# Savitribai Phule Pune University

***(Formerly University of Pune)***

**Three Year B.Sc. Degree Program in Zoology**

**(Faculty of Science & Technology)**

# F.Y.B.Sc. Zoology

## Choice Based Credit System Syllabus

**to be implemented from**

## Academic Year 2019-2020

**Preamble:**

Zoology is one of the major subjects of Basic Sciences and deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. A zoology student needs to gain understanding of many areas of the subject to keep pace with advancements in Life Sciences.

This under-graduate degree program has been designed by the Board of Studies in Zoology of Savitribai Phule Pune University with a substantial component of what is needed from zoologists as a skilled career and what zoologists need to pursue for post-graduation and further academic studies. It follows the guidelines laid down by the University Grants Commission, New Delhi. This newly designed curriculum is a perfect blend of the classical aspects in Zoology and the advanced and more specialized areas.

This degree offers Discipline Specific Core Courses **[CC]** in Animal Systematics, Animal Ecology, Animal Cell biology, Applied Zoology, Pest Management, Histology, Biological Chemistry, Genetics, Developmental Biology, Parasitology, Medical & Forensic Zoology, Animal Physiology, Molecular Biology, Entomology, Techniques in Biology and Evolutionary Biology.

In addition to the Core Courses, Ability Enhancement Compulsory Courses **[AECC]** have been added in the second year i.e. Semester III and Semester IV of the undergraduate course. In the third year i.e. Semester V and Semester VI, Discipline specific Elective Courses **[DSEC]** and Skill Enhancement Courses **[SEC**] have been offered. The students, therefore, have an opportunity to take courses in Environment Awareness, Language communication: English/Marathi, Aquarium Management, Poultry Management and Environmental Impact Assessment. In Semester VI the students also have a course dedicated to Project work.

The syllabus has been framed in such a way that the student gains each year, a broader perspective of the subject as he progresses towards completion of the degree program. Field trips, Educational visits and the Project work have been included for the student to experience the applications of the theory learnt in the classroom.

After completion of the program, it is expected that students will understand and appreciate: animal diversity, few applications of Zoology, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, and basic concepts of human health. The students would also gain an insight into laboratory and field work through the practical course, field work and the project.

While presenting this new syllabus to the teachers and students of F.Y.B.Sc. Zoology, I am extremely happy to state that efforts have been made to seek inputs of all the stake holders to make it more relevant.

The new course that will be effective from the academic year 2019- 2020 and will follow the Choice Based Credit System in a Semester mode. It has been primed keeping in view the distinctive requirements of B.Sc. Zoology students. The contents have been drawn-up to accommodate the widening prospects of the discipline of Life Sciences. They reflect the changing prerequisites of the students. This program has been introduced with 132 credits for the subject group while 08 credits to earn from any of the 08 groups offering a range of curricular, cocuricular and extracurricular activities. This pattern has been specially aimed towards the overall development of the students'. The calculation of credits and CGPA will be as per the guidelines of the University. The B.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills. The Syllabus has been revised with the following aims

- To foster curiosity in the students for Zoology
- To create awareness amongst students for the basic and applied areas of Zoology
- To orient students about the importance of abiotic and biotic factors of environment and their conservation.
- To provide an insight to the aspects of animal diversity.
- To inculcate good laboratory practices in students and to train them about proper
- handling of lab instruments.

# 1. Course Structure:

## Course Structure with Credit Distribution of the Undergraduate Science Program in Zoology

| Course | Course Code and Name of the Course | | Credits |
|---|---|---|---|
| **F.Y.B.Sc.** | **SEMESTER I** | **SEMESTER II** | |
| CC | ZO-111 Animal Diversity I | ZO-121 Animal Diversity II | 2+2 |
| CC | ZO-112 Animal Ecology | ZO-122 Cell Biology | 2+2 |
| CC | ZO-113 Zoology Practical Paper | ZO-123 Zoology Practical Paper | 1.5 +1.5 |
| **S.Y.B.Sc.** | **SEMESTER III** | **SEMESTER IV** | |
| CC | ZO-231 Animal Diversity III | ZO-241 Animal Diversity IV | 2+2 |
| CC | ZO-232 Applied Zoology I | ZO-242 Applied Zoology II | 2+2 |
| CC | ZO-233 Zoology Practical Paper | ZO-243 Zoology Practical Paper | 2+2 |
| AECC | EVS 231-Environment Awareness | EVA 241-Environment Awareness | 2+2 |
| AECC | LA 231-English/Marathi | LA 241- English /Marathi | 2+2 |
| **T.Y.B.Sc.** | **SEMESTER V** | **SEMESTER VI** | |
| DSEC | ZO-351 Pest Management | ZO-361 Medical & Forensic Zoology | 2+2 |
| DSEC | ZO-352 Histology | ZO-362 Animal Physiology | 2+2 |
| DSEC | ZO-353 Biological Chemistry | ZO-363 Molecular Biology | 2+2 |
| DSEC | ZO-354 Genetics | ZO-364 Entomology | 2+2 |
| DSEC | ZO-355 Developmental Biology | ZO-365 Techniques in Biology | 2+2 |
| DSEC | ZO-356 Parasitology | ZO-366 Evolutionary Biology | 2+2 |
| DSEC | ZO-357 Zoology Practical Paper 1 | ZO-367 Zoology Practical Paper 1 | 2+2 |
| DSEC | ZO-358 Zoology Practical Paper 2 | ZO-368 Zoology Practical Paper 2 | 2+2 |
| DSEC | ZO-359 Zoology Practical Paper 3 | ZO-369 Zoology Practical Paper 3 | 2+2 |
| SEC | ZO-3510 Aquarium Management | ZO-3610 Environmental Impact Assessment | 2+2 |
| SEC | ZO- 3511 Poultry Management | ZO-3611 Project | 2+2 |

