

# Ecology



# WHY SHOULD WE CARE FOR ECOLOGICAL ENGINEERING?

- Ecology is the study of the interactions between living organisms, including humans, animals and overall environment.
- Ecology tries to understand

organisms at the individual, population, community, ecosystem, and biosphere level and how these live and deal with each other.

This is no doubt very important for maintaining the life on this earth. Each species has a very special and important role to play in the continuation of the life of people on this earth.

VERY IMPORTANT FOR ALL OF US HUMAN BEINGS, LEST WE WOULD BE EXTINCT LIKE DYNOSUARS. SOONER THAN LATER.

Any disruption in the ecology can have a drastic and everlasting effect on the living system on earth.

We must understand the nature and the role of each species on the earth and let us leave this world in the livable condition for our posterity.

It would be difficult to do that as we all tend to forget what we have learnt in school to pass the examinations?

# Ecological studies

- The life of different organisms in the context of the environment- their growth, increase or multiplication and spreading everywhere.
- Their living conditions, day to day , meeting challenges, interactions, and adaptations.
- The movement of food, biomass and metabolic energy and exchange.
- Their inter - dependence.
- Above all acquiring smartness to meet challenges and survive in the Law of Jungle - Jungle Raj.-preserving the safe environment
- Balance of nature
- Clean Air, Water, Land.
- Sound, Vibrations, Earth quakes, Volcanoes, Asteroids, Vagaries of NatUre.
- 11 dimensions of life
- In string theory, physicists tell us that the subatomic particles that make up our universe are created within ten spatial dimensions (plus an eleventh dimension of "time") by the vibrations of exquisitely small "super-strings".
- Einstein was right – Universe is expanding.

# 11 dimesions – Video.

- [https://www.google.com/search?q=11+dimensions+on+earth+video&sca\\_esv=438508f66d5a0254&rlz=1C1RXQR\\_enIN1122IN1122&sxsrf=AHTn8zouv vbz1x07tdeD9KgO27Q0vhO98A%3A1740386966079&ei=ljK8Z7W9BPGd4-EP-eyD8Ag&ved=0ahUKEwi14lnX9tuLAxXxzjgGHXn2Al4Q4dUDCBE&uact=5&oq=11+dimensions+on+earth+video&gs\\_lp=Egxnd3Mtd2l6LXNlc nAiHDExlGRpbWVuc2lvbnMgb24gZW FydGggdmlkZW8yBRAhGKABMgUQIRigATIFECEYoAFI5SFQ2wdYnxxwAXgBkAEAmAH6AaAB0wiqAQUwLjUuMbgBA8gBAPgBAZgCB6AC-QjCAgoQABiwAxjWBBhHwglGEAAYFhgewglLEAAYgAQYhgMYigXCAGUQABjvBcICCBAAGIAEGKIEwgIFECEYnwXCAGcQIRigARgKwglEECEYFZgDAIgGAZAGCJIHBTEuNS4xoAeEGA&sclient=gws-wiz-serp#fpstate=ive&vld=cid:83300878,vid:vvUX6uHqbm0,st:0](https://www.google.com/search?q=11+dimensions+on+earth+video&sca_esv=438508f66d5a0254&rlz=1C1RXQR_enIN1122IN1122&sxsrf=AHTn8zouv vbz1x07tdeD9KgO27Q0vhO98A%3A1740386966079&ei=ljK8Z7W9BPGd4-EP-eyD8Ag&ved=0ahUKEwi14lnX9tuLAxXxzjgGHXn2Al4Q4dUDCBE&uact=5&oq=11+dimensions+on+earth+video&gs_lp=Egxnd3Mtd2l6LXNlc nAiHDExlGRpbWVuc2lvbnMgb24gZW FydGggdmlkZW8yBRAhGKABMgUQIRigATIFECEYoAFI5SFQ2wdYnxxwAXgBkAEAmAH6AaAB0wiqAQUwLjUuMbgBA8gBAPgBAZgCB6AC-QjCAgoQABiwAxjWBBhHwglGEAAYFhgewglLEAAYgAQYhgMYigXCAGUQABjvBcICCBAAGIAEGKIEwgIFECEYnwXCAGcQIRigARgKwglEECEYFZgDAIgGAZAGCJIHBTEuNS4xoAeEGA&sclient=gws-wiz-serp#fpstate=ive&vld=cid:83300878,vid:vvUX6uHqbm0,st:0)

# Successive development of ecosystems

- **Cooperation, competition and predation within and between species**
- **Developing biodiversity and its impact on ecological processes.**
- **Ecological processes, such as primary production, nutrient cycling, and niche construction, regulate the flux of energy and matter including biomass through an environment.**

# Applied ecology

- **Applied ecology has practical use in conserving biological systems, aquatic systems management, natural resource management such as agriculture, forests,, fisheries, mining, tourism etc., urban planning (urban ecology), community health, economics, basic and applied science, and human social interaction (human ecology).**
- **Silk worms, Natural Products – Medicines.**
- **Fruits and vegetables, Chicken, Crab, Algal Proteins, Single Cell Protein etc.**

# **What is the importance of preserving our ecology?**

- **It underpins our economy, our society, indeed our very existence. Our forests, rivers, oceans and soils provide us with the food we eat, the air we breathe, the water we irrigate our crops with. We also rely on them for numerous other goods and services we depend on for our health, happiness and prosperity.**
- **Natural ecosystem structures and functions produce goods and services that benefit people—ecosystems produce the air we breathe, filter the water we drink, and recycle the nutrients that allow all things to grow. Impacts from human activity on land and in the water can influence ecosystems profoundly.**
- **Mahankumbh and water-bacteriophages- Sangam?**

# Adaptation and natural selection

- Evolutionary concepts relating to adaptation and natural selection are cornerstones of modern ecological theory.
- Alaska – Snow life – Sale to USA.
- German scientist Ernst Haeckel defined ecology in 1866. Relationship between living organisms and the environment-EEE.
- Ecosystems include the **dynamics of interactions systems of different organisms**, their groups, their communities and their interaction and dealing with non-living (abiotic) environmental systems.
- Several jobs insects, microbes, birds, animals do for us freely? **Without that what would happen?**



# Ecosystems

- **Ecosystems involve biological, chemical and physical feedback mechanisms. These processes include different processes acting on living (biotic) and abiotic components of earth.  
How do different species live , propagate and develop and then their roles in the biosphere.**
- **Making our lives liveavble.**
- **Lions in search of prey , Hynaes and Jackals in search of Lion, s remains of its foods and vultures and kites from the sky and microbes from the bottom soil, Insects from the air etc. etc.**

# Ecosystems

- **Ecosystems sustain life on this earth. These perform life-supporting functions and furnish services like biomass production (food, fuel, fiber, skin, protens, carbohydrates and medicine), the regulation of climate, global biogeochemical cycles, water filtration, soil formation, erosion control, flood protection, and many other natural features of scientific, historical, economic or intrinsic value.**
- **Dogs, lions etc. eating grass as medicine.**

# Scope of ecology

- Interactions can take place at different levels, e.g., cells i.e., micro-level and macro-level at planetary or bigger biosphere levels.
- Ecosystems, include abiotic ( non-living ) resources i.e., natural resources and interacting life forms (i.e., different organisms that integrate or group up to form **populations** which aggregate into distinct ecological **communities**.
- **Bumble bee trapped in the flower or choose flower for sleep and avoid rains ?**

# Did an asteroid hit Russia?

Falling to earth: The **Chelyabinsk** Meteorite .

- A blinding flash, a loud sonic boom, and shattered glass everywhere. This is what the people of Chelyabinsk, Russia, experienced when an asteroid exploded over their city during the morning of Feb. 15, 2013.

The explosion took place over the snow covered city of **Chelyabinsk in Russia**, near the border with Kazakhstan. The impact of this meteorite caused destruction around the city. **The shock wave was powerful enough to injure around 1,500 people. It shattered more than 3,600 windows in apartments and commercial buildings.**

Asteroid AB 2025 is set to make an astonishingly close approach to Earth, passing at a distance of just 1.2 million miles. This close encounter offers a unique opportunity to study the asteroid up close without posing any threat to the planet.

Effect on Ecology/ Ecosystems - EcologyFirst, the impact delivers energy into the target area with important geological consequences and second, it rearranges the hydrologic cycle, with implications for the availability of liquid water.

# Dynamics of Ecosystems

- Ecosystems are dynamic, they keep changing. However, **do not always follow a linear follow up path, sometimes these change rapidly and at times so slowly** up to thousands of years a very little change e.g., a forest.
- An ecosystem's area can vary greatly, from tiny to large.
- Several generations of an aphid ( leaf insects ) population can exist over the lifespan of a single leaf. Each of those aphids, in turn, supports diverse microbial groups/ bacteria or ants. **Termites in the stems, wooden doirs.**
- Green insects on *Calotropis procera* ( AaK ) plant.

- The nature of interactions in ecological communities cannot be understood by studying the details of each species in **isolation**, because the developing pattern is neither revealed nor predicted until the ecosystem is studied in toto.
- Termites on the stem of a tree. **Hollow stems.**
- **Brown rot and soft rot fungi both digest a tree's cellulose and hemicellulose but not its lignin; white rot digests lignin as well.**
- **Spider killing wasp through chemical spray.**

- **Some ecological principles, however, do exhibit collective properties where the sum of the components explain the properties of the whole, such as birth rates of a population being equal to the sum of individual births over a designated time frame.**
- **World population ?**
- **1 billion in 1804?**
- **Indias population in 1947 ?**
- **Male female ratio? 106/100**

# What is the formula for population growth?

- The growth rate is computed using the exponential growth formula:  $r = \ln(p_n/p_0)/n$ , where  $r$  is the exponential rate of growth,  $\ln()$  is the natural logarithm,  $p_n$  is the end period population,  $p_0$  is the beginning period population, and  $n$  is the number of years in between.



# Heirarchy

- To structure the study of ecology into a conceptually manageable framework, the biological world is **organized into a nested hierarchy, ranging in scale from genes, to cells, to tissues, to organs, to organisms, to species, to populations, to communities, to ecosystems, to biomes, and up to the level of the biosphere.**

- **Ecological hierarchy refers to the synergy of organisms with their environment and leads to the formation of a grouping of organisms. It is grouped into four levels:**
- **individual, population, community, and ecosystem level. The individual level is the first level of ecological hierarchy.**
- **Galaxies in the local universe can be viewed as ecosystems where energy flows and material cycles are maintained by a process of self-regulation to keep them in an apparently stable, but non-equilibrium state.**
- **A galaxy is made of billions of stars as well as their solar systems. Like solar systems, galaxies are also held together by gravity. The galaxy that contains the Earth and its solar system is called the Milky Way. Solar systems orbit around their galaxies just as planets orbit around their suns -**

**Astronomy**

# Panarchy

- A panarchy exhibits non-linear behaviors. This means that effect and cause are disproportionate, so that small changes to critical variables, such as the **number of nitrogen fixers**, can lead to disproportionate, perhaps irreversible, changes in the system properties.
- A panarchy is a set of nested ( across time and space ) adaptive cycles.

# Panarchy,

- Panarchy, a concept that grew out of resilience and hierarchy theory is a useful tool for understanding uncertainty and the unforeseen in an era of rapid environmental change). A panarchy can be expressed as a conceptual model that emphasizes the inevitable and inherent dynamics of living systems: **that is, living systems are complex, adaptive, and undergo stages of growth, conservation, release, and reorganization at many levels of biological organization .**
- Panarchy was developed to avoid tendencies that prevail in ecosystem management, **such as interventions that seek to freeze systems at a fixed endpoint**, impose rigid constraints over disturbance regimes, and overly constrain extremes in system behavior to a narrow and idealized range of conditions.

