



UPSC – IAS

Civil Services Examinations

Union Public Service Commission

General Studies

Paper 3 – Volume 2

Environment, Ecology and Biodiversity



UPSC CSE - IAS

PAPER – 3 VOLUME - 2

ENVIRONMENT, ECOLOGY AND BIODIVERSITY

S.No.	Chapter Name	Page No.
1.	Ecology	1
	<ul style="list-style-type: none">• Levels of Ecological Organisations<ul style="list-style-type: none">○ Species/ Individual○ Population○ Community○ Ecosystem○ Biome○ Biosphere• Species<ul style="list-style-type: none">○ Evolution○ Adaptation○ Variation○ Mutation○ Speciation○ Extinction• Biotic Interactions• Ecotone<ul style="list-style-type: none">○ Characteristics of Ecotone• Ecological Niche<ul style="list-style-type: none">○ Components of Niche○ Characteristics of Niche• Ecological Succession<ul style="list-style-type: none">○ Stages of Succession○ Succession in Plants○ Succession in Water/ Hydrosere stages	
2.	Ecosystem	14
	<ul style="list-style-type: none">• Components of an Ecosystem<ul style="list-style-type: none">○ Biotic Components○ Abiotic Components• Functions of Ecosystems• Attributes of Ecosystem<ul style="list-style-type: none">○ Energy Flow○ Trophic Levels○ Food Chain○ Food Web• Ecological Pyramid<ul style="list-style-type: none">○ Pyramid of numbers○ Pyramid of Biomass○ Pyramid of Energy○ Limitations of Ecological Pyramids• Pollutants and Trophic level• Biogeochemical/Nutrient Cycles	

- Oxygen Cycle
- Nitrogen Cycle
- Carbon Cycle
- Water/ Hydrological Cycle
- Phosphorus Cycle
- Sulphur Cycle
- Classification of Ecosystem
 - Terrestrial Ecosystems
 - Aquatic Ecosystems
 - Man-Made Ecosystems/ Artificial Ecosystems
- Ecological Productivity

3. Biodiversity

34

- Levels of Biodiversity
 - Genetic Diversity
 - Species Diversity
- Ecosystem Diversity
- Importance of Biodiversity
- Biodiversity Loss
 - Reasons
 - Consequences of Biodiversity Loss

4. Conservation of Biodiversity

42

- In-Situ Conservation
 - Biosphere Reserve
 - National Parks
 - Wildlife Sanctuaries
 - Conservation Reserve & Community Reserves
 - Sacred Groves in India
 - Marine Protected Areas
 - Hope Spots
 - Biodiversity Hotspots
 - Nature Reserves
 - Reserved and Protected forests
 - Preservation plots
 - Tiger Reserves
 - Elephant Corridors
 - Lion Conservation in India
 - Rhino Conservation in India:
 - Gangetic Dolphin
 - Vultures
 - Snow Leopard
 - Gharial
 - Great Indian Bustard
- Ex-situ/ Off- site conservation
 - Zoo/ Zoological Parks
 - Aquarium
 - Seed banks
 - Seed vaults:
 - Gene Banks
 - Botanical gardens
 - Horticultural gardens
- Social Forestry

- Farm Forestry
- Community Forestry
- Extension Forestry
- Agroforestry
- Government Initiatives on Biodiversity Conservation
 - Major Authorities
 - Major Acts
 - Government Initiatives
 - Major Committees
 - Major International Biodiversity Organizations and NGOs

5. **Wetlands** 71

- Importance of Wetlands
- Reasons for Depletion
- Types of Wetlands
 - Swamps
 - Marshes
 - Bogs & Fens
 - Pocosin
- Functions of Wetland
- International Conservation Efforts
 - Ramsar Convention
 - Montreux Record
 - Wetland International
 - Changwon Declaration on Human well-being and Wetlands

6. **Coral Reefs** 77

- Favourable conditions
- Types of Coral Reefs
 - Fringing Reefs
 - Barrier Reefs
 - Atolls
 - Other Reef Types
- Important Coral reefs of the World
- Coral Bleaching
 - Causes of Coral Bleaching
 - Types of Coral Bleaching
- Global Efforts to Conserve Coral Reefs
 - Measures taken for coral restoration by India
 - Wetland Conservation Efforts in India

7. **Mangrove** 84

- Adaptations of Mangroves
- Benefits of the Mangroves
- Threat to Mangroves
- Global Initiatives for Mangrove Conservation
- Distribution of Mangroves in India
- Indian Government's Initiatives for Mangrove Conservation
- Coastal regulation Zones

8. **Sustainable Agriculture** 91

- Features of Sustainable Agriculture
 - Principles of Sustainable Agriculture
- Need for Sustainable Agriculture
- Sustainable Agriculture in India

- Techniques of Sustainable Agriculture
 - Zero Tillage/ No Tillage / Nil Tillage
 - Zero Budget Natural Farming (Zbnf)
 - Plantation Agriculture
 - Crop Rotation
 - Dryland Farming
 - Wetland Farming
 - Terrace Cultivation
 - Permaculture
 - Push-Pull Agricultural Pest Management
 - Polyculture Farming
 - Agroforestry
 - Biodynamic Farming
 - System Of Rice Intensification
 - Precision Farming
 - Conservation Agriculture
 - Intercropping
 - Natural Farming
 - Floating Farming
 - Vertical Farming

9. Environment

97

- Environmental Degradation
 - Environmentalism
- Major Environmental Movements in India
 - Bishnoi Movement
 - Chipko Movement
 - Save Silent Valley Movement
 - Jungle Bachao Andolan
 - Appiko Movement
 - Narmada Bachao Andolan
 - Tehri Dam Conflict
- International Efforts for Environment Protection
 - United Nations Conference on Human Development (1972)
 - United Nations Environment Programme (UNEP)
 - Brundtland Commission
 - Rio Summit/ Earth Summit (1992)
 - Global Environment Facility
 - International Renewable Energy Agency
 - International Energy Agency
- Indian Efforts for Environment
 - Center for Science and Environment
 - Green Skill Development Programme
 - National Green Corps 'Ecoclub'
 - Energy and Resource Institute
- Global and Indian Environment Funds
 - Adaptation for Smallholder Agriculture Programme (ASAP)
 - Adaptation Fund
 - Amazon Fund
 - BioCarbon Fund
 - Forest Carbon Partnership Facility
 - Global Energy Efficiency and Renewable Energy Fund

- Green Climate Fund
- Least Developed Countries Fund
- Pilot Program for Climate Resilience
- Special Climate Change Fund
- Global Climate Change Alliance
- Climate Investment Funds
- Carbon Partnership Facility
- The BioCarbon Fund Initiative For Sustainable Forest Landscape (ISFL)
- Carbon Initiative for Development
- Forest Carbon Partnership Facility
- Partnership for Market Readiness