## Detailed Syllabus of F.Y.B.Sc.

| Paper | Semester I Course Code & Course | Credits | No of Lectures | Marks (Internal + University) | | SemesterII Course Code & Course | Credits | No of Lectures | Marks (Internal + University) |
|---|---|---|---|---|---|---|---|---|---|
| I | ZO-111 Animal Diversity I | 02 | 30 | 15+ 35= 50 | | ZO-121 Animal Diversity II | 02 | 30 | 15+ 35 = 50 |
| II | ZO-112 Animal Ecology | 02 | 30 | 15+ 35 = 50 | | ZO-122 Cell Biology | 02 | 30 | 15+ 35 = 50 |
| III | ZO-113 Zoology Practical Paper | 01 | 15 practical | 15+ 35 = 50 | | ZO-123 Zoology Practical Paper | 01 | 15 Practical | 15+ 35 = 50 |

| Course No. | Course Title | Total Number of lectures/practical per Term | **Standard of passing** | | |
|---|---|---|---|---|---|
| | | | **Internal marks** | **University marks** | **Total marks** |
| ZO-111 (First term) | Animal Diversity–I | Three lectures/Week (Total 30 lectures per term) | 15 | 35 | 50 |
| ZO-121 (Second term) | Animal Diversity-II | Three lectures/Week (Total 30 lectures per term) | 15 | 35 | 50 |
| ZO-112 (First term) | Animal Ecology | Three lectures/Week (Total 30 lectures per term) | 15 | 35 | 50 |
| ZO-122 (Second Term) | Cell Biology | Three lectures/Week (Total 30 lectures per term) | 15 | 35 | 50 |
| ZO-113 (First term) | Zoology Practical Paper | Practical session of 3 hours. 15 Practicals | 15 | 35 | 50 |
| ZO-123 (Second Term) | Zoology Practical Paper | Practical session of 3 hours. 15 Practicals | 15 | 35 | 50 |

**Animal Diversity I & II**

**Objectives:**

1. To understand the Animal diversity around us.
2. To understand the underlying principles of classification of animals.
3. To understand the terminology needed in classification.
4. To understand the differences and similarities in the various aspects of classification.
5. To classify invertebrates and to be able to understand the possible group of the invertebrate observed in nature.to understand our role as a caretaker and promoter of life.

**Learning outcomes for the course:**

1. The student will be able to understand classify and identify the diversity of animals.
2. The student understands the importance of classification of animals and classifies them effectively using the six levels of classification.
3. The student knows his role in nature as a protector, preserver and promoter of life which he has achieved by learning, observing and understanding life.

**Course Title: Animal Diversity –I**

**Course Code-ZO-111**

**Semester I** **(2 credits-30 lectures)**

| No. | Title & Contents | Number of lectures |
|---|---|---|
| 1. | **Principles of Classification:** | **(05)** |

Taxonomy & Systematics

1.1 Taxonomy: Basic terminology and Introuction

- Alpha, Beta and Gamma levels of taxonomy, Micro-taxonomy
- Macro taxonomy: Phenetics (numerical taxonomy, Cladistics (Phylogenetic systematics), Evolutionary taxonomy (evolutionary systematics)
- Classical taxonomy and experimental or neo taxonomy (biochemical taxonomy and Cytotaxonomy)
- Significance of Taxonomy

