of rock (Exogenic force).

∴ Agents of weathering : wind, glacier, ice, rain, waves of rock



formation of soil : Soil formation is a slow process that can take thousands of years.

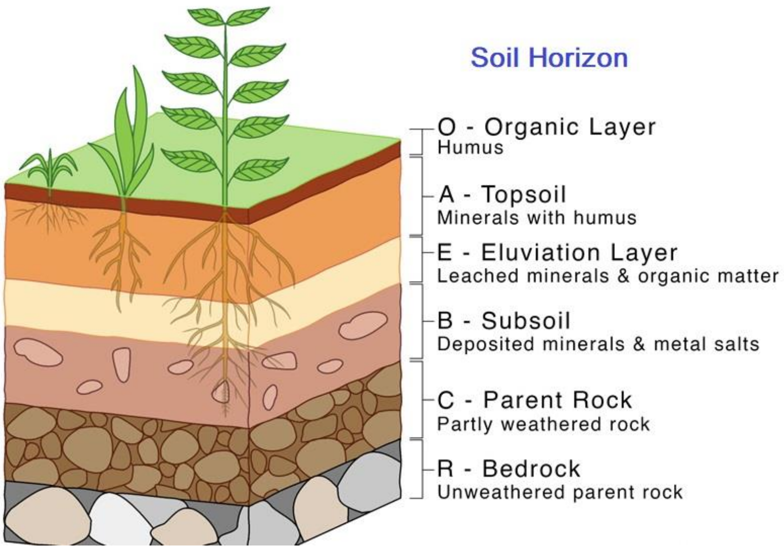
1. weathering : The breakdown of rocks in smaller particles through physical and chemical processes.

2. Organic Matter Accumulation : The addition of organic materials from decaying plants and animals contributes to soil fertility.

3. Soil horizons Development : As soil forms distinct layers or horizons develop due to the movement of water and nutrients.

Composition of soil

1. water
2. Air
3. organic matter
4. Mineral particles.



O-horizon : contains fresh or partly decomposed organic materials.

organic horizon

O_1 plant and animals residue can be seen through naked eyes.

O_2 plant, animals residue can't be seen through naked eyes.

A-horizon : It has organic matter accumulation with iron, aluminium, clay.

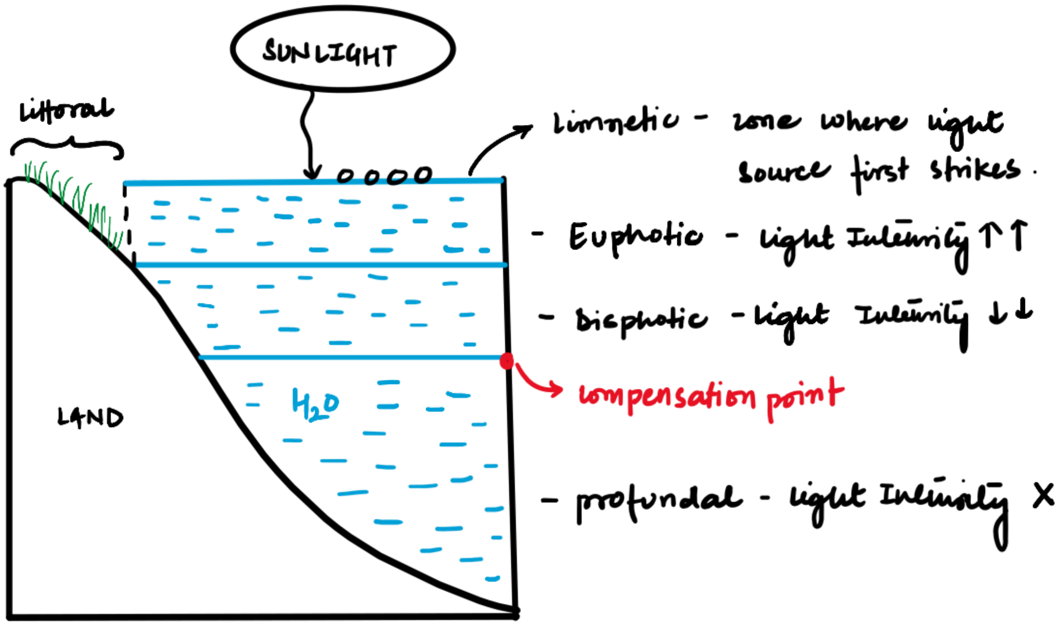
* A_1 - organic matter ↑, Darker in colour, mineral fraction can be seen.
* A_2 - " ↓, lighter in colour, quartz accumulation