10 Environmental Pollution Pollutants

107

- Air Pollution
 - Major Air Pollutants and their sources
 - Indoor Air Pollution
 - Impact of Air Pollution
 - Measures to Curb Air Pollution
 - Global Initiatives for Mitigating Air Pollution
 - Indian Initiatives for Mitigating Air Pollution
- Water Pollution
 - Sources of Water Pollution/Pollutants
 - Measurement of Water Pollution
 - Impacts of Water Pollution
 - Indian Government efforts to curb river pollution
 - Global Initiatives to curb water pollution
- Eutrophication
 - Types of Eutrophication
 - Consequences of Eutrophication
 - Controlling Eutrophication
- Acid Rain
 - Types of Acid Deposition
 - Sources
 - Acid Rain Formation
 - Impact of Acid Rain
 - Measures to Control Acid Rain
- Soil Pollution
 - Sources of soil pollution
 - Effects of soil pollution
 - Remedial Measures
 - Global Actions to Tackle Soil Pollution
 - Indian Initiatives to tackle Soil Pollution
- Noise Pollution
 - Effects of Noise pollution
 - Control of Noise pollution
 - Central Government's Regulation
- Radioactive Pollution
 - Types of radiations and their effects
 - Sources of radiation
 - Types of radiation particles
 - Control Measures
- Thermal Pollution

- Sources of thermal pollution
- Impact of thermal pollution
- Methods to control thermal pollution
- Mercury Pollution
 - Source of Mercury in the environment
 - Mercury Contamination in India
 - Effects of mercury pollution
 - Minamata disease

11. Solid Waste Management

132

- Classification of Wastes
- Waste Management
- Types of Waste
 - E-Waste
 - Organic Waste
 - Chemical waste
 - Bio-Medical Waste
 - Radioactive waste
- Methods of solid waste management
- Plastic waste management
 - Sources of Plastic Waste
 - Types of Plastic Waste
 - Impact of Plastic Waste
 - Recycling of Plastic Waste
 - India's Plastic Waste Industry
 - Government Regulations
 - Global Interventions
- Biodegradable plastics/ bioplastics
 - Advantages of bioplastics
 - Disadvantages of bio-plastics
- Sewage Treatment
 - Impact of Sewage
 - Sewage Treatment
- Bioremediation
 - In-situ remediation techniques-
 - Ex-situ remediation techniques
 - Advantages of Bioremediation
 - Limitation of Bioremediation

12. Global Warming & Climate Change

145

- Greenhouse Effect
 - Greenhouse Gases
 - Share of GHGs in Global Warming
- Global Warming
 - Causes of Global Warming
 - Effects of Global Warming
- Climate Forcing
- Climate Change
 - Factors affecting Climate Change
 - Impact of Climate Change
- Climate Change in India
 - Indian Himalayan Region
 - Indian Efforts to Counter Climate Change

- Global Efforts to Combat Climate Change
 - Under 2 coalition
 - International Resource Panel
 - Global Carbon Project
 - Intergovernmental Panel on Climate change (IPCC)
 - United Nations Framework Convention on Climate Change (UNFCCC)
 - Kyoto Protocol
 - COP 24
 - COP 25
 - COP 26

13. Climate Change Mitigation Mechanisms 159

- Carbon Credit
- Carbon Sequestration
- Carbon Sink
- Carbon offsetting
- Carbon Tax
- Green Economy
- Geo-Engineering

14. Ozone Depletion 168

- Ozone-depleting Substances
- Chemistry behind Ozone Depletion
- Impacts of Ozone Depletion
 - Ozone Pollution
 - Ozone Hole

15. Desertification 175

- Causes
- Impacts of Desertification
- Solutions of Desertification
- International efforts to curb Desertification
- Indian Government Efforts to Curb Desertification

16. Deforestation 179

- Primary Causes of Deforestation
- Major Effects of Deforestation
- International Efforts to Curb Deforestation
- Indian Government Efforts to Curb Deforestation
- Afforestation

17. Environmental Impact Assessment 186

- Evolution of EIA
- Objectives of EIA
- Environmental Components of EIA
- Significance
- Salient Features of 2006 Amendments to EIA Notification
- General Procedure of EIA
 - EIA Process (as per 2006 amendments)
 - Draft EIA Notification, 2020
- Difference in EIA and SEA
- Importance of EIA
- Shortcomings of EIA Process
- Recommendations to improve the EIA Process
- Various Stakeholders in EIA

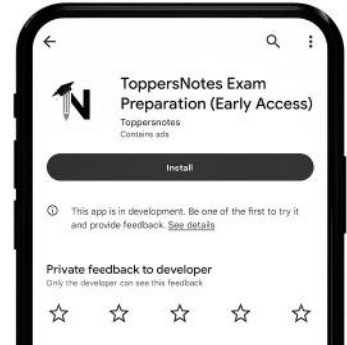
Dear Aspirant,
Thank you for making the right decision by choosing ToppersNotes.
To use the QR codes in the book, Please follow the below steps :-



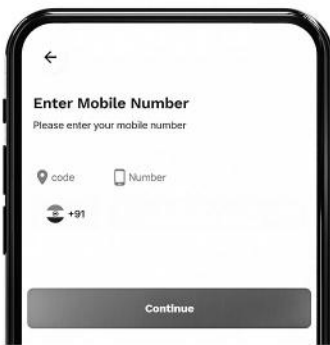
To install the app, scan the QR code with your mobile phone camera or Google Lens



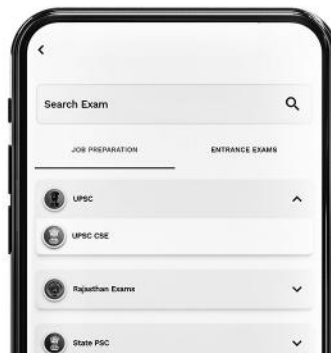
**ToppersNotes Exam
Preparation app**



Download the app from Google play store



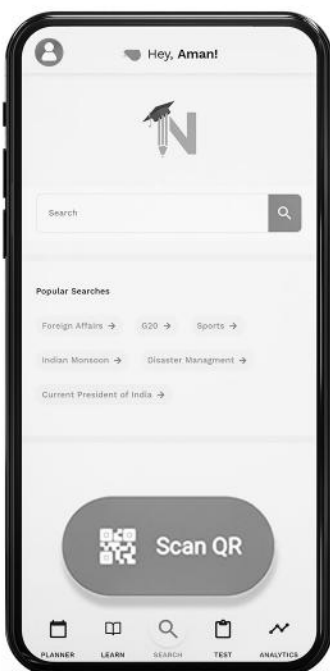
To Login enter your phone number



Choose your exam



Click on search Button



Click on Scan QR



Choose the QR from book



- Solution Videos
- Concept Videos
- Doubt Videos



- Additional Learning Material



- Topic wise practice
- Weakness analysis



- Rank Predictor
- Test Practice

For any help,
 write us at hello@toppersnotes.com or
 whatsapp on [7665641122](https://wa.me/917665641122).

1 CHAPTER

Ecology



Ecology

'Ecology' - Greek words- 'Oikos = household + 'logos' = learning about the ecosystem.

Scientific **study of the interactions** between organisms and their environment.

First coined by **Ernst Haeckel in 1869**.

Objective- to **improve the understanding of different life processes, adaptations and habitats, interactions, and biodiversity** of organisms.

Types of ecology

- Autoecology: Study of individual organism or individual species
- Synecology: Study of group of organisms of different species which are associated together as a unit in the form of a community.