1.2 Systematics: definition introduction

1.3 Linnaean system of classification (Six level classification: Phylum, class, order, family, genus, species)

1.4 Concept of Species: Biological & Evolutionary

1.5 Introduction to Binomial Nomenclature.

1.6 Introduction to Five kingdom system.

2. **General Features of kingdom Animalia** **(02)**

2.1 General characters of Kingdom Animalia, Grades of organization

2.2 Symmetry.

3. **Kingdom Protista (Phylum: Protozoa)** **(07)**

3.1 Introduction to Phylum Protozoa

3.2 Salient features of Phylum Protozoa

3.3 Classification of Phylum Protozoa up to classes with two examples of each class (names only).

Class Rhizopoda (e.g :*Entamoeba histolytica*, *Arcella*),

Class Mastigophora (e.g: *Euglena viridis*, *Trypanosoma gambiense*),

Class Ciliata (e.g *Paramoecium caudatum*, *Opalina ranarum*),

Class Sporozoa (e.g *Plasmodium vivax*, *Toxoplasma gondii*)

3.4 Locomotion in Protozoa: Amoeboid, Ciliary and Flagellar with suitable examples

3.5 Type Study: ***Paramecium caudatum***: Classification, Habit and Habitat, External morphology, Feeding and digestion, Excretion, Reproduction (binary fission and conjugation)

3.6. Economic importance of Protozoa (three harmful and one useful protozoan)

3.6.1-**Harmful Protozoa**:

*Plasmodium vivax* (malarial parasite),

*Entamoeba histolytica* (Amoebic dysentery),

*Trypanosoma gambiense* (Gambian sleeping sickness).

3.6.2- **Useful Protozoa**:

*Trichonympha*

4. **Origin of Metazoa** **(01)**

4.1 Introduction Origin and importance of Metazoa

5. **Phylum Porifera** **(06)**

5.1. Introduction to Phylum Porifera

5.2 Classification of Phylum Porifera up to classes with two examples of each class (names only, no description of specimens).

Class Calcarea (e.g.: *Leucosolenia, Sycon (Scypha)*

Class Hexactinellida (e.g: *Euplectella* (venus flower basket), *Hyalonema* (glass sponge))

Class Demospongiae (e.g: *Chalina* (Mermaid's gloves, *Spongilla* (fresh water sponge))

5.3 Canal system in sponges: Ascon, Leucon and Rhagon type.

5.4 Skeleton in sponges: Spicules, its types:

Microscleres & Megascleres,

Monoaxon – monactinal, diactinal, Amphidiscs, Triaxon, Polyaxon,

Spongin fibres.

5.5 Regeneration in sponges.

5.6 Economic importance of Phylum Porifera.

6. **Phylum: Cnidaria** **(05)**

6.1 Introduction to Phylum Cnidaria

6.2 Salient features of Phylum Cnidaria

6.3 Classification of Phylum Cnidaria up to class level with given examples each class (names of examples only)

Class Hydrozoa e.g.: Hydra, *Physalia* (Portuguese man of war)

Class Scyphozoa e.g: *Aurelia* (Jelly fish), *Leucernaria* (trumpet shaped Jellyfish)

Class Anthozoa: e.g; Metridium (Common sea anemone0

6.4 Polymorphism in Hydrozoa: Polyps & Medusa (polyp types: gastrozooids, dactylozooids, gonozooids) and functions

6.5 Economic importance of Cnidarians with reference to Corals and Coral reefs.

7. **Phylum Platyhelminthes** **(04)**

7.1 Introduction to Phylum Platyhelminthes

7.2 Salient features of Phylum Platyhelminthes

7.3 Classification of Phylum Platyhelminthes up to classes with two examples each class (names of examples only).

Class: Turbellaria (e.g: *Dugesia, Bipallium*)

Class: Trematoda (e.g*: Fasciola hepatica, Schistosoma haematobium*)

Class Cestoda: (*Taenia solium* (pork tape worm),*Echinococcus granulosus* (dog tapeworm)

7.4 Parasitic adaptations in Platyhelminthes: structural and physiological.

7.5 Economic importance of Platyhelminthes

**Course Title: Animal Ecology**

**Course Code: ZO 112**

**Semester I** **(2 Credits-30 Lectures)**

**Learning outcomes for the course:**

- The learners will be able to identify and critically evaluate their own beliefs, values and actions in relation to professional and societal standards of ethics and its impact on ecosystem and biosphere due to the dynamics in population.
- To understand anticipate, analyse and evaluate natural resource issues and act on a lifestyle that conserves nature.
- The Learner understands and appreciates the diversity of ecosystems and applies beyond the syllabi to understand the local lifestyle and problems of the community.
- The learner will be able to link the intricacies of food chains, food webs and link it with human life for its betterment and for non-exploitation of the biotic and abiotic components.
- The working in nature to save environment will help development of leadership skills to promote betterment of environment.