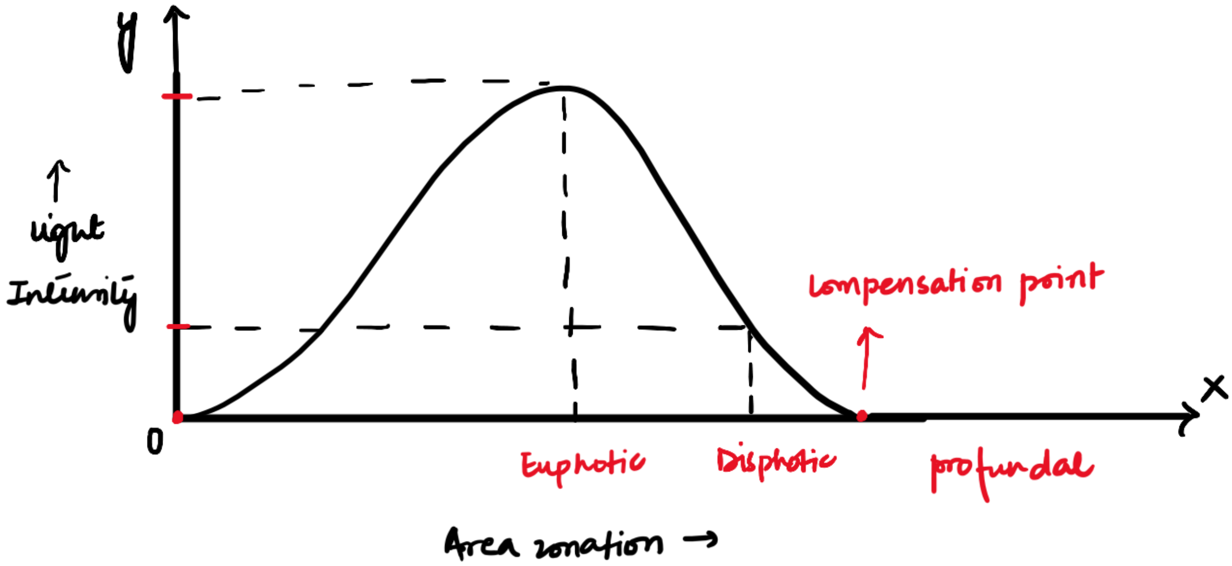
B-horizon : presence of clay, iron, aluminium ↑↑ and coating of sesquioxides will impart darker, red in colour, organic matter >>> A_2 horizon.

C-horizon : volume (A+B) - CO_2^- ↑, SO_2^- ↑, Mg ↑, Ca^{+2} ↑

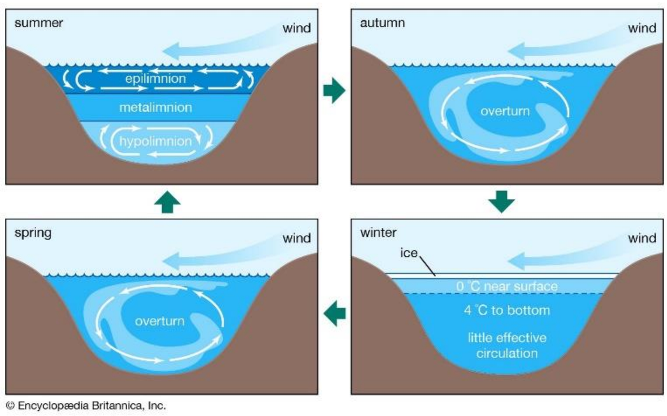
R-horizon : consolidated bed rock.