Levels of Ecological Organisations

1. Species/ Individual

- **Features:**
 - **Similar genetic makeup**
 - **Can interbreed and produce fertile offspring.**

Species Types	Features	Example
Keystone Species	<ul style="list-style-type: none"> • Determine the ability of a large number of other species to survive. • Extinction of keystone species → extinction of other species. 	Bees → pollination of fruits and flowers
Indicator Species	<ul style="list-style-type: none"> • indicator of the state/certain processes of/within an ecosystem • most sensitive species in a region. • early warning for ecological threat. 	Lichens - air pollution, Mayflies - quality of freshwater
Endemic Species	<ul style="list-style-type: none"> • Endemic to a region i.e. Exist only in one geographical region. 	Asiatic Lion - Gir forest Kashmir Stag - Kashmir valley
Invasive Alien Species	<ul style="list-style-type: none"> • non-native to an ecosystem • results in decline or total elimination of native species through competition, predation, or transmission of pathogens 	Prosopis juliflora Lantana Camara
Flagship/ Charismatic species	<ul style="list-style-type: none"> • iconic due to their unique appeal. • selected species that are raised to support biodiversity conservation. 	Panda , polar bears, lions, tigers , sea turtles etc.
Umbrella species	<ul style="list-style-type: none"> • Selected for making conservation-related decisions. • Protecting these species protects several other species that form the ecological community of its habitat. 	Spotted owl, Jaguar, Giant Panda
Dominant species	<ul style="list-style-type: none"> • Species having substantially higher abundance or biomass than other species in a community. • Exert a powerful control over the occurrence and distribution of other species. 	Tidal swamps in the tropics - dominated by species of mangrove (Rhizophoraceae).
Foundation species	<ul style="list-style-type: none"> • Play a major role in creating or maintaining a habitat that supports other species. 	Corals - produce the reef structures on which countless other organisms, including human beings, live.

Critical Link Species	<ul style="list-style-type: none"> Play an important role in supporting network species such as pollinators, dispersal agents, etc. 	Mycorrhizal fungi helps vascular plants in obtaining inorganic nutrients from soil and organic residues.
Edge Species	<ul style="list-style-type: none"> Found abundantly in an ecotone boundary. 	Birds

2. Population

- Community of interbreeding organisms (same species), occupying a **defined area during a specific time**.
- Population Growth:**
 - Variation in population** (Increase or decrease) **when measured at two different times**.
 - Can either be **positive or negative**.
 - Main **factors behind increase**- birth and **immigration**.
 - Main **factors behind decrease** - death and **emigration**.

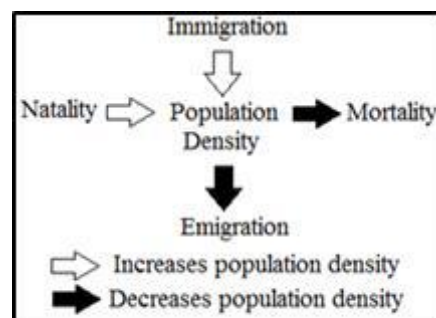


Fig.1

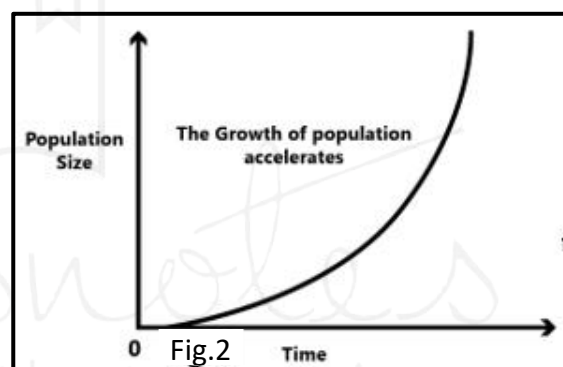
Biotic Potential

- Maximum rate at which a population can increase when resources are unlimited and environmental conditions are ideal

Patterns of Population Growth:

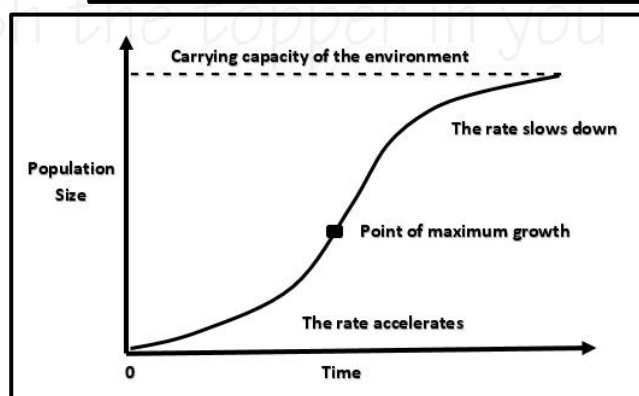
1. Exponential (Unrestricted) Growth:

- Occurs when there is **no limitation on growth** within the environment.
- 'J' shaped curve.
- Ex. **Water hyacinth/ Eichhornia Crassipes** (invasive species, lacks natural predators in India, no control on growth, aka **terror of Bengal**)



2. Logistical Growth/adapted Growth (K= Carrying Capacity):

- Population size \propto carrying capacity of the environment.
 - Carrying capacity (K):** maximum stable population size that a particular environment can support over a relatively long period of time.
- 'S' shaped curve.



"Define the concept of carrying capacity of an ecosystem as relevant to an environment. Explain how understanding this concept is vital while planning for the sustainable development of a region."
 UPSC 2019

3. Community

- Different species occupying a defined area during a specific time.**
- Usually named after dominant plant form.**
- Neither fixed nor rigid.**
- Can be small or large.**

- **Classification based on size and level of relative autonomy:**

- **Major Community -**
 - **Large Sized**
 - **Well Organized**
 - **Relatively independent**
 - **Only dependent on Sun's energy**
 - **Free of input and outputs of adjoining communities**
- **Minor Community -**
 - **Dependent on adjoining communities.**
 - **Often called societies.**
 - **Not independent completely**

4. Secondary aggregations within a major community
Ecosystem

- **A functional unit where living organisms interact among themselves and with the surrounding physical environment.**

5. Biome

- **Large naturally occurring community of flora and fauna occupying a major habitat.**
- **Plants and animals in a biome have common characteristics due to similar climate.**
- **A biome can comprise a variety of habitats.**
- **E.g. Rainforest biome or tundra biome.**

	Biome	Ecosystem
Definition	Region of vegetation and animals determined by climate and latitude	Interaction among organism in a set area
Climate	Strongly influenced by climatic factors like rainfall and temperature	Not strongly influenced by climatic factors like rainfall and temperature
Latitude	Specifically influenced	Not specifically influenced
Size	Very large, covering vast distances	Small, not covering vast distances
Animal life	Do not necessarily interact with each other	Always interact with each other in trophic levels and food webs
Examples	Tropical rainforest	Coral reef ecosystem