**ZO 112: Animal Ecology** **(2 Credits-30 Lectures)**

| No. | Topic & Content | Number of lectures |
|---|---|---|
| 1. | **Introduction to Ecology** | **(02)** |
| | 1.1 Concepts of Ecology, Environment, Population, Community, Ecosystem, Biosphere, Autecology and synecology. | |
| 2. | **Ecosystem** | **(08)** |
| | 2.1 Types of ecosystems: Aquatic (Freshwater, estuarine, Marine and terrestrial (Forest, Grassland and Desert) | |
| | 2.2 Structure and Composition of Ecosystem (Abiotic components and biotic components. | |
| | 2.3 Food chain: Detritus and grazing food chains, Food web, Energy flow through the ecosystem, Ecological pyramids: Number, Biomass, and Energy. | |
| | 2.4 concept of Eutrophication in lakes and rivers. | |
| 3 | **Population** | **(08)** |
| | 3.1Characteristic of population: Density, Natality, Mortality, Fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. | |
| | 3.2Exponential and logistic growth, | |
| | 3.3 Population regulation – density-dependent and independent factors. | |
| | Population interactions, Gause's Principle with laboratory and field interactions, | |
| | 3.4 Quadrate, line and belt transect methods. | |
| 4. | **Community** | **(07)** |
| | 4.1Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Eco tone and edge effect; Ecological succession with one example. | |
| 5. | **Animal interactions** | **(05)** |
| | 5.1Introduction to Animal interactions | |
| | 5.2 Types of Animal interactions with at least to suitable examples of each | |
| | 5.2.1-Competition: Interspecific and intraspecific | |

5.2.2- Beneficial Associations:

Commensalism (remora fish on shark, Cattle egrets on livestock),

Mutualism (Termite and *Trichonympha*, bees and flowers, cleaning symbiosis in fish by prawns.

5.3 Antagonistic associations: Parasitism (*Ascaris* and man, lice and humans), Prey predation (Lion and deer).

## Course Title: Zoology Practical Paper

## Course Code: ZO113

## Semester I (1.5 Credits-45 Hours)

**Animal Diversity –I**

1. Museum Study of phylum Protozoa: Euglena, Paramecium, Amoeba, Plasmodium sp.
2. Museum study of Phylum Porifera: *Sycon*, *Euplectella*, *Chalina*, Spongilla.
3. Museum study of phylum Cnidaria: *Hydra, Physalia, Aurelia, Metridium*.

4 Museum Study of phylum Platyhelminthes: *Planeria, Faciola hepatica, Taenia solium*

5. Study of Paramecium: Culture, External morphology, Conjugation and Binary fission.
6. Study of permanent slides: Spicules and Gemmules in Sponges, T.S. of *Sycon*, T.S. of Hydra, Taeniasolium: Scolex, Gravid proglottid.
7. Identification of any three museum specimen with help of taxonomic identification key.
8. Visit to Zoological survey of India/ Museum/National Park.

**Animal Ecology:**

1. Estimation of Dissolved oxygen from given water sample.
2. Estimation of Water Alkalinity from given water sample.
3. Study of animal community structure by quadrate method (Field or Simulation).
4. Determination of density, frequency and abundance of species by quadrat method.
5. Study of microscopic fauna of freshwater ecosystem (from pond).
6. Estimation of water holding capacity of given soil sample.
7. Estimation of dissolved and free carbon dioxide from water sample.
8. Study of Eutrophication in lake/river.

**Course Title: Animal Diversity –II**

**Course Code: ZO-121:**

**Semester II** **(2 credits-30 lectures)**

| No. | Title & Contents | Number of lectures |
|---|---|---|
| 1. | **Phylum Aschelminthes** | **(04)** |
| | 1.1 Introduction to phylum Aschelminthes<br>1.2 Salient features of Phylum Aschelminthes<br>1.3 Classification of Phylum Aschelminthes (Class Nematoda only with two examples – *Ascaris lumbricoides* (common round worm), *Wuchereria bancrofti* (Elephantiasis)).<br>1.4 Economic importance of class Nematoda. | |
| 2. | **Phylum Annelida** | **(06)** |
| | 2.1 Introduction to Phylum Annelida<br>2.2 Salient features of Phylum Annelida.<br>2.3 Classification of Phylum Annelida up to classes with examples of following classes (names of examples only).<br>Class Polychaeta ( e.g: *Nereis pelagica (neries/* sand worm, *Aphrodita aculeata* (=Aphrodite/ seamouse)<br>Class Oligochaeta (e.g.: *Pheritima posthuma* (earthworm),<br>Class Hirudinea (e.g: *Hirudinaria granulosa* common cattle leech)<br>2.4 Economic importance of Annelida with reference to earthworms as friends of farmers and in their role in vermicomposting. | |
| 3. | **Phylum Arthropoda** | **(06)** |
| | 3.1 Introduction to Phylum Arthropoda<br>3.2 Salient features of Phylum Arthropoda<br>3.3 Classification of Phylum Arthropoda with specific classes and mentioned examples (names only)<br>Class:Crustacea*:Palaemon palaemon* (Prawn) *Brachyura* spp. crabs)<br>Class: Chilopoda: *Scolopendra* sp. (centipede)<br>Class: Diplopoda: *Julus* sp. (millipede) | |

Class Insecta*: Periplaneta americana* (American Cockroach), *Anopheles stephensii* (mosquito).