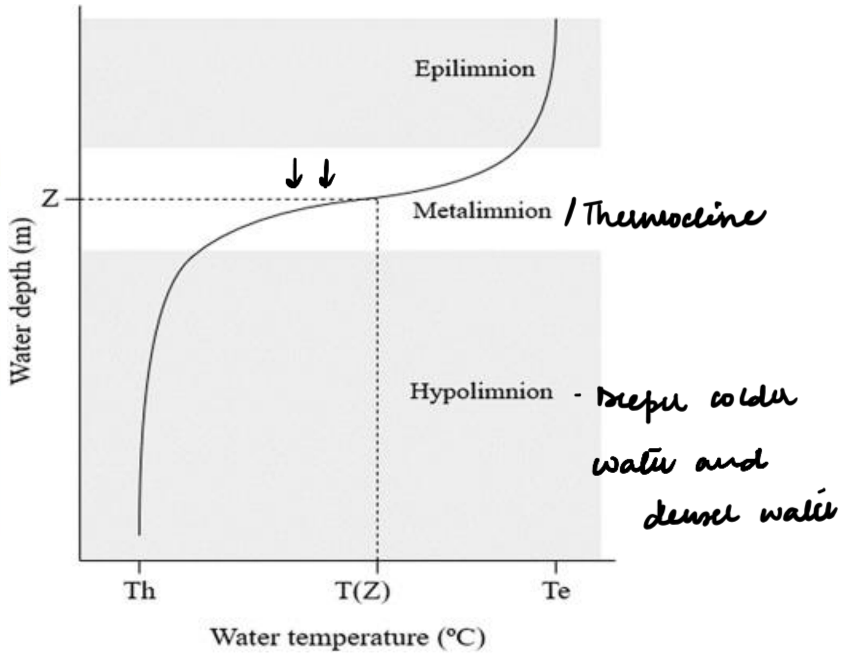
Light zonation : in light





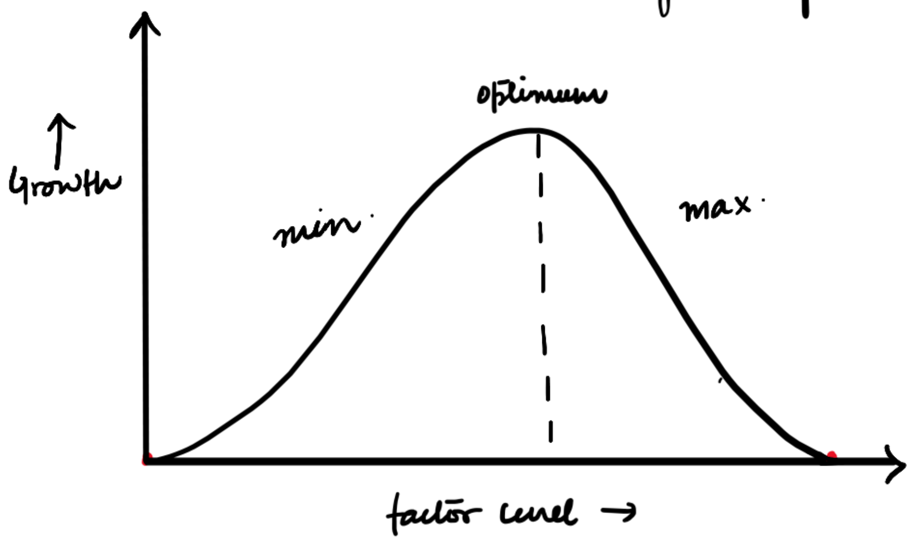
Thermal Stratification Graph :





Liebig's law of Minimum : An organisms requires minimum quantity of a particular factors for its proper growth and failing below this minimum level organisms fails to grow properly.

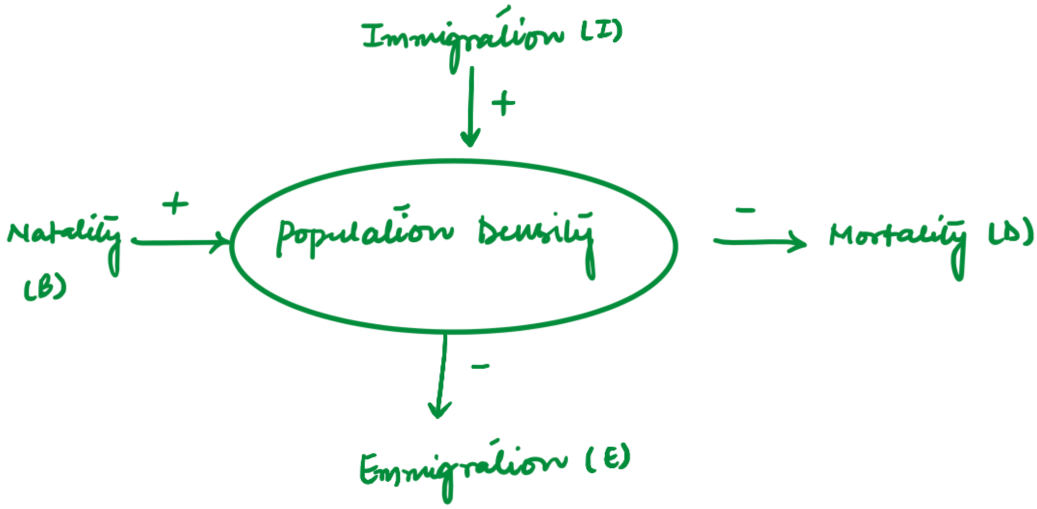
Shelford's law of tolerance : It is more over same as Liebig's law but it also states that excess amount of factors can also lead to the organisms growth abnormally.



POPULATION ECOLOGY

population characteristics : 1. population size and density

- population size is the total no. of individual that in a population
- population density is the no. of individual per unit area/vol.