# Resilience

**It is not the total collapse but a resilience and a rebuilt up after the collapse.**

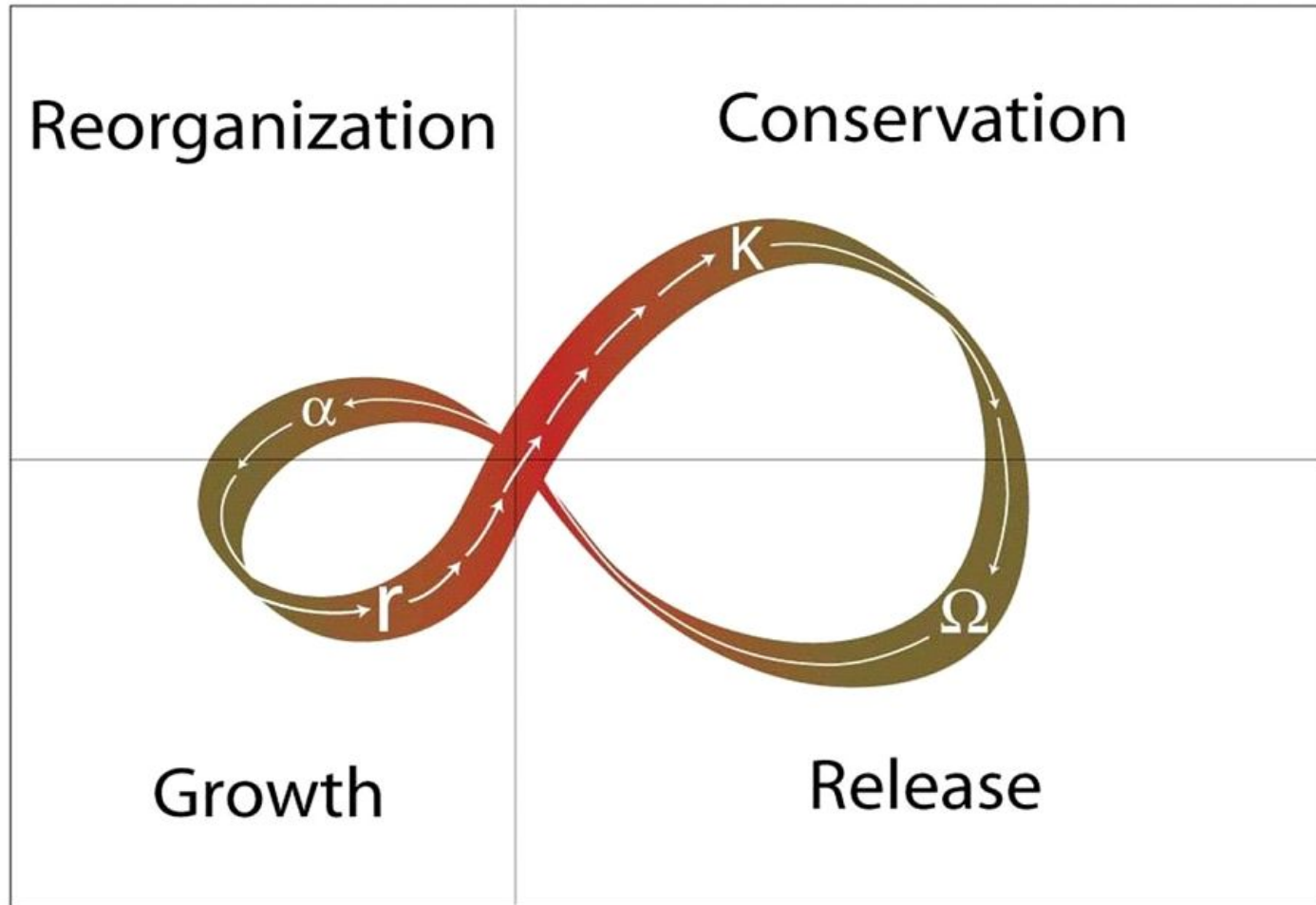
**A thing is said to be resilient if it has the capacity to withstand or recover from disturbance. In an ecological sense, resilience describes the persistence of ecosystem structure and function in the face of changing conditions**

**Many people believe that resilience is the end goal because it is supposed to keep a system intact in the face of change, but crossing the threshold and shifting to a different state is an essential part of the system.**

**Nothing lasts forever, and even when sweeping change involves entire societies or the climate, it may still all be part of a larger, adaptive system, known as panarchy.**

**It is difficult to predict the effect of environment on the growth of coral reefs.**

**Panarchy- Growth of forests- growth or exploitation  
(r) conservation (K) collapse or release (omega)  
reorganization (alpha)**



# **Top down and Bottom up – Natural rules or effects**

- **What is an example of an adaptive cycle?**
- **Some helpful examples to illustrate this model include aquatic algal blooms, commodity crop markets, and cities such as ancient Rome, Jerusalem, or San Francisco that were repeatedly attacked or damaged, and then rebuilt. Mongols - Gengis khan-Russia**
- **Gun Powder –Russia, China, Mongols and Babur**
- **Panarchy identifies four basic stages of ecosystems, represented in the Figure exploitation, conservation, release and reorganization.**

# Biodiversity

- Biodiversity includes the **diversity of life from genes to ecosystems and covers every level of biological organization**. The term has several interpretations, and there are many ways to index, measure, characterize, and represent its complex organization.
- **Biodiversity includes species diversity, ecosystem diversity, and genetic diversity** and scientists are interested in the way that this diversity affects the complex ecological processes operating at and among these respective levels.



## **How China lost the total war on sparrows? Four pests- rats, flies, mosquitoes, and sparrows.**

- **Tree sparrows ate mostly insects, not grain. And with the peckish passerines nearly extinct, an exploding locust population descended, ravenous, on China's farmlands. As the expected feast turned into famine, China's leaders made a rapid U-turn. The “war on sparrows” ended in killing 45 million people ( 1968-1962).**
- **Covid – 2019- Bats?**

# Biological wider variety

- Biodiversity plays an important role in ecosystem services which by definition maintains and improves human quality of life.
- Conservation priorities and management techniques require different approaches and considerations to address the full ecological scope of biodiversity. Natural capital that supports populations is critical for maintaining ecosystem services and species migration (e.g., riverine fish runs and avian insect control) **Russia & Europe – Death rate is more than birth rate. And reverse in US and India.**
- **Fish get killed or these migrate because of natural calamities. Birds eat pests in the agricultural farms as a pest control support of nature.**
- **Cheetahs and Tigers and Hornets – interactions?**

# Wild buffalo defeat tigresses?



# Hornet- Venomous Sting



# Habitat – Home Location

- The habitat of a species describes the environment over which a species is known to occur and the type of community that is formed as a result.
- More specifically, "habitats can be defined as regions in environmental space that are composed of multiple dimensions, **each representing a biotic or abiotic environmental variable**; that is, any component or characteristic of the environment related directly (**e.g. forage biomass and quality**) or indirectly (e.g. elevation) **to the use of a location by the animal**.

- For example, a habitat might be an **aquatic or terrestrial environment** that can be further categorized as a montane (found in mountains) or alpine ecosystem. ( ice laden )  
Habitat shifts provide important evidence of competition in nature where one population changes relative to the habitats that most other individuals of the species occupy.
- **Snake and ants?**
- For example, one population of a species of tropical lizard (*Tropidurus hispidus*) has a flattened body relative to the main populations that live in open savanna ( grass land and scattered trees ).

- **The population that lives in an isolated rock outcrop hides in crevasses where its flattened body offers a selective advantage.**
- **Habitat shifts also occur in the developmental life history of amphibians, and in insects that transition from aquatic to terrestrial habitats.**
- **What is the transition from water to land?**
- **The water-to-land transition in vertebrate evolution offers an unusual opportunity to consider computational affordances of a new ecology for the brain. All sensory modalities are changed, particularly a greatly enlarged visual sensorium owing to air versus water as a medium, and expanded by mobile eyes and neck.**
- **Micro and Macro Algae to Plants and Trees**
- **Old people - Florida**

# **What is the ontogenetic habitat shift?**

- **Ontogenetic niche shift (abbreviated ONS) is an ecological phenomenon where an organism (usually an animal) changes its diet or habitat during its ontogeny (development). During the ontogenetic niche shifting an ecological niche of an individual changes its breadth and position.**



- **Commonly fish undergo ontogenetic habitat shifts, i.e. they change habitat over their life span as they grow in size. Commonly, habitats for spawning and juvenile growth often differs from the habitat used by adults for growth.**
- **Human?**
- **Animals?**

# Niche- Activity

- Niche is the set of biotic and abiotic conditions in which a species is able to persist and maintain stable population sizes.
- The ecological niche is a central concept in the ecology of organisms and is sub-divided into the fundamental and the realized niche.
- The fundamental niche is the set of environmental conditions under which a species is able to persist. The realized niche( **made possible** ) is the set of environmental plus ecological conditions under which a species persists.
- Dogs digging ground in winter.
- Birds nests-Waever birds
- **Adaptation to winter weather can take many different forms. Some animals adapt to their colder environment by growing more feathers or thicker fur, and some change colour to make it easier to hide in the snow. Many creatures gather extra food in the fall and store it away to nibble on later.**
- **Ants**
- **Aquatic to land transition allowed some vertebrates to escape competitive pressure from other aquatic animals and explore niches on land, which eventually established the vertebrates as the dominant terrestrial phylum.**

**Phenotype refers to an individual's observable traits, such as height, eye color and blood type.**

- Biogeographical patterns and range distributions are explained or predicted through knowledge of a species' traits and niche requirements.
- Species have functional traits (character) that are uniquely adapted to the ecological niche – **Adaptation**
- A **trait** is a measurable property, **phenotype**, or characteristic of an organism **that may influence its survival**. Genes play an important role in the interplay of development and environmental expression **of traits**.

# Living species at a place

- Resident species evolve traits that are fitted to the selection pressures of their **local environment**. This tends to afford them a competitive advantage and discourages similarly adapted species from having an overlapping geographic range **i.e., place**. The competitive exclusion principle states **that two species cannot coexist indefinitely by living off the same limiting resource; one will always out-compete the other.**  
**1. A smaller (yellow) species of bird forages across the whole tree. 2: A larger (red) species competes for resources. 3: Red dominates in the middle for the more abundant resources. Yellow adapts to a new niche restricted to the top and bottom and avoiding competition.**
- **Aquarium- fish**
- **Myna and nightingale**
- **Hyena / Scavengers / dead bodies and lions**
- **Crows and parrots. Owls,**
- **Crocodiles and fish**
- **Hawks and sparrows**
- **Hornets and bees**
- **Spiders and Wasp**

# Ecotope.

- The habitat plus the niche is called the ecotope.

When similarly adapted species overlap geographically, closer inspection reveals **subtle ecological differences** in their habitat or dietary requirements.

- Some models and empirical studies, however, suggest that disturbances can stabilize the co-evolution and shared niche occupancy of similar species inhabiting species-rich communities.

# Niche construction

- Ecological niche construction, the process whereby an organism improves its environment to enhance its growth and persistence,
- The classic examples of niche construction—beavers building dams, birds building nests, and worms altering soil structure, termites, etc.
- Organisms are subject to environmental pressures, but they also modify their habitats. The regulatory feedback between organisms and their environment can affect conditions from local (e.g., a beaver pond i.e., pond built by beaver animals) to global scales, over time and even after death, such as decaying logs or silica skeleton deposits from marine organisms, remains available for use.
- Humans have different niches based on where they live, just as animals do. For example, someone living in the Amazon would have to survive on the food available from nature. Someone living in New York City would have to survive on food coming from the marketplace.

# **What is the human niche zone?**

- The temperature range that has sustained human life and activity, known as “the human climate niche”, averages 11-15° C and we have been thriving in it for thousands of years.**
- As conditions that best support life shift toward the poles, more than 600 million people are already living outside of a crucial “climate niche,” facing more extreme heat, rising food scarcity and higher death rates.**
- Climate change is already showing its ill effects on human.**

# What is the role of the beaver in its ecosystem?

- **Environmental Benefits of Beavers - King County, Washington**
- **Beavers are ecosystem engineers because they create, modify, and maintain habitat and ecosystems. They consequently have a large impact on the biodiversity of an area. They bring wood into the water, and that wood provides food and shelter for insects. Those insects become food for other species, including salmon.**
- **Beavers build dams to protect themselves from predators, such as bears or wolves. Beavers don't actually live in the dams, but in the deep pond of water that dams create. In this pool, beavers construct their real home: a small protective island or dome 'lodge' that serves as a dry living area and food store.**





# Beavers

**They live in ponds, lakes, rivers, marshes, streams and adjacent wetland areas. Beavers are one of the few animals that modify their habitat; they build watertight dams of sticks woven with reeds, branches and saplings, which are fitted with mud. Dams reduce stream erosion by forming slow-moving ponds.**



**Ecosystem engineering relates to the modification of niches according to the habitat.**

- **The process and concept of ecosystem engineering are related to niche construction, but the former relates only to the physical modifications of the habitat whereas the latter also considers the evolutionary implications of physical changes to the environment and the feedback this causes on the process of natural selection.**

- **Ecosystem engineers are defined as: "organisms that directly or indirectly modulate the availability of resources to other species, by causing physical state changes in biotic or abiotic materials. In doing so they modify, maintain and create habitats.**
- **The ecosystem engineering concept has stimulated a new appreciation for the influence that organisms have on the ecosystem and evolutionary process. The term "niche construction" is more often used in reference to the under-appreciated feedback mechanisms of natural selection imparting forces on the abiotic niche.**

# Activity for nest construction

- An example of natural selection through ecosystem engineering occurs in the nests of social insects, including ants, bees, wasps, and termites.
- Termite mounds, for example, maintain a constant internal temperature through the design of air-conditioning chimneys. The structure of the nests themselves is subject to the forces of natural selection. Moreover, a nest can survive over successive generations, so that progeny inherit both genetic material and a legacy niche that was constructed before their time.