Class: Arachnida- Spiders, *Buthus sp (*scorpion)

3.4 mouth parts in insects: Mandibulate (cockroach), Piercing and sucking (female Anopheles mosquito), chewing and lapping type (honey bee)

3.5 Economic importance of Arthropoda

Useful Insects: Honey bee, Lac insect, Silkworm.

Harmful insects: Female Anopheles mosquito, Red cotton bug, Rice weevil

4. **Phylum Mollusca** **(06)**

4.1 Introduction to Phylum Mollusca

4.2 Salient features of Phylum Mollusca

4.3 Classification of Phylum Mollusca with specific classes and mentioned examples (names only)

Class Gastropoda e.g *Pila globosa* (apple snail)

Class Pelecypoda e.g *Lamellidens marginalis*(Bivalve)

Class Polyplacophora e.g *Chiton*

Class: Cephalopodae.g: *Octopus vulgaris* (common octopus), *Sepia officinalis* (common Cuttle fish)

4.4 Economic importance of Mollusca.

5. **Study of Phylum Echinodermata** **(08)**

5.1 Introduction to Phylum Echinodermata

5.2 Salient features of Phylum Echinodermata.

5.3 Classification of Phylum Echinodermata with specific classes and mentioned examples (names only)

Class Asteroidea (*Asterias rubens* sea stars or starfish)

Class: Holothuroidea. *Holothuria sp*. sea cucumbers)

Class: Echinoidea *(Echinus esculentis* common sea urchins)

Class: Crinoidea (sea lilies or feather stars)

5.4 **Type study: *Asteriasrubens* (Sea Star):** Classification, Habit Habitat, External Morphology, Digestive system, Water vascular System and autotomy and regeneration

5.5 Pedicillaria in Echinodermata: straight, crossed, valvate, tridactylous, globigerous.

5.6 Economic importance of Echinidermata.

## Course Title: Cell biology

**Course Code: ZO122:**

**Semester II** **(2 credits-30 lectures)**

**Learning outcomes for Cell Biology**

- The learner will understand the importance of cell as a structural and functional unit of life.
- The learner understands and compares between the prokaryotic and eukaryotic system and extrapolates the life to the aspect of development.
- The dynamism of bio membranes indicates the dynamism of life. Its working mechanism and precision are responsible for our performance in life.
- The cellular mechanisms and its functioning depends on endo-membranes and structures. They are best studied with microscopy.

**ZO122: Cell biology** **(2 credits-30 lectures)**

| No. | Title & Contents | Number of lectures |
|---|---|---|
| 1. | **Introduction:** | **(04)** |
| | 1.1 Introduction cell biology, | |
| | 1.2 Cell as basic unit of life. | |
| | 1.3 Importance of Cell Biology and its applications in industry. | |
| | **Overview of Cells** | |
| | 1.3 Introduction to Prokaryotic and Eukaryotic cells. | |
| | 1.4 Structure and function of Prokaryotic *(E. coli)* | |
| | 1.5 Structure and function of Eukaryotic cells (Animal and Plant Cell) | |

2 **Techniques in Cell Biology:** **(04)**

3.1 Introduction

3.2 Microscopy: Basic Principle, Simple, Compound and applications of Electron Microscope.

3.3 Stains and dyes:
Types of Stain: Acidic, basic and neutral.

Dye (Preparation and chemistry of dyes not expected)

3.4 Micrometry.

3 **Plasma Membrane:** **(06)**

4.1Introduction

4.2 Structure of plasma membrane: Fluid mosaic model.

4.3Transport across membranes: Active and Passive transport, Facilitated transport, exocytosis, endocytosis, phagocytosis – vesicles and their importance in transport.