2. Natality : It is the production of new individual in a population

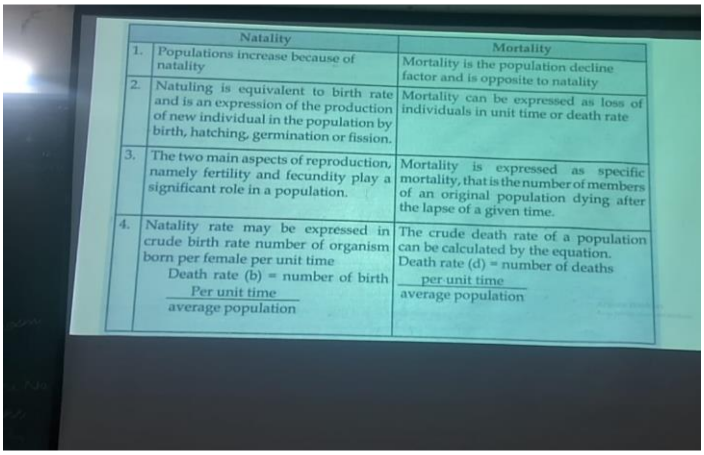
crude natality : population inc↑ under ideal conditions

$$B = \frac{\Delta N_n}{\Delta t}$$ ∵ ΔN_n : production of new individuals in population

Realised natality : population inc. ↑ under actual conditions

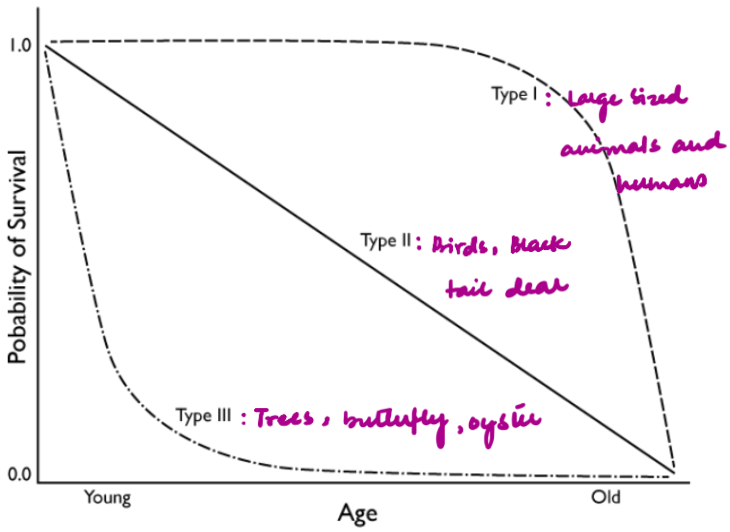
$$b = \frac{\Delta N_n}{N \Delta t}$$ ∵ N = initial population

Difference b/w natality and mortality :



	Natality	Mortality
1.	Populations increase because of natality	Mortality is the population decline factor and is opposite to natality
2.	Natuling is equivalent to birth rate and is an expression of the production of new individual in the population by birth, hatching, germination or fission.	Mortality can be expressed as loss of individuals in unit time or death rate
3.	The two main aspects of reproduction, namely fertility and fecundity play a significant role in a population.	Mortality is expressed as specific mortality, that is the number of members of an original population dying after the lapse of a given time.
4.	Natality rate may be expressed in crude birth rate number of organism born per female per unit time Death rate (b) = number of birth $\frac{\text{Per unit time}}{\text{average population}}$	The crude death rate of a population can be calculated by the equation. Death rate (d) = number of deaths $\frac{\text{per unit time}}{\text{average population}}$

3. Survivorship curve : Graphically representation of the no. of individuals in a population that can be excepted to survive to any specific age.



1. Type - I : Survivorship ↑↑
   - highly convex curve
   - parental care is max.
   - K- strategies
2. Type - II : These exhibits a constant portion of life span.
   - Max. mortality at mid phase
3. Type - III : Exhibits very ↑ mortality at young ages.
   - highly concave curve.
   - r- strategies where max. energy is directed for reproduction

4. Age structure : distribution of various ages in an population

- pre-reproductive age (0-14 years).
- Reproductive age (15-60 yrs).
- post-reproductive age (> 60 yrs).

There are 3 types of population pyramids : Expanding, Stable and Declining

- <u>Expanding</u> :- High % of pre-productive or young individuals than post-reproductive age groups.
  - birth rate (b) > death rate (d)
  - $\uparrow$ birth rate $\equiv$ population inc. $\uparrow$
  - e.g: India, china or any developing country.

- <u>Stable (Bell-shaped pyramid)</u> :- equal population in each groups.
  - $b = d$ (neither inc. $\uparrow$ nor dec. $\downarrow$)
  - mortality rate and fertility rates - no changes
  - e.g: Developed countries.