# Biome

- **Biomes are the the largest geographic biotic unit, a major community of plants and animals with similar life forms and environmental conditions - aquatic, grassland, forest, desert, and tundra (treeless),, taiga ( coniferous forest) biomes**
- **Biomes are larger units of organization that categorize regions of the Earth's ecosystems, mainly according to the structure and composition of vegetation.**
- **There are different methods to define the continental boundaries of biomes dominated by different functional types of vegetative communities that are limited in distribution by climate, precipitation, weather, and other environmental variables.**

- **Biomes include tropical rainforest ( larger ) , temperate broadleaf and mixed forest, temperate deciduous forest, taiga, tundra, hot desert, and polar desert. Other researchers have recently categorized other biomes, such as the human and oceanic microbiomes.**
- **To a microbe, the human body is a habitat and a landscape. Microbiomes were discovered largely through advances in molecular genetics, which have revealed a hidden richness of microbial diversity on the planet. The oceanic microbiome plays a significant role in the ecological biogeochemistry of the planet's oceans.**

- **Marine microbes play a crucial role in biogeochemical cycles in the oceans. They drive chemical reactions that contribute to Earth's habitability and are responsible for the cycling of elements such as carbon, oxygen, nitrogen, phosphorus, sulfur, minerals, salts and trace gases.**
- **Coral reefs are the colonies of tiny living creatures that are found in oceans. They are the underwater structures that are formed of coral polyps (a projecting growth of tissue from a surface in the body, usually a mucous membrane) that are held together by calcium carbonate. These support fish and other lives.**

# Biosphere

- The largest scale of ecological organization is the biosphere: the total sum of ecosystems on the planet.
- Ecological relationships regulate the flux of energy, nutrients, and climate all the way up to the planetary scale.
- For example, the dynamic history of the planetary atmosphere's CO<sub>2</sub> and O<sub>2</sub> composition has been affected by the biogenic flux of gases coming from respiration and photosynthesis, with levels fluctuating over time in relation to the ecology and evolution of plants and animals.
- **Oxygen level in winter?**



- [https://www.youtube.com/watch?v=\\_NEIq-uoBb8](https://www.youtube.com/watch?v=_NEIq-uoBb8)
- [https://www.google.com/search?q=video+on+ecology+&sca\\_esv=0ac4b8938639300a&rlz=1C1YTUH\\_enIN1045IN1045&sxsrf=AHtn8zr-PBl1iCvriDoYLIfjGhegW-XNIA%3A1740671760673&ei=ElvAZ8biKJuF4-EP-7Hj6A8&ved=0ahUKEwjGqtzPm-SLAXWbwjgGHfvYGP0Q4dUDCBE&uact=5&oq=video+on+ecology+&gs\\_lp=Egxnd3Mtd2l6LXNlcnAiEXZpZGVvIG9uIGVjb2xvZ3kgMgQQIxgnMgYQABgWGB4yBhAAGBYHjIGEAAyFhgeMgsQABiABBiGAXiKBTIFEAAy7wVlvFFQAFjMS3ACeAGQAQCYAcoBoAG7FaoBBjAuMTcuMbgBA8gBAPgBAZgCFKACqRaoAgrCagcQIxgnGOOCwglKEAAyGAQYQxiKBclCDRAAGIAEGLEDGEMYigXCAGsQABiABBiRAhiKBclCCxAAGIAEGLEDGIMBwglKECMYgAQYJxiKBclCCBAuGIAEGLEDwgILEC4YgAQYsQMY1ALCAgUQABiABMICCxAuGIAEGMcBGK8BwglIEAAyGAQYsQPCAgUQLhiABMICDRAAGIAEGLEDGBQYhwLCAGoQABiABBgCGMsBwglKEAAyGAQYFBiHAsICCBAAGBYYYChgemAMJ4gMFEgExIEDxBXub6rGnk7AJkgcGMi4xNy4xoAe4mwE&sclient=gws-wiz-serp#fpstate=ive&vld=cid:2601248c,vid:GlnFylwdYH4,st:0](https://www.google.com/search?q=video+on+ecology+&sca_esv=0ac4b8938639300a&rlz=1C1YTUH_enIN1045IN1045&sxsrf=AHtn8zr-PBl1iCvriDoYLIfjGhegW-XNIA%3A1740671760673&ei=ElvAZ8biKJuF4-EP-7Hj6A8&ved=0ahUKEwjGqtzPm-SLAXWbwjgGHfvYGP0Q4dUDCBE&uact=5&oq=video+on+ecology+&gs_lp=Egxnd3Mtd2l6LXNlcnAiEXZpZGVvIG9uIGVjb2xvZ3kgMgQQIxgnMgYQABgWGB4yBhAAGBYHjIGEAAyFhgeMgsQABiABBiGAXiKBTIFEAAy7wVlvFFQAFjMS3ACeAGQAQCYAcoBoAG7FaoBBjAuMTcuMbgBA8gBAPgBAZgCFKACqRaoAgrCagcQIxgnGOOCwglKEAAyGAQYQxiKBclCDRAAGIAEGLEDGEMYigXCAGsQABiABBiRAhiKBclCCxAAGIAEGLEDGIMBwglKECMYgAQYJxiKBclCCBAuGIAEGLEDwgILEC4YgAQYsQMY1ALCAgUQABiABMICCxAuGIAEGMcBGK8BwglIEAAyGAQYsQPCAgUQLhiABMICDRAAGIAEGLEDGBQYhwLCAGoQABiABBgCGMsBwglKEAAyGAQYFBiHAsICCBAAGBYYYChgemAMJ4gMFEgExIEDxBXub6rGnk7AJkgcGMi4xNy4xoAe4mwE&sclient=gws-wiz-serp#fpstate=ive&vld=cid:2601248c,vid:GlnFylwdYH4,st:0)

# Population ecology

- **Population ecology studies the dynamics of species populations and how these populations interact with the wider environment.**
- **A population consists of individuals of the same species that live, interact, and migrate through the same niche ( activity ) and habitat.**
- **Total number of species present on earth are considered to be about 7 million as estimated by Robert May. Plants constitute more than 70% of all the species recorded, whereas animals constitute less than 22% of the total number of species. Insects constitute more than 70% of all the animal species.**

- **A primary law of population ecology is the Malthusian growth model which states, "a population will grow (or decline) exponentially as long as the environment experienced by all individuals in the population remains constant. Simplified population models usually starts with four variables: death, birth, immigration, and emigration.**

- **An example of an introductory population model describes a closed population, such as on an island, where immigration and emigration does not take place.**
- **$N(t + h) = N(t) + bhN(t) - dhN(t)$ .**

- In these island models, the rate of population change is described by
$$dN(t)/dt = b N(t) - d(t) = (b-d) N(t) = r N(t).$$
- where  $N$  is the total number of individuals in the population,  $b$  and  $d$  are the per capita rates of birth and death respectively, and  $r$  is the per capita rate of population change.  $t$  is the time

- Using these modeling techniques, Malthus' population principle of growth was later transformed into a model known as the logistic equation by Pierre Verhulst:
- $\frac{dN(t)}{dt} = r N(t) - \alpha (t)^2$
- i.e.,  $\alpha t^2 = r N(t) (K - N(t)) / K$ .

- where  $N(t)$  is the number of individuals measured as biomass density as a function of time,  $t$ ,  $r$  is the maximum per-capita rate of change commonly known as the intrinsic rate of growth, and  $\alpha$  is the crowding coefficient, which represents the reduction in population growth rate per individual added. The formula states that the rate of change in population size  $dN(t)/dt$  will grow to approach equilibrium, where  $dN(t)/dt = 0$ .

# Metapopulations and **migrations**

- The concept of metapopulations was defined by Levins in 1969 as "a population of populations which go extinct locally and recolonize."
- These occur in patches – Natural disturbances may also cause this. Pests in agriculture.  
A metapopulation is a group of spatially separated populations of the same species that interact at some level. An example would be separate populations of frogs living in different forest patches; though isolated, they maintain a degree of interaction through migration.
- **Spreading or moving to different areas with time and due to some changes in the environment.**
- **Many species of monkeys live in tight family groups with strong social bonds. Each family group inhabits a small bit of territory that is heavily defended from other family groups, thus forming subpopulations across their environment.**
- **Metapopulations are linked by the migratory behaviours of organisms.**



# Migrating birds – Siberian cranes

- **Animal migration is set apart from other kinds of movement because it involves the seasonal departure and return of individuals from a habitat – birds, animals, human etc. – Birds, elephants,**
- **Migrating birds - European roller, rufous-tailed scrub robin, and common white throat, cuckoo.**
- **Migration is also a population-level phenomenon, as with the migration routes followed by plants as they occupied northern post-glacial environments. Plant ecologists use pollen records that accumulate and stratify in wetlands to reconstruct the timing of plant migration and dispersal relative to historic and contemporary climates.**
- **Marigold seeds- antibacterial, antiviral, pest deterrence in rice fields.**

- **These migration routes involved an expansion of the range as plant populations expanded from one area to another. There is a larger taxonomy of movement, such as commuting, foraging ( natural food collection ) , territorial behavior, stasis ( standstill) and ranging.**
- **Dispersal is usually distinguished from migration because it involves the one-way permanent movement of individuals from their birth population into another population.**

- In metapopulation terminology, migrating individuals are classed as emigrants (when they leave a region) or immigrants (when they enter a region), and sites are classed either as sources or sinks.
- A site is a generic term that refers to places where ecologists sample populations, such as **ponds or defined sampling areas in a forest**. **Source patches** are productive sites that generate a seasonal supply of juveniles that migrate to other **patch locations**.
- Gold cards in US
- IIT Graduates to US ?

- Sink patches are unproductive sites that only receive migrants; the population at the site **will disappear unless rescued by an adjacent source patch or environmental conditions** become more favorable. Metapopulation models examine patch dynamics over time to answer potential questions about spatial and demographic ecology. **Canada and USA – Asians.**

# What is meant by meta population?

- A metapopulation is a “population of populations” distributed in discrete habitat patches that are linked by occasional dispersal. Rather than track individual organisms through time, a metapopulation approach tracks the occupancy of habitat patches through time.
- A metapopulation is a group of spatially separated populations of the same species that interact at some level. An example would be separate populations of frogs living in different forest patches; though isolated, they maintain a degree of interaction through migration.
- The metapopulation concept includes any system in which subpopulations inhabit discrete habitat patches and interpatch dispersal is both high enough to ensure demographic connectivity among patches yet low enough to maintain some degree of independence in local population dynamics

- The ecology of metapopulations is a dynamic process of extinction and colonization. Small patches of lower quality (i.e., sinks) are maintained or rescued by a seasonal influx of new immigrants. A dynamic metapopulation structure evolves from year to year, where some patches are sinks in dry years and are sources when conditions are more favorable. **Ecologists use a mixture of computer models and field studies to explain metapopulation structure**

# Video on metapopulations

- [https://www.google.com/search?q=hvideo+on+metapopulation+&sca\\_esv=0ac4b8938639300a&rlz=1C1YTUH\\_enIN1045IN1045&sxsrf=AHTn8zoLHBBgNbpRwSTT3xSng6A4m5WnNA%3A1740671557781&ei=RYrAZ-uOL\\_Hx4-EPiqux8Ao&ved=0ahUKEwir6\\_zumuSLAXx-DgGHYpVDK4Q4dUDCBĒ&uact=5&oq=hvideo+on+metapopulation+&gs\\_lp=Egxnd3Mtd2l6LXNlcuAiGWh2aWRlbyBvbiBtZXRhcG9wdWxhdGlubiAyBxAhGKABGApl8k5QAFj3SnAAeAGQAQCYAewBoAGDI6oBBjAuMTguN7gBA8gBAPgBAZgCGKAC2yLCAgQQlxgnwglLEAAYgAQYkQIYigXCAGoQABiABBhDGloFwgILEAAYgAQYsQMYgwHCAggQABiABBixA8ICCAuGIAEGLEDGNQCwglLEC4YgAQYsQMYgwHCAgUQABiABMICBRAuGIAEwgIKEC4YgAQYQxiKBclCBxAAGIAEGArCAGsQLhiABBjHARivAcICChAAGIAEGLEDGARCAgcQIxixAhgnwglOEAAAYgAQYkQIYsQMYigXCAGYQABgWGB7CAgcQlxixAhgnwglKEAAYgAQYsQMYDclCBxAAGIAEGA3CAgYQABgNGB7CAggQABgIGA0YHsICCAAGIAEGIYDGloFwglIEAAYBRgNGB7CAggQABiABBiiBJgDAJIHBjAuMTcuN6AH67gB&sclient=gws-wiz-serp#fpstate=ive&vld=cid:730d3919,vid:xmDexBCQb2E,st:0](https://www.google.com/search?q=hvideo+on+metapopulation+&sca_esv=0ac4b8938639300a&rlz=1C1YTUH_enIN1045IN1045&sxsrf=AHTn8zoLHBBgNbpRwSTT3xSng6A4m5WnNA%3A1740671557781&ei=RYrAZ-uOL_Hx4-EPiqux8Ao&ved=0ahUKEwir6_zumuSLAXx-DgGHYpVDK4Q4dUDCBĒ&uact=5&oq=hvideo+on+metapopulation+&gs_lp=Egxnd3Mtd2l6LXNlcuAiGWh2aWRlbyBvbiBtZXRhcG9wdWxhdGlubiAyBxAhGKABGApl8k5QAFj3SnAAeAGQAQCYAewBoAGDI6oBBjAuMTguN7gBA8gBAPgBAZgCGKAC2yLCAgQQlxgnwglLEAAYgAQYkQIYigXCAGoQABiABBhDGloFwgILEAAYgAQYsQMYgwHCAggQABiABBixA8ICCAuGIAEGLEDGNQCwglLEC4YgAQYsQMYgwHCAgUQABiABMICBRAuGIAEwgIKEC4YgAQYQxiKBclCBxAAGIAEGArCAGsQLhiABBjHARivAcICChAAGIAEGLEDGARCAgcQIxixAhgnwglOEAAAYgAQYkQIYsQMYigXCAGYQABgWGB7CAgcQlxixAhgnwglKEAAYgAQYsQMYDclCBxAAGIAEGA3CAgYQABgNGB7CAggQABgIGA0YHsICCAAGIAEGIYDGloFwglIEAAYBRgNGB7CAggQABiABBiiBJgDAJIHBjAuMTcuN6AH67gB&sclient=gws-wiz-serp#fpstate=ive&vld=cid:730d3919,vid:xmDexBCQb2E,st:0)

# The types of ecology :

- Autecology is the study of individual organisms
- Aquatic Ecology. It deals with the study of ecosystems found in water bodies such as estuarine, freshwater and marine. ...
- Microbial Ecology. ...
- Terrestrial Ecology. ...
- Taxonomic Ecology. ...
- Systems Ecology. ...
- Evolutionary Ecology. ...
- Behavioural Ecology. ...
- Population Ecology.
- Community ecology
- Social ecology
- Genetic ecology
- Cellular ecology
- Neo ecology- the major social change toward a resource-efficient, sustainable economy.
- Space ecology
- Cosmic ecology
- Galaxy stellar ecology etc. etc.