Major Biomes of the world, PRE 2021

Biomes	Subtypes	Regions	Climatic Characteristics	Soil	Flora and Fauna
Tropical	Equatorial Forest	10° N-S	Temp. 20-25°C, evenly distributed	Acidic, poor in nutrients	Multi- layered canopy tall and large trees
	Tropical Deciduous Forest	10°-25° N-S	Temp. 25-30°C, Rainfall: 1,000mm, seasonal	Rich in nutrients	Less dense, trees of medium height; many varieties coexist. Insects, bats, birds and mammals are common species in both
	Temperate Forest	Eastern North America, N.E. Asia, Western and Central Europe	Temp. 20-30° C, Rainfall evenly distributed 750-1,500 mm, Well defined seasons	Fertile, enriched with decaying litter	Moderately dense broad leaves. Less diversity of plant species. Oak, Beach, Maple etc. are some common species. Squirrels, rabbits, skunks, birds, black bears, mountain lions etc.
	Boreal Forest	Eurasia and North America (Siberia, Alaska, Canada, and Scandinavia)	Short moist moderately warm summers and long cold dry winter. Mostly snowfall	Acidic, poor in nutrients, thin soil cover	Evergreen conifers like pine, fir and spruce etc. Woodpeckers, hawks, bears, wolves, deer, hares and bats are common animals
Desert	Hot and Dry	Sahara, Kalahari, Thar, Rub-al-Khali	Temp. 20 - 45°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Scanty vegetation; few large mammals, insects, reptiles and birds
	Semi arid	Marginal areas of hot deserts	Temp. 21 - 38°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Scanty vegetation; few large mammals, insects, reptiles and birds
	Coastal	Atacama	Temp. 15 - 35°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Scanty vegetation; few large mammals, insects, reptiles and birds
	Cold	Tundra regions	Temp. 2 - 25°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Rabbits, rats, antelopes and ground squirrels
Grassland	Tropical Savannah	Large areas of Africa, Australia, South America and India	Warm hot climates, Rainfall 500-1,250 mm	Porous with a thin layer of humus.	Grasses; trees and large shrubs absent; giraffes zebras, buffalos, leopards, hyenas, elephants, mice, moles, snakes and worms etc., are common animals
	Temperate Steppe	Parts of Eurasia and North America	Hot summers and cold winters, Rainfall 500 - 900 mm	Thin flocculated soil, base rich	Grasses; occasional trees such as cottonwoods, oaks and willows; gazelles, zebras, rhinoceros, wild horses, lions, varieties of birds, worms, snakes etc.

Aquatic	Freshwater	Lakes, streams, rivers and wetlands	Temp. vary widely with cooler air temperatures and high humidity	Swamps and marshes	Algal and other aquatic and marine plant communities with varieties of water dwelling animals
	Marine	Oceans, coral reefs, lagoons and estuaries	Temp. vary widely with cooler air temperatures and high humidity	Tidal swamps and marshes	Algal and other aquatic and marine plant communities with varieties of water dwelling animals
Altitudinal	-----	Slopes of high mountain ranges like Himalayas, Andes and Rockies	Temperature and precipitation vary depending upon latitudinal zone	Regolith over slopes	Deciduous to tundra vegetation varying according to altitude

Homeostasis

- Resistance to change.
- A **mechanism used by organisms to control their internal environment** despite a change in the external environment **through physiological, morphological, and behavioral processes.**
- A self-regulating process **essential for survival.**
- **Eg.** During summers, humans tend to sweat to regulate their body temperatures

- It is the zone where life exists.
- **Complicated and interconnected web that links all organisms with their physical environment.**
- Stretches out from the lower part of sea channels to around 8 km over the ocean level.
- A zone of cooperation between the other 'spheres'.
- **Only the biosphere has water in liquid form**
- **Transfer of energy and the cycling of minerals takes place.**

6. Biosphere/Ecosphere:

- Narrow zone where **all the spheres of the earth co-exist.**

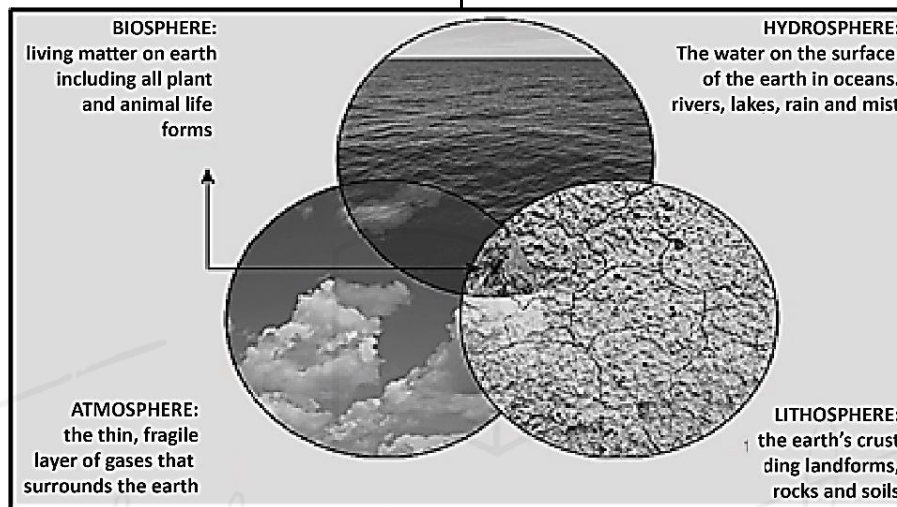


Fig 4

Difference between Ecology, Ecosystem, and Environment

- **Environment** - surroundings, or the area in which living organisms survive
- **Ecosystem**- functional unit of the environment - composed of biotic and abiotic components and their relationships with each other.
- **Ecology**- scientific study of the interactions between organisms, their surroundings occurring within an ecosystem or environment.

Species

Ecological Amplitude

- Every species has a specific range within which it can tolerate ecological changes



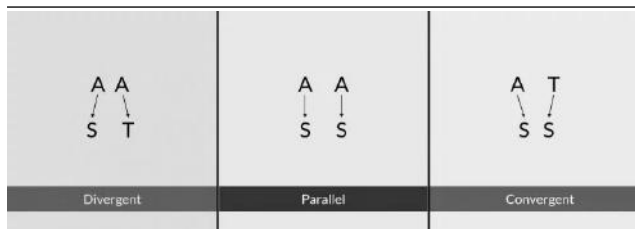
Evolution

- **The process of species' features developing over time.**
- **Gradual change in the characteristics of population** that occurs over the course of successive generations as a result of natural selection.

- **Accounts for speciation and extinction, progressive changes as a result of natural selection, as well as the diversity of organisms of supposed common ancestry across geological time.**

Types :

- **Convergent evolution**
 - Process by which **two or more unrelated species develop similar traits in different types of environment.**
 - **Eg. Whales and penguins** have decreased limbs and have evolved comparable adaptation features
- **Divergent evolution**
 - Occurs when a single species branches off into more than one
 - Eg. Darwin's Finches
- **Parallel evolution**
 - Happens when two independent species evolve separately while preserving a high level of resemblance.
 - Eg. The woolly mammoth and elephant



- **Coevolution**
 - Evolution of two biologically-related taxonomic groups at the same time.
 - Eg. blooming plants and the insects that pollinate them.

Adaptation

- Appearance, behaviour, structure, or manner of life of an organism that helps it to survive in a given environment.
- **Forms:**
 - **Morphological** — Giraffe's neck grow longer as the trees grew taller;
 - **Physiological** — In North American deserts, the kangaroo rat, in absence of an external source of water, is able to meet its water needs by oxidising the fat stored in its body;
 - **Behavioural** — Migration of animals to a less harsh environment.