- <u>Declining (Urn-shaped)</u>: - narrow base
  - PR groups > R > pre-productive groups
  - population is dec. $\downarrow$ due to low birth rates and low fertility rates.
  - high life expectancy
  - e.g Japan

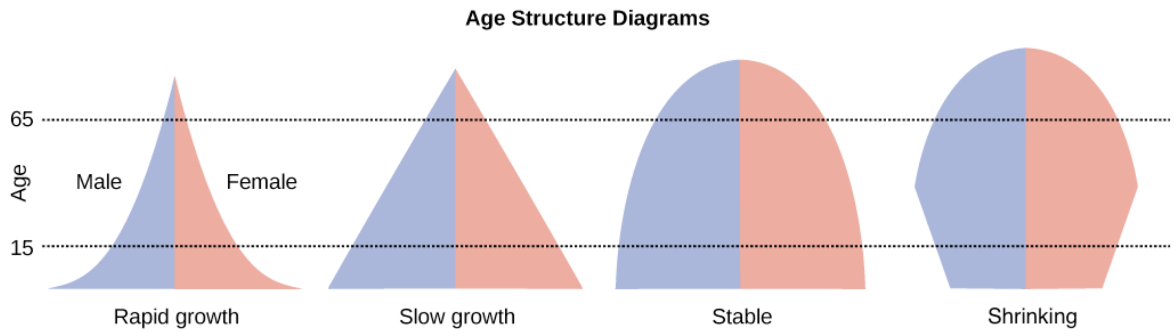


figure : population pyramids

Growth Rate

1. Expotential growth : a. population show growth where no limiting factors

b. Abundant resource available.

c. no predation or competition

d. shows geometric growth.

$$\text{Equation} : \frac{dN}{dt} = rN \quad \text{or} \quad \frac{1}{N}\frac{dN}{dt} = r$$

$\because$ N = no. of individuals

r = intrinsic rate (max. reproduction potential of an individual)

closed population,

$r = b - d$ ⇒ (instentenious per capita)

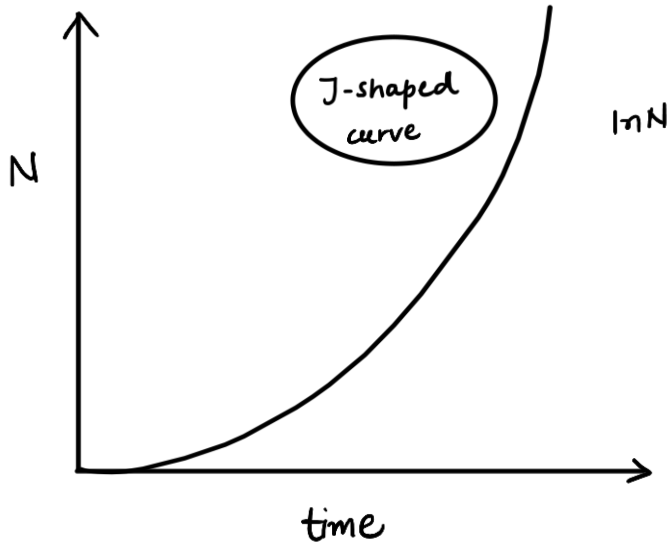
open population, ⇒ Birth + immigration - death + emigration

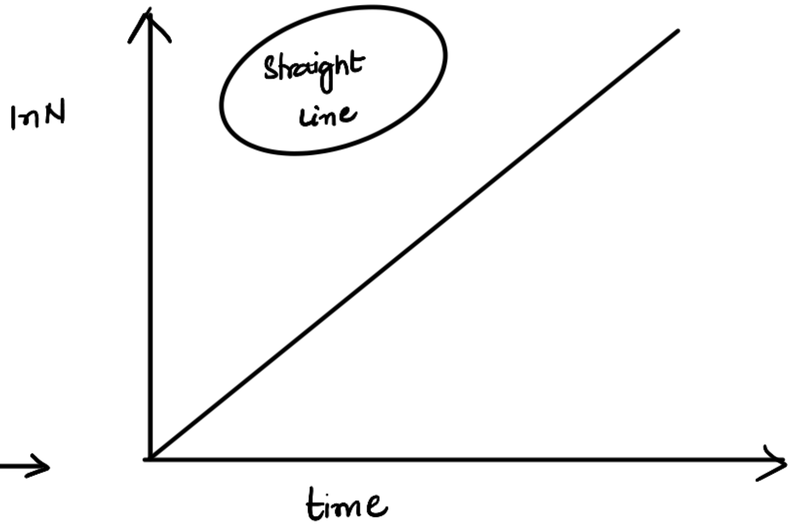
if, $b > d$ = r is +ve (population inc.↑)

$d > b$ = r is -ve (—〃— dec.↓)