# Video on types of ecology

- [https://www.google.com/search?q=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D\\_NEIq-uoBb8%0D%0A&sca\\_esv=0ac4b8938639300a&rlz=1C1YTUH\\_enIN1045IN1045&sxsrf=AHTn8zpMw8z\\_S-z0sJSeqSx6i5RNGwn3tg%3A1740670543461&ei=T4bAZ8nsG5D1juMPnrSWuQ8&ved=0ahUKEwiJ0KeLI-SLAXWQumMGHR6ajfcQ4dUDCBE&uact=5&oq=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D\\_NEIq-uoBb8%0D%0A&gs\\_lp=Egxnd3Mtd2l6LXNlc nAiLGh0dHBzOi8vd3d3LnlnvdXR1YmUuY29tL3dh dGN oP3Y9X05FSX EtdW9CYjgKMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCSNx BUABY0zpwAXgAkAEA mAE AoAE AqgEA uAE DyAEA-AEB-AECmA lBoAlJqAlKmAMJ8QU NL06 B45RXw5IHATGgBwA&sclient=gws-wiz-serp#fpstate=ive&vld=cid:f8b25344,vid:CVioFslmW8s,st:0](https://www.google.com/search?q=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D_NEIq-uoBb8%0D%0A&sca_esv=0ac4b8938639300a&rlz=1C1YTUH_enIN1045IN1045&sxsrf=AHTn8zpMw8z_S-z0sJSeqSx6i5RNGwn3tg%3A1740670543461&ei=T4bAZ8nsG5D1juMPnrSWuQ8&ved=0ahUKEwiJ0KeLI-SLAXWQumMGHR6ajfcQ4dUDCBE&uact=5&oq=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D_NEIq-uoBb8%0D%0A&gs_lp=Egxnd3Mtd2l6LXNlc nAiLGh0dHBzOi8vd3d3LnlnvdXR1YmUuY29tL3dh dGN oP3Y9X05FSX EtdW9CYjgKMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCMgcQlxgnGOoCSNx BUABY0zpwAXgAkAEA mAE AoAE AqgEA uAE DyAEA-AEB-AECmA lBoAlJqAlKmAMJ8QU NL06 B45RXw5IHATGgBwA&sclient=gws-wiz-serp#fpstate=ive&vld=cid:f8b25344,vid:CVioFslmW8s,st:0)

# Community ecology

- **Community ecology is the study of the interactions among a collection of species that inhabit the same geographic area. Community ecologists study the patterns and processes for two or more interacting species.**
- **Research in community ecology might measure species diversity in grasslands in relation to soil fertility. It might also include the analysis of predator-prey dynamics, competition among similar plant species, competition amongst herbivores or mutualistic interactions between crabs and corals.**
- **A forest community comprises all the trees, the plant community, birds, deer, squirrels, foxes, fungi, insects, fish in forest rivers, and other local or seasonal species.**
- **Allelopathy in plants – Banyan, Eucalyptus, Black walnut trees**

# Ecosystem ecology

- Ecosystems may be **habitats** within biomes that form an integrated wholesome and a dynamical system having both physical and biological complexes – Life Bubbles and systems.
- Ecosystem ecology is the science of determining the fluxes of materials (e.g. carbon, phosphorus) between different pools (e.g., tree biomass, soil organic material). Ecosystem ecologists attempt to determine the underlying causes of these fluxes. Interactive actions for food and space and care, cooperation and sharing habits.

# Ecosystem - A natural lake with biotic and abiotic parts and climate change – life Bubble



- **Research in ecosystem ecology might measure primary production in a wetland in relation to decomposition and consumption rates). This requires an understanding of the community connections or interaction between plants (i.e., primary producers) and the decomposers (e.g., fungi and bacteria).**
- **At times animals may drink water or bathe and predators crocodiles/Gharials/fleas, viral hepatitis etc.**

- **Within an ecosystem, organisms are linked to the physical and biological components of their environment to which they are adapted. Ecosystems are complex adaptive systems where the interaction of life processes form self-organizing patterns across different scales of time and space.**

**Ecosystems are broadly categorized as terrestrial, freshwater, atmospheric, or marine. Differences stem from the nature of the unique physical environments that shapes the biodiversity within each.**



# Man made ecosystems

- A more recent addition to ecosystem ecology are technoecosystems, which are affected by or primarily the result of human activity.
- Artificial lakes in IIT Tirupati campus – Rains
- Lakes may come up in Delhi. Udaipur is city of



# What is chaos in ecology?

- In general, ecologists sort the fluctuations in different places into three broad categories: “regular” (fluctuating around a stable equilibrium), “random” (impossible to predict) – or “chaotic” (predictable in the short term but not the long term, and sensitive to very small changes).
- Hurricanes generate strong winds that can completely defoliate forest canopies and cause dramatic structural changes in wooded ecosystems.
- Thunderstorms are important for heat balance.
- Forest fires in Hollywood.



# Can a butterfly cause a storm?

- The answer, it turns out, is no.
- But it is complicated. The metaphor of the butterfly effect was first articulated by mathematician Edward Lorenz, one of the pioneers of so-called "chaos theory," which is a serious branch of mathematics that focuses on dynamical systems that are highly sensitive to initial conditions. Tornadoes, cyclones ?
- Chaos in plasma fusion reactors- Sudden bursts of power. Solar wind can disturb magnetic system on earth and disturb communications.
- **Chaology – Theories and complicated equations – Computations.**

# Food webs

- A food web is the archetypal ( model ) ecological network. Plants capture solar energy and use it to synthesize simple sugars during photosynthesis – Biogenesis- Primary and Secondary metabolites.
- As plants grow, they accumulate nutrients and are eaten by grazing herbivores, and the energy is transferred through a chain of organisms by consumption.

- The simplified linear feeding pathways that move from a bottom trophic species to a top consumer is called the food chain.
- **Eagles, Falcons to lion to snakes, frog, insects, fungi to bacteriophages.**
- The **larger interlocking** pattern of food chains in an ecological community creates a complex food web. Food webs are a type of concept map that is used to illustrate and study pathways of energy and material flows.
- **Life cycle on earth – Highly interlinked , interdependent and complex but very essential for the continuity of life on the Globe.**

# One man,s flesh is other man,s meat?

- Food webs are often limited relative to the real world. Complete empirical measurements are generally restricted to a specific habitat, such as a cave or a pond, and principles gleaned from food web microcosm ( a little world ) studies are extrapolated to larger systems.
- Snake and ants, Dead and live fish and insects.
- Tiger may move away 100 kms even in search of food /prey  
Ranthambore national park
- Feeding relations require extensive investigations into the gut ( intestine system ) contents of organisms, which can be difficult to decipher, or stable isotopes can be used to trace the flow of nutrient diets and energy through a food web. Despite these limitations, food webs remain a valuable tool in understanding community ecosystems. Role of E.coli .
- Light worm in lizard belly.
- Animal in crocodile belly. Cant bite
- Insect in snake tummy.
- Metabolomics, Interactomics, Genomics, Reverse genomics, proteomics etc.

# Attack from air, water and land- Jungle Phenomenon

- Food webs exhibit principles of ecological emergence through the nature of trophic relationships: some species have many weak feeding links (e.g., omnivores) while some are more specialized with fewer stronger feeding links (e.g., primary predators).
- Law of jungle –Failure of of Predators- Intensity, Anger, Situation , Urgency ( mother – fledgling/ puppy , cub etc.), Confidence , Guts, Smartness, Vigilance, Cooperation calls, State of energy, Unity , Experience, Inherited traits, Training, Persistence.
- Hungry lion or Eagle and agile birds, careful animals, mighty animals but lazy, Thirsty animals,
- Carelessness, Strategic attacks, Over confidence, Day-night difference, Land, Water or Air etc. may
- Snake sees the mongoose first or vice versa.
- Man and snake.
- it behoves the waker to be always acive for contibuous survival?
- it behoves the waker to be always acive for contibuous survival?

**Cobra-Cat- Peacock?  
Snake-Fish-Ants ?  
Porcupine and snake?**



# Trophic levels

- Trophic level is "a group of organisms acquiring a considerable majority of its energy from the lower adjacent level (according to ecological pyramids) nearer the abiotic source.
- Links in food webs primarily connect feeding relations or trophism among species. Biodiversity within ecosystems can be organized into trophic pyramids, in which the vertical dimension represents feeding relations that become further removed from the base of the food chain up toward top predators, and the horizontal dimension represents the abundance or biomass at each level. Bottom up -  
**Pyramid**

- When the relative abundance or biomass of each species is sorted into its respective trophic level, they naturally sort into a 'pyramid of numbers'.
- Species are broadly categorized as autotrophs (or primary producers), heterotrophs (or consumers), and Detritivores (or decomposers). **Autotrophs are organisms that produce their own food (production is greater than respiration) by photosynthesis or chemosynthesis-Ribulose biphosphate Carboxylase-Oxygenase or RuBisCO and carbonic anhydrase enzymes.**



- **Heterotrophs are organisms that must feed on others for nourishment and energy (respiration exceeds production).**
- **Heterotrophs can be further sub-divided into different functional groups, including primary consumers (strict herbivores), secondary consumers (carnivorous predators that feed exclusively on herbivores), and tertiary consumers (predators that feed on a mix of herbivores and predators).**

- Omnivores do not fit neatly into a functional category because they eat both plant and animal tissues. It has been suggested that omnivores have a greater functional influence as predators because compared to herbivores, **they are relatively inefficient at grazing.**
- Trophic levels are part of the holistic or complex systems view of ecosystems. Each trophic level contains unrelated species that are grouped together.

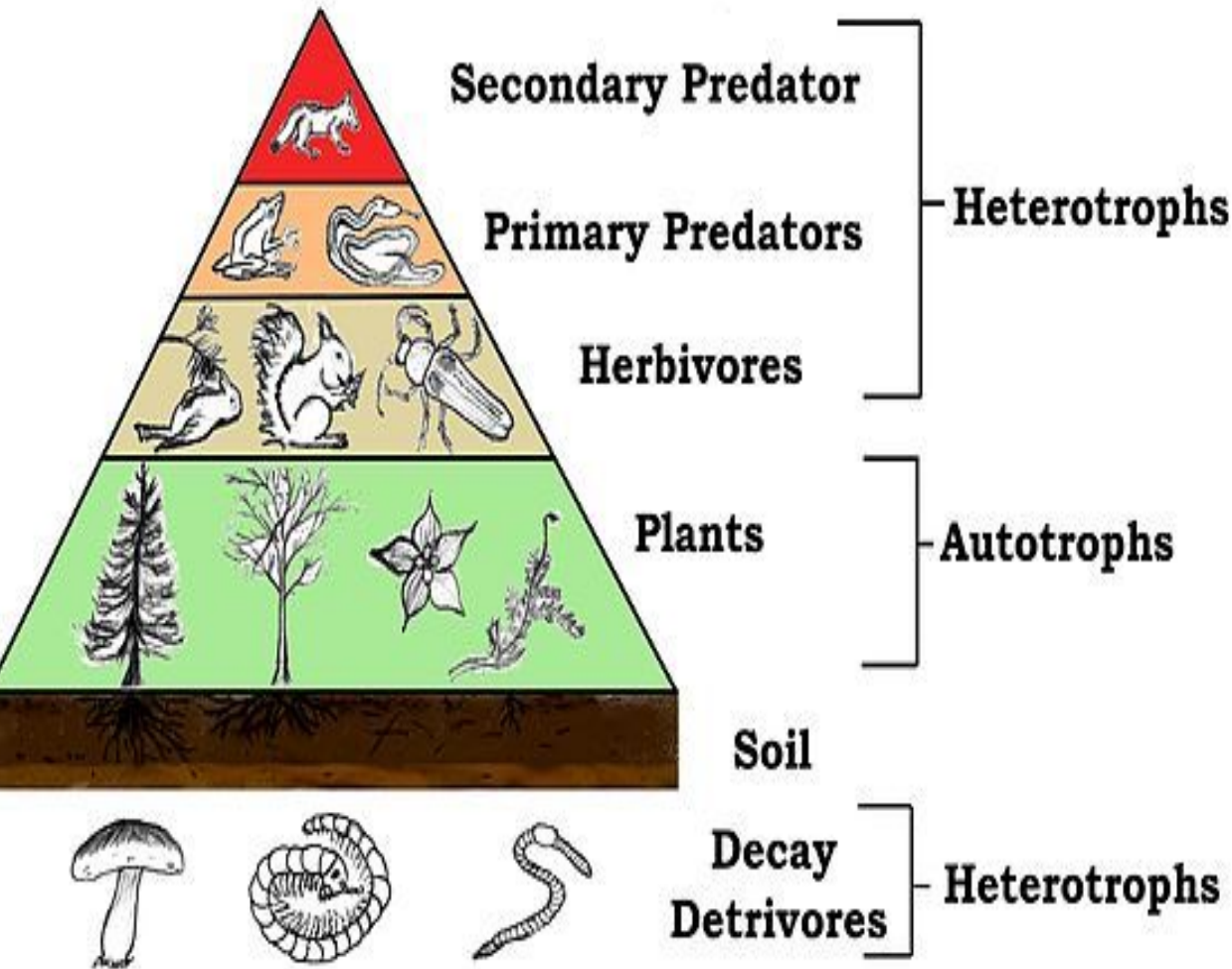
## **Discovery-Geographic or Wild life TV channels- Jungle News- News Nation ?**