4.4 Other functions of Cell membrane in brief Protection, cell recognition, shape, storage, cell signalling.

4.5 Cell Junctions: Tight junctions, gap junctions, Desmosomes.

4 **Nucleus: Structure and function** **(04)**

5.1Introduction to Nucleus

5.2 Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleoplasm, Nucleolus

5.3 Chromatin: Eu-chromatin and Hetro-chromatin, nature and differences.

5.4 Functions of nucleus

5. **Endomembrane System** **(04)**

6.1 Introduction

6.2 Structure, location and Functions: Endoplasmic Reticulum, Golgi apparatus, Lysosomes and vacuoles.

7. **Mitochondria and Peroxisomes** **(03)**

7.1 Introduction

7.2 Mitochondria: ultrastructure and function of mitochondrion.

7.3 Peroxisomes

**Cell Division** **(05)**

7.1 Introduction

7.2 Cell cycle (G1, S, G2, M phases),

7.3 Mitosis.

7.4 Meiosis.

**Course Title: Zoology Practical Paper**

**Course Code: ZO123**

**Semester II** **(1.5 Credits-45 Hours)**

**Animal Diversity –II**

1. Museum study of Phylum Aschelminthes: *Ascaris lumbricoides*,
2. Museum study of phylum Annelida: *Neries*, Earthworm, Leech.
3. Museum study of phylum Arthropoda: Prawn, Cockroach, Centipede, Millipede, Crab
4. Museum study of phylum Mollusca: *Pila*, *Chiton*, Bivalve, Octopus.
5. Museum study of phylum Echinodermata: Sea Star, Sea urchin, Brittle Star, sea cucumber.
6. Study of permanent slides: Mouthparts of Insects -Mandibulate, Piercing and sucking, Chewing and Lapping.
7. Types of Shells in Mollusca. *Pila*, Bivalve, Chiton, Sepia.
8. Economic importance of honey bees, Lac insects silk worms, red cotton bug, Anopheles mosquito
9. Earthworm: vermicomposting bin preparation and maintenance.
10. Visit to a vermicomposting unit/ field for insect pest collection and its identification

**Cell Biology**

1. Study of Microscope: Simple and Compound
2. Micrometry: Measurement of microscopic objects
3. Study of cell: Preparation of temporary mount of human buccal epithelial cells.
4. Preparation of blood smears to observe the blood cells
5. Temporary preparation of mitotic cell from onion roots
6. Study of Cell organelles (any three) by using microphotographs

## Recommended Reference Books

**Animal Diversity – I and II**


1. Anderson, D.T (Ed) 1988: Invertebrate Zoology, Oxford University Press.
2. Barnes, R.D. (1982). Invertebrate Zoology, V Edition. Holt Saunders International Edition.
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
4. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
5. Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home.
6. Brusca, R.C andBrusca, G. J (2003): Invertebrate (2$^{nd}$ ed.) Sinauer Associates Inc., Publishers Sunderland.
7. Hadzi, J (1963): The Evolution of Metazoa, Macmillan Newyork.
8. Hyman, L. H (1940): Invertebrates Vol I, Protozoa through ctenophore.
9. Hyman. L. H (1955): The Invertebrates Vol: IV, Echinodermata, the coelomate bilateria, Mcgraw Hill, Newyork.
10. Modern Text-Book of zoology, Vertebrates. By Kotpal, RL., Rastogi and Co., Meerut.
11. Nigam H.C., Zoology of Chordates, Vishal Publication, Jalandhar-144008.
12. Phylum Protozoa to Echinodermata (series) by Kotpal, RL. Rastogi and Co., Meerut
13. Parker T.J and W.A Haswell (1972): A text book of Zoology, Vol –I (7$^{th}$ edition by Marshall and Williams) Mcmillan Press ltd.
14. Jordan, E.L. and P.s.Verma Invertebrate Zoology, S. Chand and Co., Ltd. Ram Nagar, New Delhi.

15.Russel Hunter: - A Biology of higher invertebrates, MacMillon Co. Ltd. London

**Animal Ecology**


1. Colinvaux, P. A. (1993). Introduction to Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology: The Experimental Analysis of Distribution and Abundance, 6th Edition, ©2009, Pearson
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert Leo Smith Ecology and field biology Harper and Row publisher
5. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press
6. Sharma P.D. (2002) Ecology and Environment, Himalaya Publication


**Cell Biology**


1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI EditionJohn Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIIEdition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition.ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London
6. Inside the Cell (2005); US Department of Health Sciences, National Institute of Health, Natinal institute of General Medicine Sciences.
7. Lodish, H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell. (2010).
8. Molecular Cell Biology, Eds. 3, Scientific American & W. H. Freeman. New York.
9. Powar C B.: Cell Biology, Himalaya Publication, Meerut


*Note: Latest editions of the recommended books may be referred.*

# F Y B Sc Zoology

## Paper II Sem I

# Animal Ecology

## Course Code: ZO 112

*(2 Credits-30 Lectures)*

## Syllabus (Lect no. 1-)

By
Dr Bhausaheb R Ghorpade
Dept Of Zoology
Shri Anand College Pathardi
Dist Ahmednagar (MS)