Integral form of exponential growth eq^n

$\because N_t = N_0 e^{rt}$

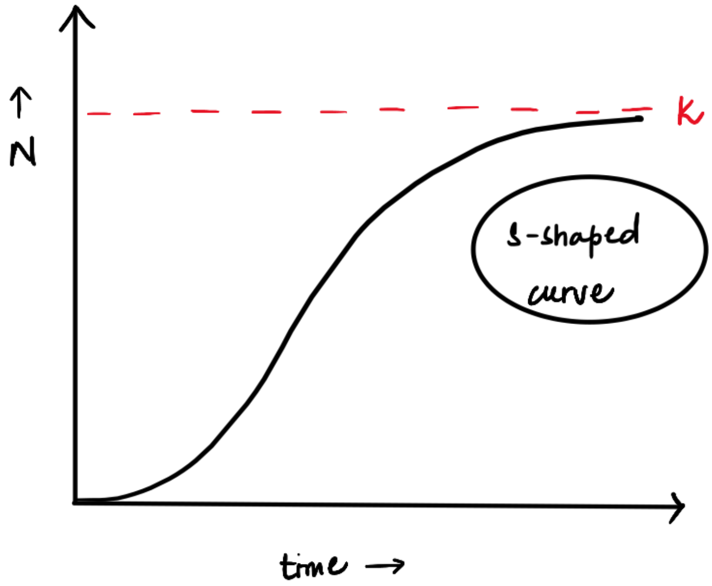


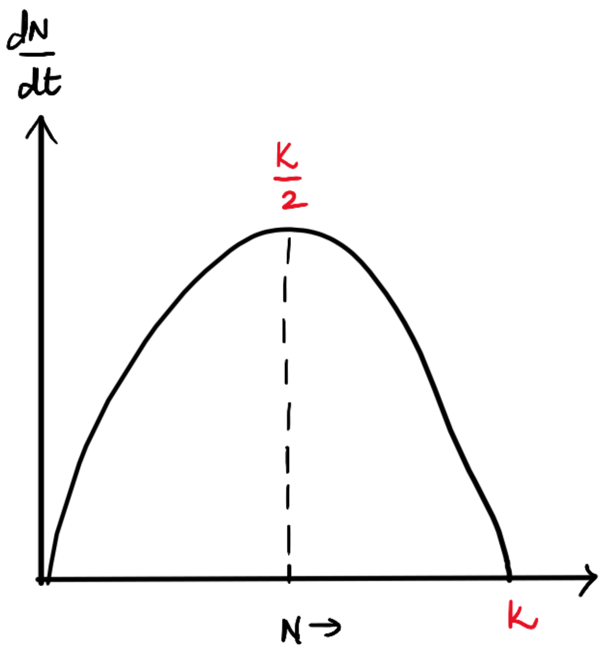


2. Logistic growth : An environment can support a particular no. of individuals of a population in real life.

K = carrying capacity.

- k is not fixed
- It can varies wt space/time.
- Determined by predation, environment condition.



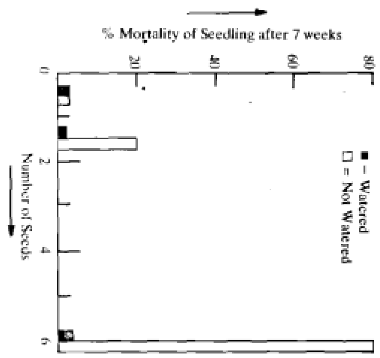


$$\boxed{\text{Equation} : \frac{dN}{dt} = \frac{rN(K-N)}{K}}$$

12.4.1 Density Dependent Factors

The density dependent factors are intrinsic or biotic factors and they depend on interactions between individuals within same population or populations of different species. Density dependent factors may stabilise the population at the level determined by carrying capacity of the environment. The important density dependent factors are reproductivity, emmigration, competition for resources, predation, parasites, and diseases. The contribution of these factors may vary from species to species. You have already read how in large populations the number of offsprings produced are less, thus self-regulating the population size. You have also read how emmigration of individuals from a population reduces its density. Competition can be between individuals of same species called *intraspecific competition* and between individuals of different species called *interspecific competition*. Generally, members of the same species need same resources and are bound to compete for them. In some bird species males and females have different beak lengths enabling them to feed on different insect prey.

Let us take an example, where seeds of white clover, *Trifolium repens,* were planted at three different densities. Half of the plants at each density were watered throughout the experiment but other half were watered only for first 18 days. After seven weeks, the densities of the surviving seedlings were measured. As shown in Fig. 12.7 among the seedlings that were watered regularly, mortality was low



12.4.2 Density Independent Factors

Density independent factors are the extrinisic factors which tend to regulate the density of a population in ways that are not correlated with its density. Environmental factors such as bad weather and scarcity of space, pollution etc. are some factors. A hurricane, a severe winter, or a drought may kill most of the individuals in a population irrespective of its density. In a bad weather only some individuals may be able to shelter from it; if the number of shelters is limited. Thus only a fraction of a large population will be protected. However, we cannot pinpoint one or two factors and say that they determine the size of a particular population. Often the sizes of natural populations are affected by many different factors whose interactions can be complex.