- While the notion of trophic levels provides insight into energy flow and top-down control within food webs, it is troubled by the prevalence of omnivory in real ecosystems.
- This has led some ecologists to "reiterate that the notion that species clearly aggregate into discrete, homogeneous trophic levels is fiction.
- Law of jungle or opportunity or vigilance .
- Siberian Tiger and Python are the apex ( top ) predators.
- Eagles ? Falcons.

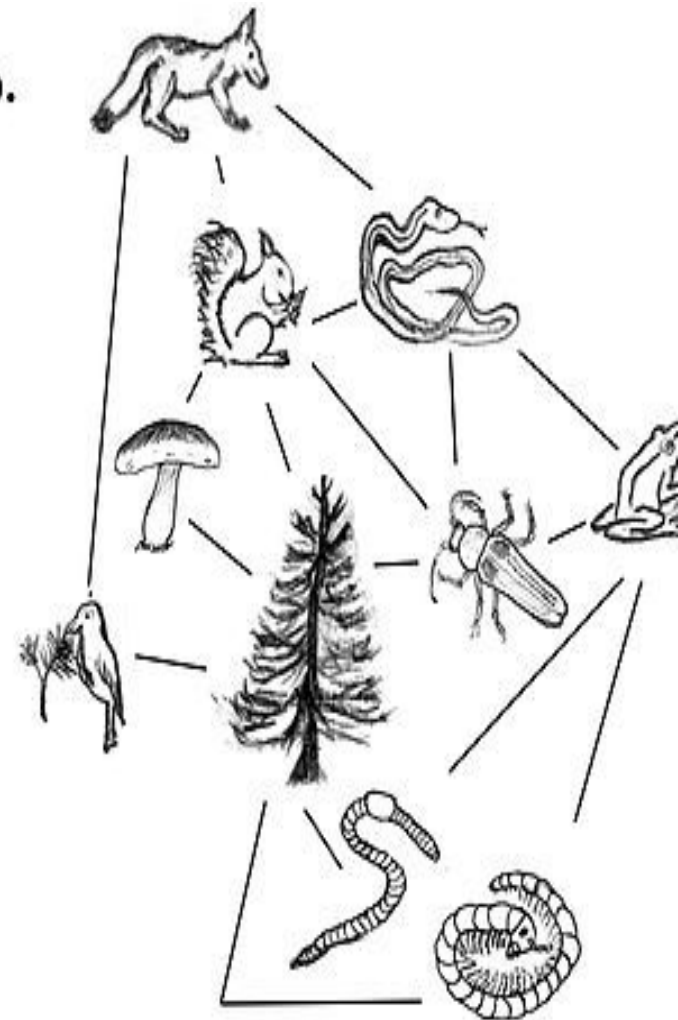
# Omnivores

- Recent studies have shown that real trophic levels do exist, but "above the herbivore trophic level, food webs are better characterized as a tangled web of omnivores.
- An omnivore is an organism that regularly consumes a variety of material, including plants, animals, algae, and fungi. They range in size from tiny insects like ants to large creatures—like people. Human beings are omnivores. People eat plants, such as vegetables and fruits.

a.



b.



# Keystone species

- A keystone species is a species that is connected to a disproportionately large number of other species in the food-web. Keystone species have lower levels of biomass in the trophic pyramid relative to the importance of their role.
- The loss of a keystone species results in a range of dramatic cascading effects (termed trophic cascades) that alters trophic dynamics, other food web connections, and can cause the extinction of other species.

- The removal of a keystone species can result in a community collapse just as the removal of the keystone in an arch can result in the arch's loss of stability.
- **Sea otters (*Enhydra lutris*)** are commonly cited as an example of a keystone species because they limit the **density of sea urchins that feed on kelp**. If sea otters are removed from the system, **the urchins graze until** the kelp beds disappear, and this has a dramatic effect on community structure.
- Wolf, tiger , snake and elephant **ARE KEYSTONE SPECIES.**
- **Maintain prey population under control - Yellowstone National park in California**

# Keystone species

- Hunting of sea otters, for example, is thought to have led indirectly to the extinction of the Steller's sea cow (*Hydrodamalis gigas*).
- Sloth bears are a keystone species in India because their food, which mostly consists of **termites**, fruits, and tubers, helps to preserve the health of a forest. Bees, Large Mammalian Predators, Sea Stars, Hummingbirds, Tiger Sharks etc.
- Lions are a keystone species. They are important predators – the only wild animals in Africa big enough to bring down big herbivores like elephants and giraffes. **If herbivore populations are left unchecked there is less food available for all animal populations – including people.**
- **Elephants in Africa are keystone species as during dry season they dig land to create water for all animals.**
- **Balance in Jungle?**



# Complexity

- Complexity in ecology is of at least **six** distinct types: spatial/ space , temporal/time, structural, process, behavioral, and geometric. From these principles, ecologists have identified emergent and self-organizing phenomena that operate at different environmental scales of influence, ranging from molecular to planetary, and these require different explanations at each integrative level.
- Why is understanding these so important?

# **Spreading mango, Jamun and other fruit seeds – on open or barren lands ?**

- **Complexity stems from the interplay among levels of biological organization as energy, and matter is integrated into larger units that superimpose onto the smaller parts.**
- **Complex ecological systems (e.g., forests) are those in which structure (e.g., gap-size distribution) and dynamics (e.g., succession) derive from memory-based (e.g., previous tree falls, seed bank), cross-scale (e.g., 100 sq. m to 100000 sq.m).**

# Which tree moves from one place to another

- These trees can actually walk through the forest!
- The *Socratea exorrhiza*, or "walking palm," found in South American rainforests, is renowned for its ability to "walk" across the forest floor. With stilt roots that grow in the direction of better sunlight and soil, the tree gradually moves over time.
- While plants themselves are generally rooted and don't move from one place to another, certain plants exhibit rapid movement of their parts, like the Venus flytrap, *Mimosa pudica*, and Prayer plant, for catching prey or responding to stimuli. Leaves shut to catch insects.
- Banyan trees in India.

# **Holism- As a whole**

- **This means over all patterns of a whole functional system, such as an ecosystem, cannot be predicted or understood by a simple summation of the parts.**
- **Mutualism, Commensalism Antagonism and other interactions – unpredictable by summation.**
- **New properties emerge because the components interact. Pollens carried by wind, butterflies or insects etc.**
- **Some seeds are eaten or carried away by insects etc.**
- **Seeds grow during suitable weather conditions only.**
- **Marigold flowers, Sun flower etc.**
- **Grams sprouting. Onions and Potato sprouting.**

- An example of metaphysical holism is identified in the trend **of increased exterior thickness in shells of different species**. The reason for a thickness increase can be understood through reference to principles of **natural selection via predation** without having any particular biological function but defence.

# **Relation to evolution**

- **Ecology and evolutionary biology are considered sister disciplines of the life sciences.**
- **Both disciplines discover and explain emergent and unique properties and processes operating across different spatial or temporal scales of organization.**
- **Ecologists study the abiotic and biotic factors that influence evolutionary processes and evolution can be rapid, occurring on ecological timescales as short as one generation.**

**Behavioural ecology**-These natural processes respond primarily to light and dark and affect most living things, including animals, plants, and microbes.

**Chronobiology is the study of circadian rhythms**

- All organisms can exhibit behaviours. Even plants express complex behaviour, including memory and communication.
- **Touch me not and sun flower** . Flowers and bumble bee.
- Circadian rhythms are physical, mental, and behavioral changes that follow a 24-hour cycle.

**Behavioural ecology** is the study of an organism's behaviour in its environment and its ecological and evolutionary implications.

**Ethology** is the study of observable movement or behaviour in animals. This could include investigations of motile sperm of plants ( mobility ) , mobile phytoplankton, zooplankton swimming toward the female egg, the cultivation of fungi by weevils, ( beetles), the mating dance of a salamander/ type of lizard or social gatherings of amoeba

# **What are 5 example of fungi?**

- **Fungus, any of about 144,000 known species of organisms of the kingdom Fungi, which includes the yeasts, rusts, smuts, mildews, molds, and mushrooms. There are also many fungus like organisms, including slime molds and oomycetes (water molds), that do not belong to kingdom Fungi but are often called fungi.**
- **Which insect is cultivator of fungi?**
- **Fungus-farming ants, termites, beetles and wasps are prime examples of obligate ( necessity ) fungiculture. Insects cultivate fungi for food or structure.**



# Fungus and Bacteria



# **Behaviour and actions of Plants**

- **Sun flower moving with sun, Touch me not, closing flower killing Bumblebee ( Bhanwara).**
- **Busting of seeds etc. Plumping of cucumber in night.**
- **What is an example of plant behavior?**
- **Highlights include corn shoots growing toward a light bulb, the rapid response of a mimosa plant to a flame, vines twining, and pumpkins plumping at night.**
- **Behaviours can be recorded as traits and inherited in much the same way that eye and hair colour can. Behaviours can evolve by means of natural selection as adaptive traits.**
- **Sparrows in the night bulb - do not sleep.**
- **Fish**

- **To be adapted to their environment and face predatory threats, organisms must balance their energy budgets as they invest in different aspects of their life history, such as growth, feeding, mating, socializing, or modifying their habitat - Running, caves, nests, holes etc.**

**Elaborate sexual displays and posturing are encountered in the behavioural ecology of animals. The birds-of-paradise, for example, sing and display elaborate ornaments during courtship.**

**Indian Villager Lives with Crane He Rescued from Death: 'I Can't Imagine Life Without Him'**  
Arif Gurjar nursed a sarus crane back to health , and the animal was not leaving his side since

**An unexpected bond has become unbreakable between a crane and the man who saved its life  
in rural India.**



# Cognitive ecology- Learning through interactions

- Cognitive (the processes of understanding) ecology integrates theory and observations from evolutionary ecology and neurobiology, primarily cognitive science.
- In order to understand the effect that animal interaction with their habitat has on their cognitive systems and how those systems restrict behavior within an ecological and evolutionary framework one has to understand their ecological evolution in their habitat and ecosystems.
- Birds flying towards sun.

# **Social ecology**

- **Social-ecological behaviours are notable in the social insects, slime moulds, social spiders, human society, and naked mole-rats where eusocialism has evolved.**
- **Social behaviours include reciprocally beneficial behaviours among kin and nest mates and evolve from kin and group selection.**
- **Bees and ants – cooperation .**

# **Coevolution**

- **Ecological interactions can be classified broadly into a host and an associate relationship. A host is any entity that harbours another that is called the associate. Relationships between species that are mutually or reciprocally beneficial are called mutualisms.**

- **Examples of mutualism include fungus-growing ants employing agricultural symbiosis, bacteria living in the guts of insects or animals and other organisms, the fig wasp and yucca moth pollination complex, lichens with fungi and photosynthetic algae, and corals with photosynthetic algae.**



- If there is a physical connection between host and associate, the relationship is called symbiosis. Approximately 60% of all plants, for example, have a symbiotic relationship with Arbuscular mycorrhizal fungi living in their roots forming an exchange network of phosphates, carbohydrates for mineral nutrients.
- Indirect mutualisms occur where the organisms live apart. For example, trees living in the equatorial regions of the planet supply oxygen into the atmosphere that sustains species living in distant polar regions of the planet. During winter when trees at other places shed leaves.
- Rhizobium bacteria
- Algae – Oxygen

- **This relationship is called commensalism because many others receive the benefits of clean air at no cost or harm to trees/algae supplying the oxygen.**
- **If the associate benefits while the host suffers, the relationship is called parasitism.**
- **Co-evolution is also driven by competition among species or among members of the same species under the banner of reciprocal antagonism, such as grasses competing for growth space.**

# **Development of defence in hosts and at the same time in predators through adaptations**

- The Red Queen Hypothesis, for example, posits that **parasites track down and specialize on the locally common genetic defense systems of its host** that drives the evolution of sexual reproduction to diversify the genetic constituency of populations responding to the antagonistic pressure.