*Note: This material is only for educational purpose and is non -commercial .*

# Chapter1. Introduction to Ecology (02 Lectures)

## 1.1 Concepts of Ecology, Environment, Population, Community, Ecosystem, Biosphere, Autecology and synecology.

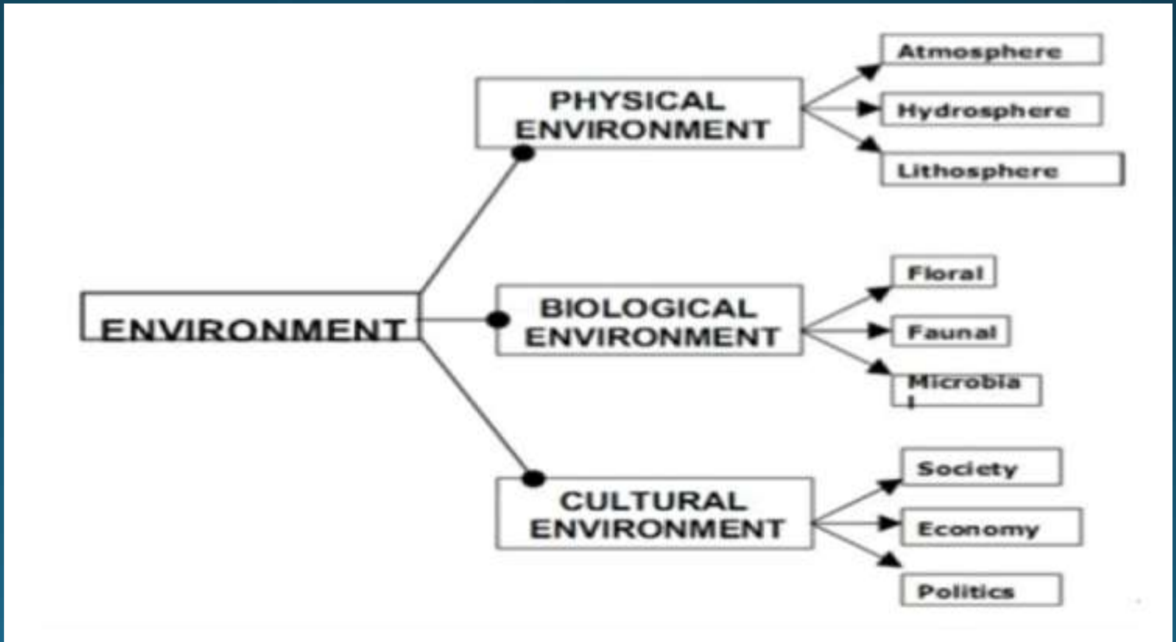




**Figure 3.** Classification of environment.

**Chapter 2. Ecosystem (08 Lectures)**

**2.1 Types of ecosystems: Aquatic (Freshwater, estuarine, Marine and terrestrial (Forest, Grassland and Desert)**

**2.2 Structure and Composition of Ecosystem (Abiotic components and biotic components.**

**2.3 Food chain: Detritus and grazing food chains, Food web, Energy flow through the ecosystem, Ecological pyramids: Number, Biomass, and Energy.**

**2.4 concept of Eutrophication in lakes and rivers.**

**Chapter 3 Population (08 Lectures)**

**3.1Characteristic of population: Density, Natality, Mortality, Fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion.**