Acclimatisation

Modest changes occurring in the body of an organism over a short period of time in order to overcome minor challenges caused by changes in the environment.

Eg. When we're climbing high mountains, we need to breathe more quickly. Our bodies acclimate to the new conditions on the high mountain after a few days.

Phenotypic Plasticity

Refers to the changes in an organism's behaviour, morphology and physiology in response to a unique environment.

Fundamental to the way in which organisms cope with environmental variation, phenotypic plasticity encompasses all types of environmentally induced changes (e.g. morphological, physiological, behavioural) that may or may not be permanent throughout an individual's lifespan. For example, genetically identical water flea (*Daphnia*) clones can differ in their morphology depending on whether they are reared in the absence or presence of a potential predator.

Variation

- Changes in genetic makeup caused by the addition or deletion of certain genes.

- **Causes:** Mutations, climatic change, geographical barriers, and other factors.
- Eg: Variance in skin colour, hair type (curly or straight), eye colour and blood type among ethnic groups.

Adaptive Radiation

- "Adaptive Radiation refers to the adaptation of an organism that enables them to spread successfully or radiate into other environments."
- Ex. Finch species found in the Galápagos Archipelago have evolved through adaptive radiation, resulting in the diversification of their beak forms, allowing them to utilise a variety of food sources.

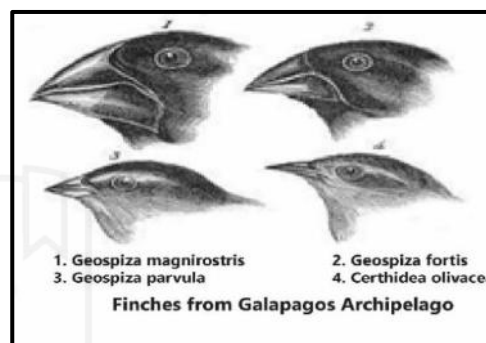


Fig. 5

Mutation

- Change in genetic material caused by an error in DNA replication.
- New genes emerge in a population as a result of mutation.
- Meiosis and fertilisation produce a new mix of genes in every generation, in a sexually reproducing population known as recombination.
- As a result, members of the same species are not similar and differ.
- **Causes of mutation:**
 - **Internal Causes:** When DNA fails to duplicate correctly.
 - **External Causes:** When the DNA is exposed to certain chemicals or radiations, that causes the DNA to break down.

Speciation

- Elaborate process of forming new species from other existing species.
- Includes splitting of one species into two or more genetically distinct species.
- Takes place through continuous mutation of genes.
- **Types:**
 - **Allopatric-** occurs when one particular species moves away from each other because of the geographical barrier, like waterways or mountain range.

- **Parapatric-** occurs when species sharing a common geographical area, breed only within their preferred region- show varied characteristics and nature.
- **Peripatric-** Happens due to change in habitation. However, in the process, they gain several character traits and pass on their offspring.
- **Sympatric-** When several members of a species are living closely. However, they **mate with other members based on specific food habits or environment**.
- **Artificial-** Results from lab experiments and scientific advancement. Humans carry research work on other living organisms like fruit flies and create new species.

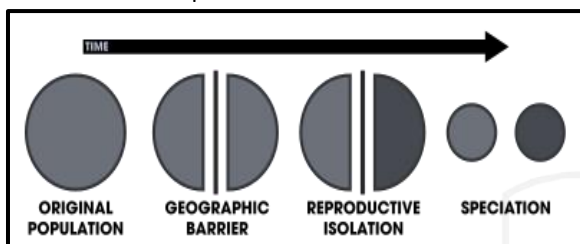


Fig. 6

Extinction

- Process of evolution that leads to the disappearance of a population or species.”
- **Over 99% of all the species that once lived on the Earth** amounting to over five billion species are estimated to have been extinct.
- **Types:**
 - **Natural Extinction:** May occur due to tectonic movement, a spike in volcanic activity or global warming
 - **Artificial Extinction:** May be induced by humans
- **Direct causes - Hunting, collecting, or capturing as well as persecution**
- **Indirect causes - Habitat loss, change and fragmentation**, as well as the introduction of exotic species

Biotic Interactions

Type	Species A	Species B	Interaction
Mutualism	+	+	Obligate Mutualism: <ul style="list-style-type: none"> ● Neither can survive without the other, ● Ex. algae and coral polyps (Zooxanthellae algae does photosynthesis and supplies food to coral polyps and coral polyps in turn provide shelter to the algae) Facultative Mutualism (Proto-cooperation): <ul style="list-style-type: none"> ● One species may survive without the other, ● Ex. Hermit crab and Sea anemone (Sea anemone grows on the back of the Hermit crab, providing camouflage and protection. In turn, the sea anemone is transported to areas of new food sources)
Commensalism	+	0	<ul style="list-style-type: none"> ● One is benefited from the other while the other remains unaffected ● Ex. Cattle egrets (a type of bird) live near cattle because when cattle graze, their movement stirs up insects. The birds have their insects and cattle are unaffected.
Parasitism	+	-	<ul style="list-style-type: none"> ● One is benefited while the other is harmed ● Ex. Fleas are present on the body of dogs. They get shelter and food from them while they harm their host by biting them, sucking their blood and causing itching.
Predation	+	-	<ul style="list-style-type: none"> ● One survives by eating the other and in its absence dies itself. ● Ex. Lion and Deer
Competition	-	-	<ul style="list-style-type: none"> ● Adversely affects both the species. Occurs when resources are scarce. ● inter-specific (within different species- ex. Lion and Cheetah competing for deer)



			<ul style="list-style-type: none"> • intra-specific (within same species- ex. Monkeys fighting for fruits)
Neutralism	0	0	<ul style="list-style-type: none"> • None is affected by the association.
Amensalism	-	0	<ul style="list-style-type: none"> • One is harmed while the other remains unaffected • Ex. Algal bloom kills fishes but algae does not benefit from the death of fishes.

*0 = No effect on species, + = beneficial for species, - = harmful to the species

Ecotone

- **Transition area between two biomes** (diverse ecosystems).
- Zone where **two communities meet and integrate**.
- **Eg. the mangrove forests** - ecotone between marine and terrestrial ecosystem, **grassland** (between forest and desert), **estuary** (between freshwater and saltwater) and **marshland** (between dry and wet).



Characteristics of Ecotone

- **Zone of tension** that contains **features of both bordering communities and some species** not found in the overlapping communities.
- **May be narrow** (grassland and forest) or **broad** (forest and desert).
- **Incoming community** - number and **density of species increases**
- **Outgoing community** - number and **density of species decreases**.
- **Well-developed ecotone** - when some organisms are entirely different from adjoining communities.