# Biogeography

- **Biogeography (an amalgamation of biology and geography) is the comparative study of the geographic distribution of organisms and the corresponding evolution of their traits in space and time.**

**Biogeographical patterns result from ecological processes that influence range distributions, such as migration and dispersal and from historical processes that split populations or species into different areas.**

- Biogeography is the study of the distribution of species and ecosystems in geographic space and through geological time. Organisms and biological communities often vary in a regular fashion along geographic gradients of latitude, elevation, isolation and habitat area.

# BIOMES



SAVANNA



TROPICAL RAINFOREST



MARINE



DESERT



TEMPERATE FOREST



POLAR



- For example, the range and distribution of biodiversity and **invasive species responding to climate change is a serious concern and active area of research in the context of global warming.**
- When an island is first colonized, density of individuals is low. The initial increase in population size is not limited by competition, leaving an abundance of available resources for rapid population growth. These early phases of population growth experience density-independent forces of natural selection, which is called
- **r-selection.**
- As the population becomes more crowded, **it approaches the island's carrying capacity, thus forcing individuals to compete more heavily for fewer available resources.** Under crowded conditions, the population experiences density-dependent forces of natural selection, **called K-selection.**

- In the r/K-selection model, the first variable  $r$  is the intrinsic rate of natural increase in population size and the second variable  $K$  is the carrying capacity of a population. Different species evolve different life-history strategies spanning a continuum between these two selective forces. An r-selected species is one that has high birth rates, low levels of parental investment, and high rates of mortality before individuals reach maturity.



- Humans and elephants are examples of species exhibiting K-selected characteristics, including longevity and efficiency in the conversion of more resources into offspring.
- K-selected species produce offspring that each have a higher probability of survival to maturity. Although not always the case, K-selection is more common in larger animals, like whales or elephants, with longer lifespans.
- Turtles, tortoises, sharks, and elephants, the true top contenders for animal with the longest lifespan. Did you know that a sea sponge in Antarctica has lived for 15,000 years or that some corals in Hawaii have lived for almost 5,000?
- Glass sponges are considered the oldest animals on Earth—and it is by a long shot. Scientists estimate that they can live for more than 10,000 years, possibly 15,000 years maximum.

- **The giant tortoise is known for its long lifespan, with some individuals living over 150 years.**
- **As of February 2024, two different species of giant tortoise are found on two remote groups of tropical islands: Aldabra Atoll and Fregate Island in the Seychelles and the Galápagos Islands in Ecuador.**



## Omnivory – A Flexible Feeding Strategy

David R. Gillespie, in Reference Module in Life Sciences, 2017

- Nightingales are classified as omnivorous; during the spring and **summer** they eat insects like beetles, gnats, worms, spiders, and more, while in **autumn** they will eat more berries and seeds.
- Similarly Parrots are also omnivores.
- Jumping spiders are also omnivores
- The majority of marine fish are omnivorous, which means they need to eat both meat- and plant-based foods.
- Fox is omnivore. **Grapes are sour?**

# Omnivory

- **Animal with wide food preferences, which can eat both plant and animal matter. Many small birds and mammals are omnivorous; deer, mice and mockingbirds have diets that at different times may include a preponderance of insects or berries.**
- **Spiders use webs to trap other insects and even animals. Jumping spiders are also omnivores, though spiders are mostly carnivores.**
- **The new findings alter our view of food web dynamics and show that rather than looking for a simple and general omnivory-stability relationship, we should focus on identifying conditions under which omnivory is a stabilizing feature of more complex natural systems.**

•  
Predators or herbivores, which cannibalize conspecifics (an organism belonging to the same species) as another are omnivores

- Omnivory includes a diverse array of relationships between omnivores and their foods. Animals which feed on herbivore and prey on other predators are omnivores. **Zoophytophagous predators**, by definition, feed on plants or plant parts, and on other animals, and are therefore omnivores. Predators or herbivores, which cannibalize conspecifics, are omnivores. Scavengers that eat both animal carrion and plants or plant parts are omnivores.
- **These species feed on resources from different trophic levels at different stages of growth.** For example, perch (*Perca fluviatilis*) shift from feeding on zooplankton to benthic invertebrates to fish as they grow from larva to adult.
- Conspecifics- Belonging to their own species.
- Omnivory – A Flexible Feeding Strategy
- Bears, humans, rats etc.

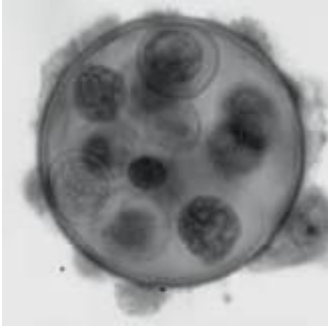
# What is trophic cascade an ecological phenomenon?

- Trophic cascades are ecological phenomena that occur when **there is a change in the population of a particular species**, which then causes a ripple effect throughout the food chain, impacting other species in either a positive or negative manner.
- What is another example of a trophic cascade?
- **Vultures & Rabies. One of the strangest trophic cascade effects is the correlation between the decimation of India's vultures and an epidemic outbreak of rabies.** In a relatively short period, vulture populations dwindled due to the use of an anti-inflammatory drug administered to cattle called diclofenac.

# Vultures and rabies

- [https://www.google.com/search?q=video+on+vultures+and+rabies&sca\\_esv=a7e19c87745cb1b1&rlz=1C1RXQR\\_enIN1122IN1122&sxsrf=AHtn8zqfNYAcmbEVsXOxRnkZtQbBCk30KQ%3A1742549157058&ei=pTDdZ-6gA5ql4-EPipPcuAg&ved=0ahUKEwih4q87ZqMAxUaxDgGHYoJF4cQ4dUDCBA&uact=5&oq=video+on+vultures+and+rabies&gs\\_lp=Egxnd3Mtd2l6LXNlcniAAWJN1cAF4AJABAjgBgwKgAccnqgEGMC4yMy41uAEDyAEA-AEBmAldoAKYKagCFMICBxAjGCcY6gLCAhAQABgDGLQCGOoCGI8B2AEBwglQEC4YAXi0AhjqAhiPAdgBAclCBBAjGCfCAG4QABiABBiRAhixAXiKBclCDhAAGIAEGLEDGIMBGloFwglFEAAyGATCaggQABiABBixA8ICCBauGIAEGLEDwglIEC4YgAQY5QTCAGoQABiABBhDGloFwglKEC4YgAQYQxiKBclCCxAAGIAEGJECGloFwglKEAAyGAQYAhjLAclCChAjGIAEGCcYigXCAGsQABiABBixAXiDAclCBBAAGAPCaggQABiABBjLAclCBhAAGBYHsICCBAAGBYChgewglIEAAyGAQYogTCAGsQABiABBIGAXiKBclCBRAAGO8FwglHECEYoAEYCpgDD\\_EF\\_bYOBsp7VTW6BgYIARABGAqSBwYxLjLzLjWgB4bFABlHBjAuMjMuNbgHiSk&sclient=gws-wiz-serp#fpstate=ive&vld=cid:7ba399c0,vid:OwYPzeD3TJc,st:0](https://www.google.com/search?q=video+on+vultures+and+rabies&sca_esv=a7e19c87745cb1b1&rlz=1C1RXQR_enIN1122IN1122&sxsrf=AHtn8zqfNYAcmbEVsXOxRnkZtQbBCk30KQ%3A1742549157058&ei=pTDdZ-6gA5ql4-EPipPcuAg&ved=0ahUKEwih4q87ZqMAxUaxDgGHYoJF4cQ4dUDCBA&uact=5&oq=video+on+vultures+and+rabies&gs_lp=Egxnd3Mtd2l6LXNlcniAAWJN1cAF4AJABAjgBgwKgAccnqgEGMC4yMy41uAEDyAEA-AEBmAldoAKYKagCFMICBxAjGCcY6gLCAhAQABgDGLQCGOoCGI8B2AEBwglQEC4YAXi0AhjqAhiPAdgBAclCBBAjGCfCAG4QABiABBiRAhixAXiKBclCDhAAGIAEGLEDGIMBGloFwglFEAAyGATCaggQABiABBixA8ICCBauGIAEGLEDwglIEC4YgAQY5QTCAGoQABiABBhDGloFwglKEC4YgAQYQxiKBclCCxAAGIAEGJECGloFwglKEAAyGAQYAhjLAclCChAjGIAEGCcYigXCAGsQABiABBixAXiDAclCBBAAGAPCaggQABiABBjLAclCBhAAGBYHsICCBAAGBYChgewglIEAAyGAQYogTCAGsQABiABBIGAXiKBclCBRAAGO8FwglHECEYoAEYCpgDD_EF_bYOBsp7VTW6BgYIARABGAqSBwYxLjLzLjWgB4bFABlHBjAuMjMuNbgHiSk&sclient=gws-wiz-serp#fpstate=ive&vld=cid:7ba399c0,vid:OwYPzeD3TJc,st:0)

# Why oomycetes are called water molds?



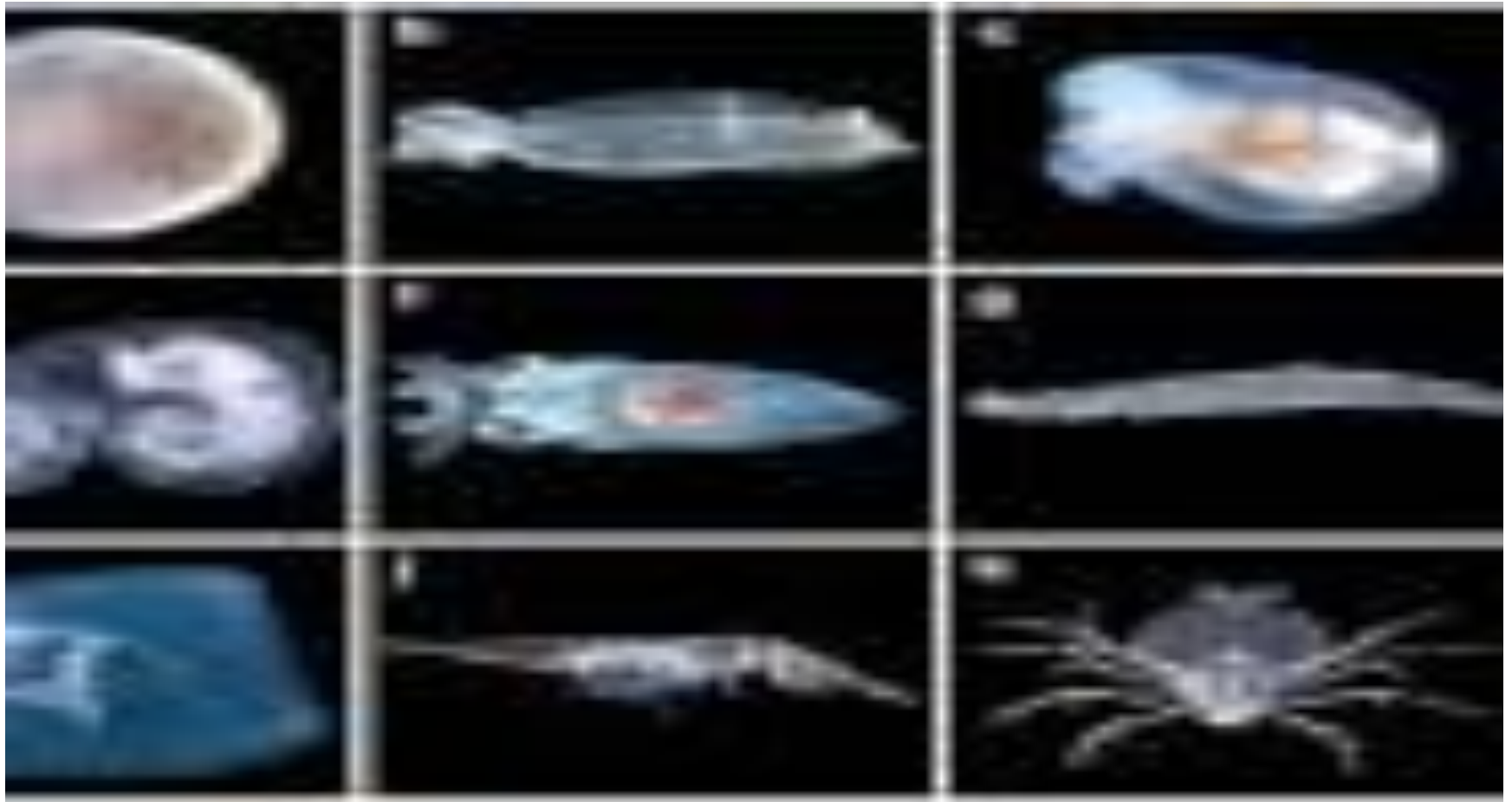
- **Oomycota -- The Water Molds - Oomycetes (a term used to refer to organisms in the phylum Oomycota) are a group of fungus-like organisms that rely on water for completion of their life cycle, hence the common name “water molds”.**
- **Water molds belong to the phylum Oomycota. These fungus-like organisms have cellulose cell walls, a diplontic life cycle.**



# **What is zooplankton?**

- **Zooplankton are small, aquatic microorganisms in the water column that include crustaceans, rotifers, open water insect larvae and aquatic mites. The zooplankton community is composed of both primary consumers, which eat free-floating algae, and secondary consumers, which feed on other zooplankton.**

**Zooplankton may be herbivores or, carnivores or omnivores.**



# Omnivory is tangled and complex

- **Can an omnivore be a predator?**
- Since omnivores hunt and are hunted, they can be both predators and prey. Omnivores can also be scavengers, animals that feed on the remains of dead animals. For example, bears eat twigs, honey, small insects, small deer and berries but will also hunt small animals and eat dead animals if they happen to stumble upon them. **These species feed on resources from different trophic levels at different stages of growth.** Thus it is not easy to fit them into trophic webs and their position is tangled and complex.
- Omnivores have an advantage in an ecosystem because their diet is the most diverse. These animals can vary their diet depending on the food that is most plentiful, sometimes eating plants and other times eating meat. Chances of starving are lesser.