SPECIES INTERACTIONS

Sl. No.		Interaction	Species A	Species B
Positive Interaction	1	Mutualism	+	+
	2	Commensalism	+	0
	3	Proto-cooperation	+	+
Positive Interaction	4	Ammensalism	0	-
	5	Parasitism	+	-
	6	Predation	+	-
	7	Cannibalism	+	-
	8	Competitions	-	-

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1. Mutualism

Obligate

- Both the Species need each other w/o they can't Survive w/o each other.
- e.g fungi and Algae

facultative

- They can live without each other.
- e.g honey bees - flower pollination.

2. Commensalism : Relationship where one species benefits and other one is unaffected.

orchids (epiphytes) grows on trees

Birds with grazing animals.

Barnacles stick with whales

3. parasitism : relationship where one gets benefits and another gets affected.

Lice on humans

Roundworm Tapeworm

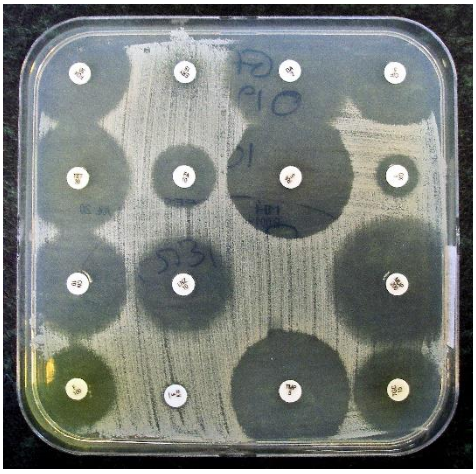
4. competition : (-ve, -ve) and it can be interspecies or intraspecies.

- e.g birds for nest sites or mating and lion, leopard want to deer.

5. predation : (+ve, -ve) e.g : Deer (prey) and lion (predator).

6. Amensalism : (-ve, 0) e.g : humans and other species under extinction due to humans effects.

7. Antibiosis : (-ve, 0)



penicillin and bacteria

COMMUNITIES : populations of living organisms in an particular area. self-regulation and community can be stratified.

Communities

location and structure
- forest, grasslands, aquatic, etc.

Adaptation
- Mesophytes, Xerophytes, Heliophyte, etc.

Succession
- seral, climax or stable communities.

Ecotone : The transition zone b/w two or more diverse community.

- These area are ecological rich area.
- both the communities's animals or plants have chance to interact.

Edge effect : presence of higher diversity than either of main communities, there diversity that is not directly controlled.

e.g species of owl that live in near ecotones b/w forests and grassland.

Quantitative

DENSITY

: $\dfrac{\text{no. of individual in all sampling unit}}{\text{total no. of sampling unit studied}}$

ABUNDANCE

: $\dfrac{\text{total no. of ind. of a species in all quadrats}}{\text{total no. of quadrats in which species occurred}}$

FREQUENCY

$\dfrac{\text{no. of quadrants in species occur}}{\text{no. of quadrants studied}} \times 100\%$

RLF : $A > B > C = D < E$

$(E+D)\ (B+C) > 1$: heterogeneous

$(E+D)\ (B+C) < 1$: homogeneous

BASIC TYPES OF SUCCESSION

Based on different criteria, there are following kinds of succession:

1. **Primary succession.** If an area in any of the basic environments (such as terrestrial, fresh- water or marine) is colonized by organisms for the first time, the succession is called **primary succession**. Thus, primary succession begins on a sterile area (an area not occupied previously by a community), such as newly ex- posed rock or sand dune where the conditions of existence may not be favourable initially.

2. **Secondary succession.** If the area under colonization has been cleared by whatsoever agency (such as burning, grazing, clearing, felling of trees, sudden change in climatic factors, etc.) of the previous plants, it is called **secondary succession**. Usually the rate of secondary succession is faster than that of primary succession because of better nutrient and other conditions in area previously under plant cover.

3. * **Autogenic succession.**
After the succession has begun, in most of the cases, it is the community itself which, as a result of its reactions with the environment, modifies its own environment and, thus, causing its own replacement by new communities. This course of succession is known as **autogenic succession**.