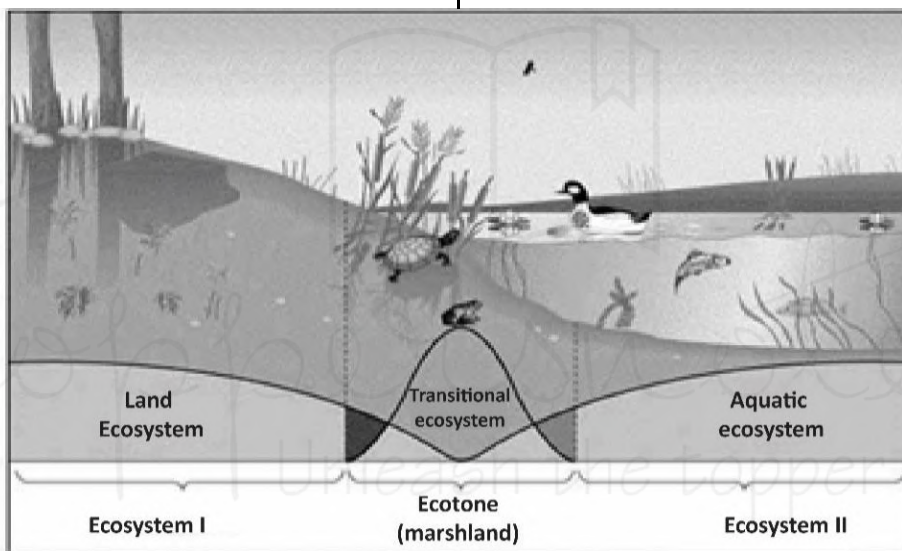


Fig. 7

Ecocline

- **Zone of gradual but continuous change from one ecosystem to another** when there is no sharp boundary between the two in terms of species composition.
- Occurs **across the environmental gradient** (gradual change in abiotic factors such as altitude, temperature (thermocline), salinity (halocline), depth, etc.).

Ecophene or Ecads

- These are variations in **phenotypes** (observable physical characteristics)

- Eg. Indian living in Africa will have higher melanin in skin than one living in India

Ecotype

A group of organisms, normally a subdivision of a species, that is adapted to a specific environment.

- It occurs when ecophenes remain in their new environment for too long
- The morphological changes become genetically fixed.

Edge Effect

- When the **number and population density of species in the ecotone >> either community** - edge effect.

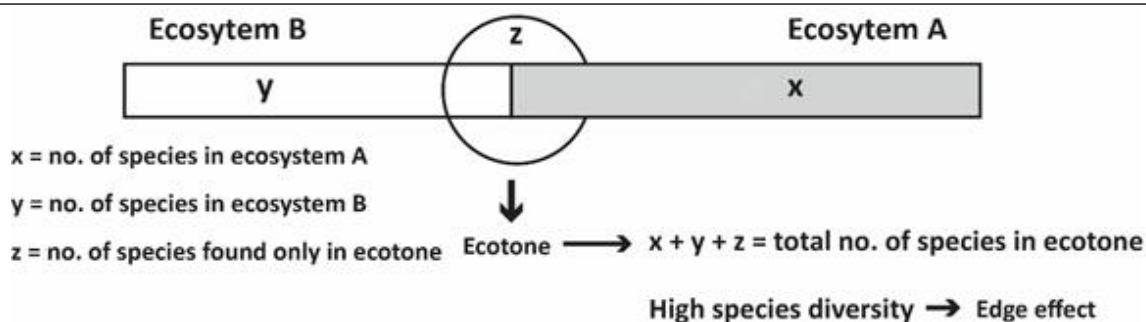


Fig.8

- Eg. The density of birds is greater between forest and desert.

Edge Species

Species that occur primarily or most abundantly in the ecotone.

Ecological Niche

- Joseph Grinnell has defined Ecological Niche as the sum of the habitat requirements and behaviours that allow a species to persist and produce offspring
- Unique functional role of a species in an ecosystem

Components of Niche

- Habitat:** Environment in which an organism lives ; supplies all the required factors for the existence of a species.
- Food:** Food resources that the species obtains from its environment.
- Environmental condition:** Physical and chemical factors (temperature, soil, humidity).
- Relationships:** Interaction of species with other organisms in the ecosystem

Types of Ecological Niche:

- Habitat niche** – where it lives,
- Food niche** – what it eats or decomposes & what species it competes with,
- Reproductive niche** – how and when it reproduces,
- Physical & chemical niche** – temperature, land shape, land slope, humidity & another requirement.

- Fundamental Niche-** Niche that would prevail in the absence of competition and limiting factors - theoretical in nature.
- Realized Niche-** Due to competition for resources from other members, a species only occupies a part of its niche- species live in it
- Fundamental niche is always > realized niche.

Characteristics of Niche

- Describes organism's life history, habitat, interactions with other species and its place in the food chain
- Affected by physical conditions of an area
- Changes with the change in physical and biological factors
- Species commonly do not exploit their entire niche due to the presence of other species.
- No two species can have exactly identical niches.
- If so happens, there will be competition for the available resources and the less well-adapted species will be eliminated.

Niche vs Habitat

Habitat	Niche
Refers to the place where species live	Role played by species in an environment
Too many species, occupy a single habitat	No two species can have the same niche

Ecological Succession

- Process by which communities of plant and animal species in an area are replaced or changed into another over a period of time.
- A universal process of directional change in vegetation, on an ecological time scale.
- Occurs due to large scale changes or destruction (natural or manmade).
- Involves a progressive series of changes with one community replacing another until a stable, mature, climax community develops.



Stages of Succession

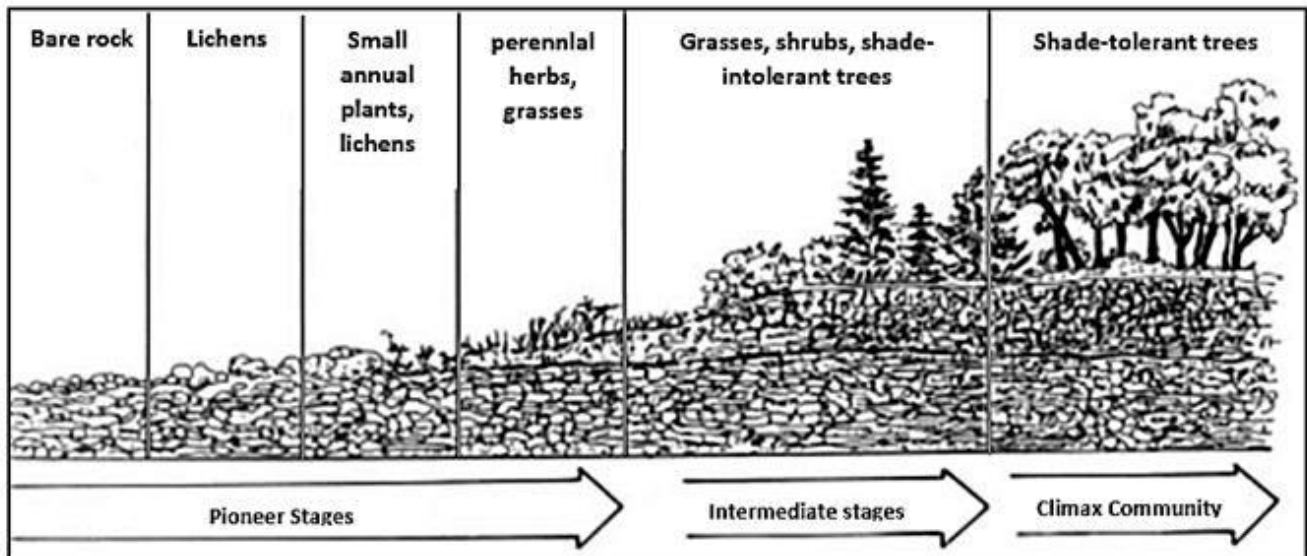


Fig. 9

- **Pioneer community**- First plant to colonize an area.
- **Climax community**- Final stage of succession- stable, mature, more complex and long-lasting.
- **Successional stages or seres** - stage leading to the climax community.
- Each **transitional community** that is formed and replaced during succession is known as **stage in succession** or a **seral community**.
- **Succession is characterized by:**
 - Increased productivity
 - Shift of nutrients from the reservoirs
 - Increased diversity of organisms
 - Gradual increase in the complexity of food webs.
- **Faster in areas existing in the middle of the large continent** because here seeds of plants belonging to the different species would reach much faster.