# Molecular ecology

- Molecular ecological research became more feasible with the development of rapid and accessible genetic technologies, such as the polymerase chain reaction (PCR) .
- **PCR Tests conducted during Corona-19.**
- Newer technologies opened a wave of genetic analysis into organisms once difficult to study from an ecological or evolutionary standpoint, such as virus, bacteria, fungi, and nematodes.
- Molecular ecology is a hybrid field that combines molecular biology techniques with ecological data to make sense of natural processes such as the growth or decline of populations, formation of new species, extinctions and invasiveness.
- Human genome sequencing.

# Veddeo on Human Genome Mapping Project

- <https://www.youtube.com/watch?v=-hryHoTlHak>

# What type of genetics are Indians?

- The extant Indian gene pool is composed of largely four ancestral genetic components, namely Ancestral North Indian (ANI), Ancestral South Indian (ASI), Ancestral Tibeto-Burman (ATB), and Ancestral Austro-Asiatic (AAA).
- ANI are genetically closer to Middle Easterners, Central Asians and Europeans. The proportion of ANI ancestry in most groups ranges from 39-71%. Indigenous Andaman Islanders have exclusively ASI ancestry, but such groups weren't found in mainland India.
- The first humans to live in what is now India were likely African hunter-gatherers who migrated to the Indian subcontinent around 65,000 years ago, and their descendants are considered the "First Indians".

# Assignment 3 : Management of computer , electronics and solar panel etc. wastes : Suggested References :

## 1. Electronic Waste Management Assignment 3

and Disposal Issues and Alternatives, KATE GmSON and JESSICA KUNDMAN TIERNEY, Environmental Claims Journal. 18(4/Fall):321-332 (2006).

[https://www.iilsindia.com/study-material/201599\\_1623512320.pdf](https://www.iilsindia.com/study-material/201599_1623512320.pdf).

2. Physical and chemical characterization and recycling potential of desktop computer waste, without screen, Claudia Adriana Kohland Luciana Paulo Gomes, Journal of Cleaner Production, Volume 184, 20 May 2018, Pages 1041-1051

<https://www.sciencedirect.com/science/article/abs/pii/S0959652618305511>

3. Assessment and Management of Radioactive and Electronic Wastes, Edited by Hosam El-Din Saleh, Cristina A. Lucier and Brian J. Gareau, Published: 18 April 2019. <https://www.intechopen.com/chapters/66785>

4. Popular E-waste disposal methods in India :

<https://enterclimate.com/blog/e-waste-disposal-methods-in-india/#:~:text=Common%20E%2Dwaste%20disposal%20methods&text=It%20involves%20excavating%20trenches%20or,into%20the%20soil%20and%20groundwater>. etc. etc

**Last of submission April 13 ,2025**

# Human ecology

- **People affect ecosystems when they use resources such as water, fish, timber and livestock grazing land. After using materials from ecosystems, people return the materials to ecosystems as waste. People intentionally modify or reorganize existing ecosystems, or create new ones, to better serve their needs due to the anthropogenic actions.**
- **Ecosystems relate importantly to human ecology as they are the ultimate base foundation of global economics as every commodity and the capacity for exchange ultimately stems from the ecosystems on Earth.**



# Ecosystem of class room

- All the contexts of our lives may be thought of as some type of ecosystem, i.e., **frames of reference in which we interact with others and with our environment.** From the point of view of education, a classroom, a school, and an institute are all educational ecosystems.
- A classroom, then, can be seen as an ecosystem, a system i.e., a frame within which the biotic components—the students, teacher, TAs—and the abiotic components ( knowledge, heat , light etc.) are interdependent via the transaction between and among all components, biotic and abiotic learning occurs or information is exchanged.

- **Ecology is an employed/ applied science of restoration, repairing disturbed sites through human intervention ( solar, wind ) in natural resource management, and in environmental impact assessments. Edward O. Wilson predicted in 1992 that the 21st century will be the era of restoration in ecology.**
- **Life in arctic regions ? Difficult to live there but life and ecosystems exist there and reverses in climate change may help restoring the melting of ice there.**

# Arctic Animals & Wildlife

- **Polar Bears. Land-based Mammals. Arctic Fox.**
- **Reindeer. ...**
- **Musk Oxen. ...**
- **Arctic Hare. ...**
- **Walrus & Seals. ...**
- **Bearded Seal. ...**
- **Ringed Sea**
- **Shark- 8000 years old.**
- **Pelicans**
- **Sea lions etc. etc.**
- **Life in Alaska- Russia & US deals**

# Ecological conservation

- Ecological science has boomed in the investment of restoring ecosystems and their processes in abandoned sites after disturbance.
- **Cheetahs have been imported- Kuno Park , MP.**
- Natural resource managers, in forestry, for example, employ ecologists to develop, adapt, and implement ecosystem based methods into the planning, operation, and restoration phases of land-use. Cheetah Mitras are volunteers roped in to protect the Cheetahs brought from Namibia

- Ecological science is used in the methods of sustainable harvesting, disease control ( Vultures ), Natural or synthetic Pesticides or insecticides or neem (*Azadirachta indica*) , and forest fire outbreak management,
  - In fisheries stock management is important.
  - Hatcheries for fish, poultry, turtles etc. for hatching artificially the eggs in the artificial ways.
- Use of sugar industry or distilleries wastes.

# **What is the most sustainable method of harvesting trees?**

- In a sustainable harvest either the best trees will be left standing until a new forest of younger, healthy trees begins to grow underneath it, or everything will be removed so there is no vegetation left to compete with the young sprouts and seedlings.**
- What is an example of a sustainable crop?**
- Shade-grown coffee, a form of polyculture (an example of sustainable agriculture) in imitation of natural ecosystems. Trees provide resources for the coffee plants such as shade, nutrients, and soil structure; the farmers harvest coffee and timber.**

# Relation to the environment

- **Resources** for organisms at any time throughout their life cycle may be managed properly.
- The physical environment may also be well organized and this would include abiotic factors such as temperature, radiation, light, chemistry, climate and geology.
- Light pollution? Too much light or even strong sun light or glaring light ?
- **The biotic or biological environment includes genes, cells, organisms, members of the same species** (conspecifics, e.g., wasp nest having worker wasps) and other species that share a habitat.

# Disturbance and resilience

- Ecosystems are regularly confronted with natural environmental variations and disturbances over time and geographic space. A disturbance is any process that removes biomass from a community, **such as a fire, flood, drought, cyclones or predation- Locusts.**
- Disturbances occur over vastly different ranges in terms of magnitudes as well as **distances and time periods and are both the cause and product of natural fluctuations in death rates, species assemblages, booms, and biomass densities within an ecological community.** These disturbances may create new species or habitats even. Excessive rains or nutritions – **algal blooms.**  
**Photosynthesis for carbon management or eutrophication.**



# Metabolism and the early atmosphere

- The Earth was formed approximately 4.5 billion years ago.
- As it cooled and a crust and oceans formed, its atmosphere transformed from being dominated by hydrogen to one composed mostly of **methane and ammonia**.
- Over the next billion years, the metabolic activity of life transformed the atmosphere into a mixture of carbon dioxide, nitrogen, and water vapor. These gases changed the way that light from the sun hit the Earth's surface and greenhouse effects trapped heat.

# **Climate change – Global warming- Cyclic phenomenon**

## **- on earth on roughly 100,000-year cycles for at least the last 1 million years.?**

- There were untapped sources of free energy within the mixture of reducing and oxidizing gases that set the stage for primitive ecosystems to evolve and, in turn, the atmosphere also evolved.
- Throughout history, the Earth's atmosphere and biogeochemical cycles have been in a dynamic equilibrium with planetary ecosystems –Cyanobacteria brought oxygen through photosynthesis. The history is characterized by periods of significant transformation followed by millions of years of stability – Dynosaurs and so on.
- **Dunosaur**s lived for 200 million years and got eliminated 65 million years ago.
- **A huge asteroid or comet slammed into Earth 65 million years ago, blocking sunlight, changing the climate and setting off global wildfires.**

# Earlier geochemistry or atmospheric chemistry

- The evolution of the earliest organisms, likely anaerobic methanogen microbes, started the process by converting atmospheric hydrogen into methane ( $4\text{H}_2 + \text{CO}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$ ).  
Anoxygenic photosynthesis ( no  $\text{O}_2$  production ) reduced hydrogen concentrations and increased atmospheric methane, by converting hydrogen sulfide into water or other sulfur compounds (for example,  $2\text{H}_2\text{S} + \text{CO}_2 + h\nu \rightarrow \text{CH}_2\text{O} + \text{H}_2\text{O} + 2\text{S}$ ).  
Early forms of fermentation also increased levels of atmospheric methane ( greenhouse gas).  
Photoautotrophs..

- **The transition to an oxygen-dominant atmosphere (the Great Oxidation) did not begin until approximately 2.4–2.3 billion years ago, but photosynthetic processes started 0.3 to 1 billion years prior. Average Temp. on earth = 15 Deg. C.**
- **The average temperature on the Moon (at the equator and mid latitudes) varies from (-183 degrees Celsius), at night, to 106 degrees Celsius during the day – no or very less CO<sub>2</sub> there.**
- **The average Temp. on Venus = 464 Deg.C. Due to CO<sub>2</sub> atmosphere there.**

# Radiation: heat, temperature and light

- Heat affects growth rates, activity, behaviour, and primary production. **Temperature is largely dependent on the incidence of solar radiation.**
- The latitudinal and longitudinal spatial variation of temperature greatly affects climates and **consequently the distribution of biodiversity** and levels of primary production in different ecosystems or **biomes across the planet.**
- **Solar wind -The solar wind is created by the outward expansion of plasma (a collection of charged particles) from the Sun's corona (outermost atmosphere). This plasma is continually heated to the point that the Sun's gravity can't hold it down. It then travels along the Sun's magnetic field lines that extend radially outward.**

- **Plants, algae, and some bacteria absorb light and assimilate the energy through photosynthesis. Organisms capable of assimilating energy by photosynthesis or through inorganic fixation of  $H_2S$  are autotrophs. Autotrophs—responsible for primary production—assimilate light energy which becomes metabolically stored as potential energy..**

# Physical environments

- Diffusion of carbon dioxide and oxygen is approximately 10,000 times slower in water than in air. When soils are flooded, they quickly lose oxygen, becoming hypoxic (an environment with O<sub>2</sub> concentration below 2 mg/liter) and eventually completely anoxic where anaerobic bacteria thrive among the roots. Water also influences the intensity and spectral composition of light as it reflects off the water surface and submerged particles.
- Photosynthetic efficiency ?

# Azolla – sea plant

- Aquatic plants exhibit a wide variety of morphological and physiological adaptations that allow them to survive, compete, and diversify in these environments. For example, their roots and stems contain large air spaces (aerenchyma) that regulate the efficient transportation of gases (for example, CO<sub>2</sub> and O<sub>2</sub>) used in respiration and photosynthesis.
- Rubisco is lethargic enzyme. Carbonic anhydrase
- $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HCO}_3^- + \text{H}^+$ .



# Circadian rythm

- Salt water plants (halophytes) have additional specialized adaptations, such as the development of **special organs for shedding salt and osmoregulating their internal salt (NaCl) concentrations, to live in estuarine, brackish, or oceanic environment.**
- Anaerobic soil microorganisms in aquatic environments use nitrate, manganese ions, ferric ions, sulfate, carbon dioxide, and some organic compounds; other microorganisms are facultative anaerobes and use oxygen during respiration when the soil becomes drier – towards droughts.