4. * **Allogenic succession.** In some cases replacement of one community by another is largely due to forces other than the effects of communities on the environment. This is called **allogenic succession** and it may occur in a highly disturbed or eroded area or in ponds where nutrients and pollutants enter from outside and modify the environment and in turn the communities.

inc. ↑ om

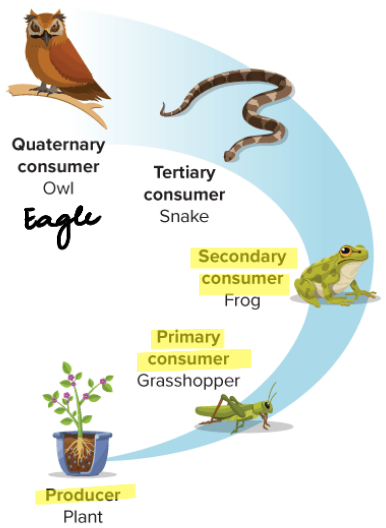
5. **Autotrophic succession.** It is characterized by early and continued dominance of autotrophic organisms such as green plants. It begins in a predominantly inorganic environments and the energy flow is maintained indefinitely. There is gradual increase in the organic matter content supported by energy flow.

6. **Heterotrophic succession.** It is characterized by early dominance of heterotrophic organisms such as bacteria, actinomycetes, fungi and animals. It begins in a medium which is rich in organic matter such as small areas of rivers, streams; these are polluted heavily with sewage or in small pools receiving leaf litter in large quantities.

ECOSYSTEM

- Habitat : 1. It is an address of organisms.
  2. It is an physical state.
  3. Not species specific.
  4. place where organisms gets food, mate and predator.
- Niche : 1. It is an profession of the organisms
  2. It is an activity state.
  3. Species specific
  4. How a organisms finds food, mate, etc.

Trophic organisation :



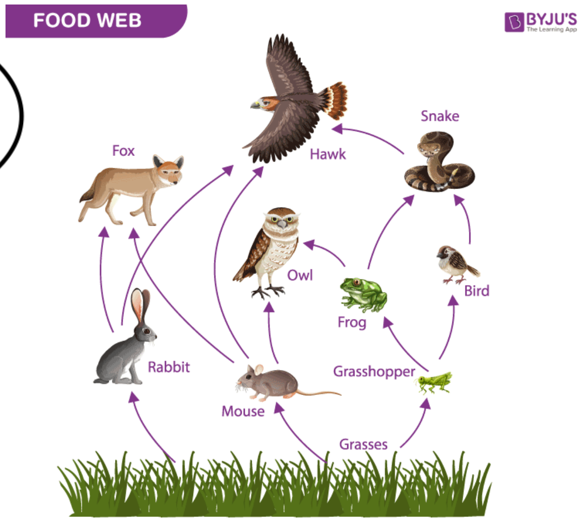
food chain : transfer or flow of energy in form of foods through series of organisms

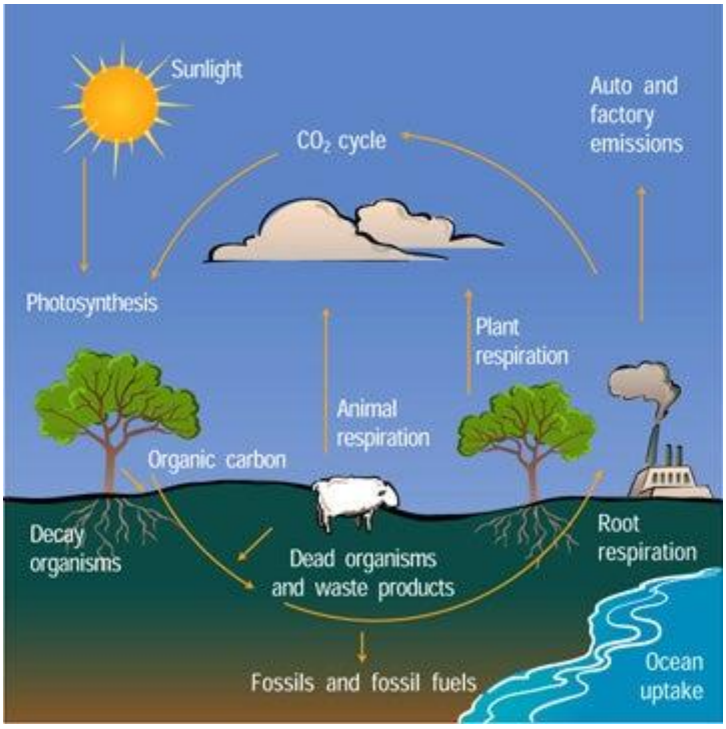
1st trophic level : all the green plant synthesize their own food from sun.

food chain : Grazing food chain – started wt plants or grass.
Detritus food chain – started wt dead organic matter.
and end up like grazing food chains.
parasitic food chain – producers → herbivores → parasite
(deer)

food web : food chain does not exists in real life. The network of interconnected food chain is called food web.

trophic levels
are not fixed





Biogeochemical cycles