Types of Ecological Succession

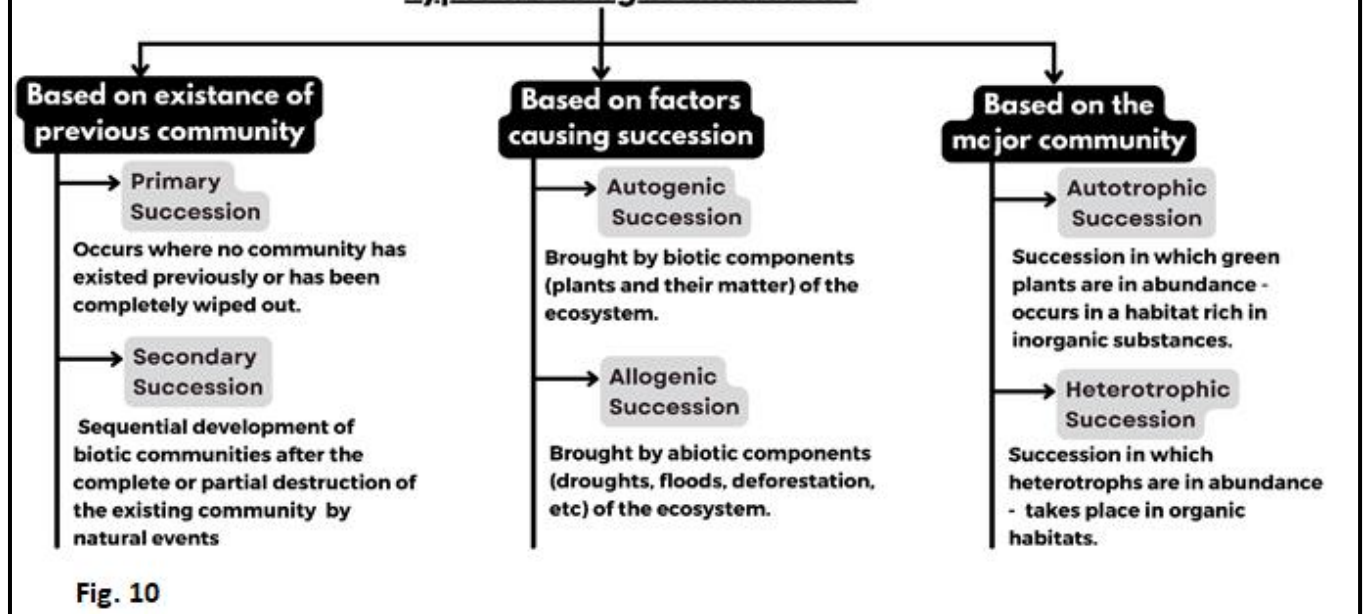


Fig. 10

1. Primary Succession

- Occurs **where no community has existed previously** or has been completely **wiped out**.
- Terrestrial site** is first **colonized by a few hardy pioneer species** (microbes, lichens and mosses).

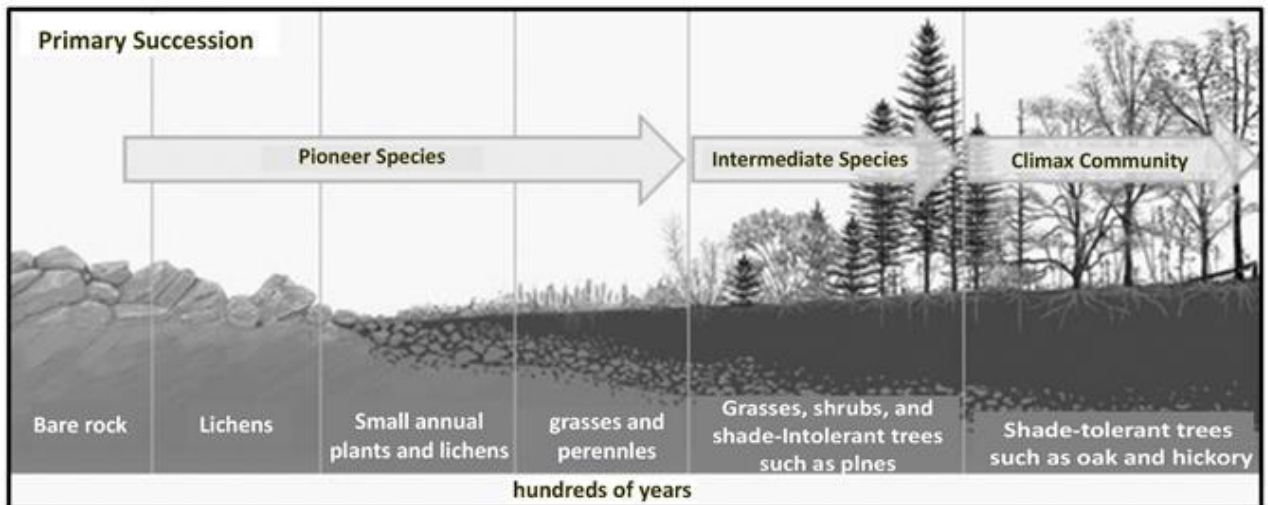


Fig. 11

- Successful colonisation of plants is **followed by animals, insects, birds and small invertebrates**.
- Areas of occurrence** - rock outcrops, newly formed **deltas and sand dunes**; emerging **volcano islands and lava flows**, glacial **moraines** (muddy area exposed by a retreating glacier), etc.

2. Secondary Succession

- Sequential development of biotic communities **after the complete or partial destruction** of the existing community by natural events (floods,

droughts, fires, or storms or by human interventions such as deforestation, overgrazing)

- Abandoned land** is first **occupied by hardy species of grasses** (that can survive in harsh conditions).
- Followed by tall grasses and herbaceous plants** along with **mice, rabbits, insects and seed-eating birds**.
- Eventually, **some trees grow**, seeds of which may be brought by wind or animals.
- Abandoned land** with time becomes dominated by trees and is **transformed into a forest**.