- **The physiology of fish is also specially adapted to compensate for environmental salt levels through osmoregulation. Their gills form electrochemical gradients that mediate salt excretion in salt water and uptake in fresh water.**

# Photosynthesis in algae

- CO<sub>2</sub> conc. In water is just 10 ppm and in air it is 421 ppm.

In eukaryotic algae, carbon concentrating mechanisms (CCMs) involve inorganic carbon (Ci) transporters at the plasma membrane and chloroplast envelope and carbonic anhydrases, which act in concert to deliver above ambient concentrations of CO<sub>2</sub> to Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO) , usually within a chloroplast microcompartment called the pyrenoid.

# Gravity

- On a large scale, the distribution of gravitational forces on the earth is uneven and influences the shape and movement of tectonic plates as well as influencing geomorphic processes such as orogeny ( formation of hills and mountains ) and erosion.
- Shift of India to form Himalaya.
- People and animals living on hills.
- Crows on hills.
- Hair or fur on hill animals.

Gravitational forces provide directional cues for plant and fungal growth (gravitropism), orientation cues for animal migrations, and influence the biomechanics and size of animals, shapes of trees etc. Squirrels in USA, Germany were different from those in India.

- **Behaviour of animals and birds before Earth Quakes.**

# Sunita William in space

- [https://www.google.com/search?q=sunita+william+and+gravity+video+&sca\\_esv=52923c0e22342b43&rlz=1C1YTUH\\_enIN1045IN1045&sxsrf=AHTn8zp-Q-ibHLrWnp3BKZfyS-5VHYWdhA%3A1742627309127&ei=7WHeZ7O6B9C4seMPw\\_ySuA0&ved=0ahUKEwjz5PHNkJ2MAxVQXGwGHUO-BNcQ4dUDCBI&uact=5&oq=sunita+william+and+gravity+video+&gs\\_lp=Egxnd3Mtd2l6LXNlcuAilXN1bml0YSB3aWxsaWFtIGFuZCBncmF2aXR5IHZpZGVvIDIFECEYoeAeyBRAhGKABMgUQIRigATIFECEYnwUyBRAhGJ8FMgUQIRifBTIFECEYnwVI1yFQughYvh1wAXgAkAEAmAHSAaAB7AqqAQUwLjUuM7gBA8gBAPgBAZgCCKAChwrCAgoQABiwAxjWBBhHwglHECEYoeAeYCpgDAIgGAZAGB5IHBTEuNC4zoAf7N7IHBTAuNC4zuAf7CQ&sclient=gws-wiz-serp#fpstate=ive&vld=cid:69d74ad6,vid:YwXvkVMWL9s,st:0](https://www.google.com/search?q=sunita+william+and+gravity+video+&sca_esv=52923c0e22342b43&rlz=1C1YTUH_enIN1045IN1045&sxsrf=AHTn8zp-Q-ibHLrWnp3BKZfyS-5VHYWdhA%3A1742627309127&ei=7WHeZ7O6B9C4seMPw_ySuA0&ved=0ahUKEwjz5PHNkJ2MAxVQXGwGHUO-BNcQ4dUDCBI&uact=5&oq=sunita+william+and+gravity+video+&gs_lp=Egxnd3Mtd2l6LXNlcuAilXN1bml0YSB3aWxsaWFtIGFuZCBncmF2aXR5IHZpZGVvIDIFECEYoeAeyBRAhGKABMgUQIRigATIFECEYnwUyBRAhGJ8FMgUQIRifBTIFECEYnwVI1yFQughYvh1wAXgAkAEAmAHSAaAB7AqqAQUwLjUuM7gBA8gBAPgBAZgCCKAChwrCAgoQABiwAxjWBBhHwglHECEYoeAeYCpgDAIgGAZAGB5IHBTEuNC4zoAf7N7IHBTAuNC4zuAf7CQ&sclient=gws-wiz-serp#fpstate=ive&vld=cid:69d74ad6,vid:YwXvkVMWL9s,st:0)

- **Ecological traits, such as kind of biomass in trees during growth are subject to as gravitational forces influence the position and structure of branches and leaves - Pine trees - Soft wood ?**
- **The cardiovascular systems of animals are functionally adapted to overcome the pressure and gravitational forces that change according to the features of organisms (e.g., height, size, shape), their behaviour (e.g., diving, running, flying), and the habitat occupied (e.g., water, hot deserts, cold tundra).**
- **Shapes of animals, trees , insects etc.**

# Pressure

- Climatic and osmotic pressure places physiological constraints on organisms, especially those that fly and respire at high altitudes, or dive to deep ocean depths.
- These constraints influence vertical limits of ecosystems in the biosphere, as organisms are physiologically sensitive and adapted to atmospheric and osmotic water pressure differences.
- Atmospheric pressure on earth is about 14.7 pounds per square inch.
- Too much height of persons and heart pumping?

- **For example, oxygen levels decrease with decreasing pressure and are a limiting factor for life at higher altitudes.**
- **Water transportation by plants is another important ecophysiological process affected by osmotic pressure gradients.**
- **Water pressure in the depths of oceans requires that organisms adapt to these conditions. For example, diving animals such as whales, dolphins, and seals are specially adapted to deal with changes in sound due to water pressure differences - 8000 years old shark.**



# Wind and turbulence

- Turbulent forces in air and water affect the environment and ecosystem distribution, form, and dynamics.
- Wind power and the turbulent forces influence heat, nutrient, and biochemical profiles of ecosystems.
- For example, wind running over the surface of a lake creates turbulence, mixing the water column and influencing the environmental profile to create thermally layered zones, affecting how fish, algae, and other parts of the aquatic ecosystem are structured- Thermal pollution
- Dissolved oxygen levels in water increase due to turbulence.
- Storms and Tsunamis ?

- **Wind speed and turbulence also influence evapotranspiration rates and energy budgets in plants and animals.**
- **The air expands and moisture condenses as the winds increase in elevation; this is called orographic lift and can cause precipitation**

# Fire

- Plants convert carbon dioxide into biomass and emit oxygen into the atmosphere. By approximately 350 million years ago (the end of the Devonian period), photosynthesis had brought the concentration of atmospheric oxygen above 17%, which allowed combustion to occur.
- Fire is a significant ecological parameter that raises many issues pertaining to its control and suppression – **Forest fires in summer- Very Harmful.**

- Most ecosystems are adapted to natural fire cycles. Plants, for example, are equipped with a variety of adaptations to deal with forest fires. Some species (e.g., *Pinus halepensis*) **cannot germinate until after their seeds have lived through a fire or been exposed to certain compounds from smoke.** Environmentally triggered germination of seeds is called serotiny. Fire plays a major role in the persistence and resilience of ecosystems
- Toy train to Simla - Steam Engine – Fires.

# Soils

- **Soil is the living top layer of mineral and organic dirt that covers the surface of the planet. It is the chief organizing centre of most ecosystem functions, and it is of critical importance in agricultural science and ecology. The decomposition of dead organic matter (for example, leaves on the forest floor), results in soils containing minerals and nutrients that feed into plant production.**
- **India is number 1 or 2 in having maximum fertile or arable land in the world.**

# Nutrients and food

- Invertebrates ( no backbone-insects) that feed and shred/ break or tear off larger leaves, for example, create smaller bits for smaller organisms in the feeding chain. Collectively, these organisms are the **detritivores** that regulate soil formation. Tree roots, fungi, bacteria, worms, ants, beetles, centipedes, spiders, mammals, birds, reptiles, amphibians, and other less familiar creatures all work to **create the trophic web of life in soil ecosystems.**

# Biogeochemistry and climate

- Six major elements (hydrogen, carbon, nitrogen, oxygen, sulfur, and phosphorus; H, C, N, O, S, and P) form the constitution of all biological macromolecules and feed into the Earth's geochemical processes.
- Understanding the relations and cycles mediated between these elements and their ecological pathways has significant bearing toward understanding global biogeochemistry.

# Carbon footprints and Carbon dioxide levels on earth

- The ecology of global carbon budgets gives one example of the linkage between **biodiversity and biogeochemistry**. It is estimated that the Earth's **oceans** hold **40,000 gigatonnes (Gt) of carbon**, that vegetation and **soil** hold **2070 Gt**, and that **fossil fuel** emissions are **6.3 Gt carbon per year**.
- There have been major restructurings in these global carbon budgets during the Earth's history, regulated to a large extent by the **ecology of the land**. For example, through the early-mid Eocene volcanic outgassing, the **oxidation of methane stored in wetlands, and seafloor gases increased atmospheric CO<sub>2</sub> (carbon dioxide) concentrations to levels as high as 3500 ppm**.



# Switch grass, Sugarcane, Sweet sorghum, maize

- In the Oligocene, from twenty-five to thirty-two million years ago, there was another significant restructuring of the global carbon cycle as **grasses evolved a new mechanism of photosynthesis, C4 photosynthesis**, and expanded their ranges. This new pathway evolved in response to the drop in atmospheric CO<sub>2</sub> concentrations below 550 ppm.
- Present conc. Of CO<sub>2</sub> = 421 ppm ( 2022).

# Greenhouse effect and climate change

- The relative abundance and distribution of biodiversity alters the dynamics between organisms and their environment such that ecosystems can be both cause and effect in relation to climate change.
- **Human-driven modifications** to the planet's ecosystems (e.g., disturbance, biodiversity loss, agriculture) contributes to rising atmospheric greenhouse gas levels.

# Climate change hazards

- Transformation of the global carbon cycle in the next century is projected to raise planetary temperatures, lead to more extreme fluctuations in weather, alter species distributions, and increase extinction rates. The effect of global warming is already being registered in melting glaciers, melting mountain ice caps, and rising sea levels. Consequently, species distributions are changing along waterfronts and in continental areas where migration patterns and breeding grounds are changing according to the prevailing shifts in climate. Flooding ravages in several countries presently.

- Large sections of permafrost are also melting to create a new mosaic of flooded areas having increased rates of soil decomposition activity that raises methane (CH<sub>4</sub>) emissions. There is concern over increases in atmospheric methane in the context of the global carbon cycle.
- Methane is more than 28 times as potent as carbon dioxide at trapping heat in the atmosphere. Over the last two centuries, methane concentrations in the atmosphere have more than doubled, largely due to human-related activities.
- A single cow produces between 154 to 264 pounds of methane gas per year.
- The Intergovernmental Panel on Climate Change (IPCC, 1996) estimated the global emission rate from paddy fields at 60 Tg/yr, with a range of 20 to 100 Tg/yr.

# Emerging climate challenges

- Hence, there is a relationship between global warming, decomposition and respiration in soils and wetlands producing significant climate feedbacks and globally altered biogeochemical cycles.
- Methane has 28 times more greenhouse effect in comparison to CO<sub>2</sub>.

# Early beginnings

- **Alexander von Humboldt (1769–1859), Father of Physical Geography, was an early pioneer in ecological thinking and was among the first to recognize ecological gradients, where plant species are replaced or altered in form along environmental gradients, such as a cline forming ( continuous slight differentiation ) along a rise in elevation.**
- **Numerous other animals and plants owe their scientific name to the Prussian polymath: a South American bat species, the delicate Humboldt squirrel monkey from the Amazon basin, blood-sucking parasites as well as fungi, violets, delicate orchids and the colourful Humboldt lily in California.**
- **Alexander von Humboldt Foundation in Germany.**

# Ecological damage

- The projects or activities which are requiring prior environmental clearance under the Environment Impact Assessment Notification, 2006 from the concerned Regulatory Authority but are brought for environmental clearance after starting the construction work, or have undertaken expansion, modernization, and change in product- mix without prior environmental clearance, **such projects are treated as cases of violations as per the Notification S.O 804 (E) dated 14.03.2017.**

# **DIFFERENT TYPES OF WORKPLACE HAZARD CONSIDERED IN RA**

- **Source of water and damage to water quality**
  - **Bulk and Tankers (Including Pipe supply by Industrial park management in case industry is located in a Private / State owned Industrial Parks).**
- **MONETARY VALUES FOR ASSESSMENT OF SOIL DAMAGE - Applies to both construction & Operation period of violation**



# **Damage to Ecosystems**

- **Any change in LULC ( Land use and land cover ).analysis .**
- **Damage through noise and vibration**
- **Damage to Air Quality**
- **Energy Conservation**
- **Wild life damage**
- **Damage to forests**
- **Damage to environmentally sensitive areas or environmental receptors.**
- **Damage to soil and water ecosystems**

# Mexicos underwater city

- 557 hectares area.
- 120000 people can live in this city

200 years old alive clam ( clamfish born in 1809 in sea in Florida

- The person who found it did not eat it.
- Maldives is the lowest lying country in the world, just 1 meter above sea level, and a number of techniques are used to protect islands against flooding and erosion. Nevertheless, the country is expected to be entirely submerged by 2100.
- The Maldivian president and ministers held the world's first underwater cabinet meeting on Saturday, in a symbolic cry for help over rising sea levels that threaten the tropical archipelago's existence. 19 Oct 2009.
- On December 26, 2004, a calm morning in the Maldives turned into a nightmare as a 9.1-magnitude earthquake originating near Sumatra triggered a devastating tsunami in Asia. With an average elevation of just 1.5 meters above sea level, the tsunami had devastating impacts on the Maldives.