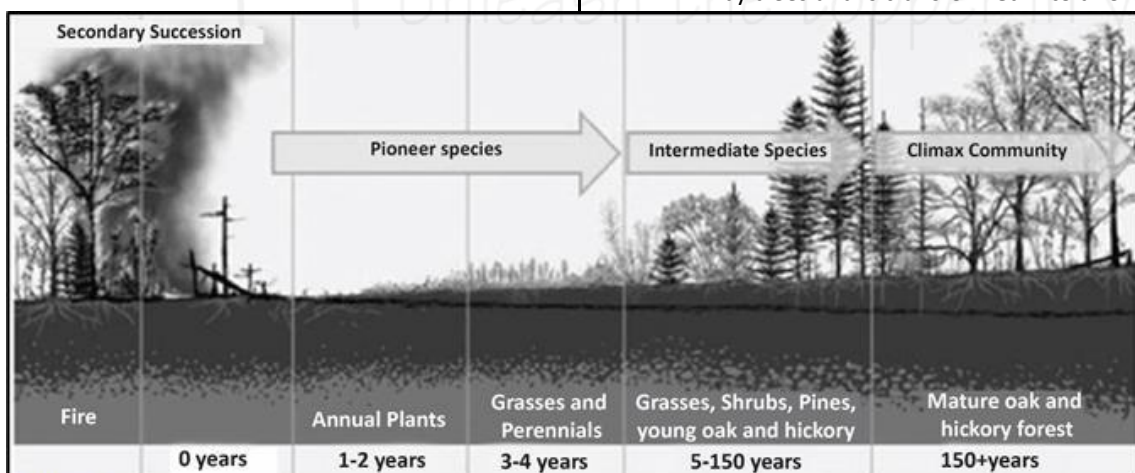


Fig. 12

Difference between Primary and Secondary Succession

Primary Succession	Secondary Succession
Soil is gradually developed.	Soil is well developed
Progress of succession is slow	Progress of succession is fast

Develops on a barren area	Develops on a disturbed area
Pioneer species come from the outside	Pioneer species come from within

Note:

Cyclic Succession

- Change in the structure of an ecosystem on a cyclic basis.
- Some plants remain dormant for the rest of the year and emerge all at once.
- Drastically changes the structure of an ecosystem.

Succession in Plants

- **Xerarch-** Succession that occurs on land (dry areas) where **moisture content is low**. Eg. on a **bare rock**.
- **Hydrarch-** Succession that takes place in a **water body**. Eg. **ponds or lake**.
- Hydrarch and xerarch succession **lead to medium water conditions** (mesic) – neither too dry (xeric) nor too wet (hydric).



2 CHAPTER

Ecosystem



Toppers' Analysis

Weightage from the Exam's point of view:

Prelims: 10-20% of total questions asked from the Environment.

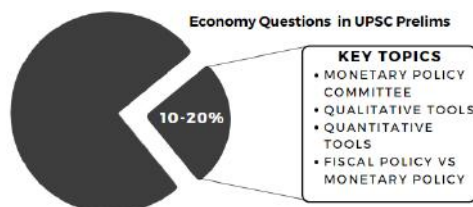
Mains: Rare chance of direct questions being asked from the chapter, but a current Based Question can be asked.

Pre-requisite of the Chapter:

Class 12 NCERT Biology -Chapter-14

This chapter is crucial to building basic concepts of environment and is highly recommended for understanding day-to-day economic changes.

Aspirants must read this chapter before reading Newspapers and track regular policy changes.



Ecosystem Pre-2013,2015,2016, 2017

- A functional unit where organisms interact among themselves and with the surrounding physical environment.

PSC Pre – 2015,
2029

- Can be of any size but usually encompasses specific and limited species.
- Every organism in an ecosystem is dependent on other species and elements in that ecological community.
- If one part of an ecosystem is damaged, it has an impact on everything else.

Components of an Ecosystem

Biotic Components

Autotrophs

Produce their own food using light, water, CO₂, etc.

Photoautotrophs

Use sunlight to prepare their own food

Chemoautotrophs

Produce energy from CO₂ using inorganic energy sources

Heterotrophs

They take nourishment from others as they are not capable of making their food

Herbivores

Feed directly on plants. Eg: Cow, Goat, grasshopper, etc.

Carnivores

Feed on primary consumers. Eg: foxes, snakes, etc.

Top Carnivores

Feed on secondary consumers Eg: Hawk, Tiger, Lion, etc.

Omnivore

Eat both plants and animals. Eg: Crows, rats, etc.

Saprotrophs

Feed on dead organic matter generated from plants and animals

Decomposers

Microorganisms that feed on and decompose dead organic material. Release simple inorganic and organic substances to the environment as by-products resulting in the recycling of nutrients.

Detritus Feeders

Small animals, like earthworms, mites, etc., feed on partially decomposed organic material. Contribute to the breakdown of detritus.

UPSC Pre - 2021

Phototropism

- **Directional growth** of plants and other organisms in response to light.
 - **Positive Phototropism:** towards the source of light
 - **Negative Phototropism:** away from the source of light

Photoperiodism:

- **Physiological reaction** of organisms to the length of day or night.
- **Ex.** Long-day plants (Spinach, sugar beet), Short-day plants (soybean, chrysanthemum) and day-neutral plants (sunflower, corn).

Abiotic Components

- **Consist of non-living things**, like rocks, soil, minerals, water, etc.
- **Serve as sources of nutrients** essential to the growth & metabolism of an organism.

Sun Light

- Solar radiation = primary source of energy
- Necessary for photosynthesis
- On the basis of light requirement plants are of following types:
 - **Heliophytes:** require full Sunlight for growth (ex. Sunflower)
 - **Sciophytes:** grow best in shady conditions (ex. Sandal tree)

Temperature

- Affects the **kinetics** of enzymes and **basic metabolism** of the organism

Note:

Depending on the temperature tolerance capability, organisms are:

- **Eurythermal:** tolerate a **wide range of temperatures** (ex. Cat, Dog, Tiger etc.)
- **Stenothermal:** restricted to a **narrow range of temperature** (ex. Penguin, Python, Crocodile etc.)

Water

- Used by plants to distribute the nutrients to survive.

Note:

On the basis of water requirement plants are of following types:

- **Hydrophytes:** adapted to grow well in water. (ex. Lotus, water lily, sea weeds)
- **Mesophytes:** average water requirements. (ex. Rose)
- **Xerophytes:** adapted themselves to survive in water scarce areas like Deserts. (ex. Cactus, Pineapple)

On the basis of tolerance to salinity, organisms are of following types:

- **Euryhaline:** tolerant to a **wide range of salinity** (ex. Green crab)
- **Stenohaline:** tolerant to **narrow range of salinity** (ex. Goldfish)

Atmospheric Gases

Important for various biological processes necessary for organisms' growth and survival.

- Oxygen (required for respiration),
- Carbon dioxide (required by plants for photosynthesis),
- Nitrogen (required by plants as a macronutrient)

Wind

- A **natural thermal regulator**
- Aids in **seed dispersal**
- Negative effects of wind include soil erosion, forest fires.

Soil or Edaphic factor

- **Acts as a provider of important nutrients** for the plants.
- **Anchors the plants to keep them in place to grow.**
- Soil also **absorbs and holds water** for plants and animals.

Physiographic Factor

- **Altitude:** determines temperature- influences vegetation
- **Latitude:** variation in availability of insolation, climate, etc.
- **Slopes:** slope direction influences the availability of sunlight.