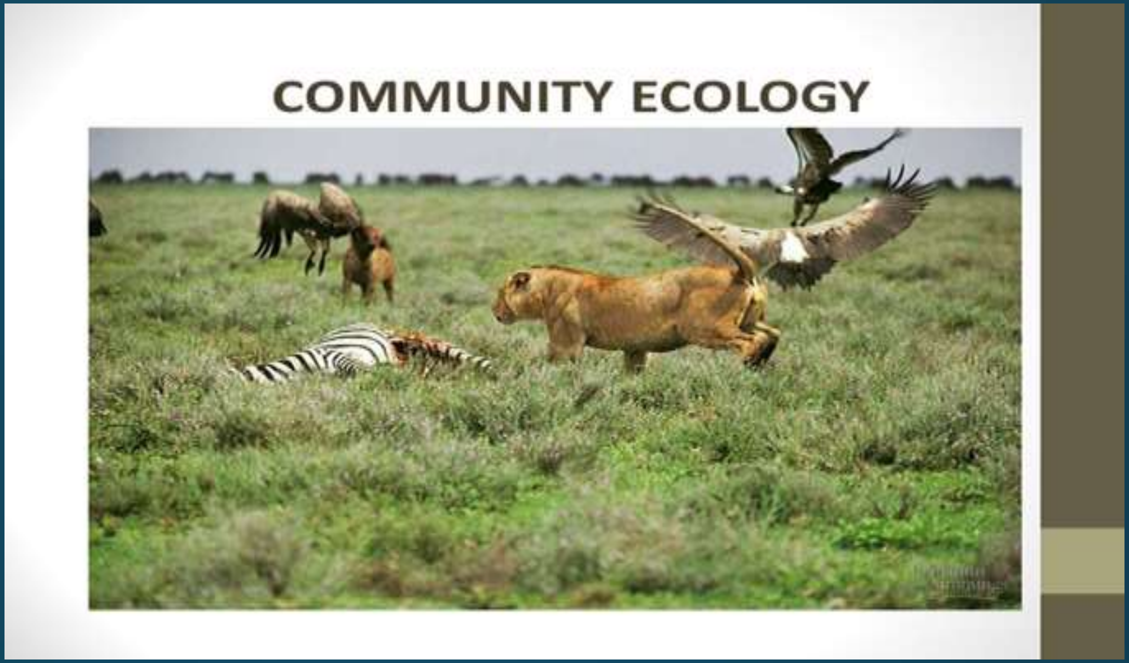
**3.2Exponential and logistic growth,**

**3.3 Population regulation – density-dependent and independent factors. Population interactions, Gause's Principle with laboratory and field interactions,**

**3.4 Quadrate, line and belt transect methods.**

**Chapter 4. Community (07 Lectures)**

**4.1Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Eco tone and edge effect; Ecological succession with one example.**




Chapter 5. Animal interactions (05 Lectures)

5.1Introduction to Animal interactions

5.2 Types of Animal interactions with at least to suitable examples of each

5.2.1-Competition: Interspecific and intraspecific

5.2.2- Beneficial Associations: Commensalism (remora fish on shark, Cattle egrets on livestock), Mutualism (Termite and Trichonympha, bees and flowers, cleaning symbiosis in fish by prawns.

5.3 Antagonistic associations: Parasitism (Ascaris and man, lice and humans), Prey predation (Lion and deer).

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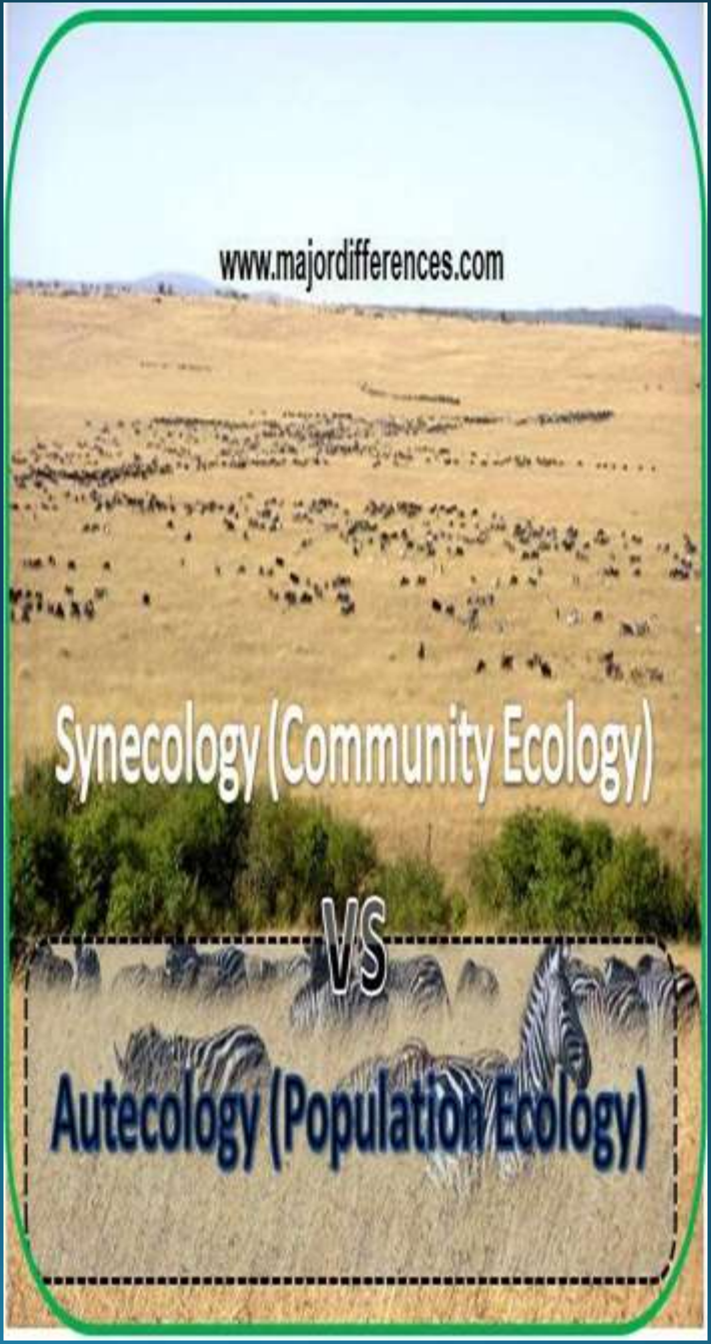

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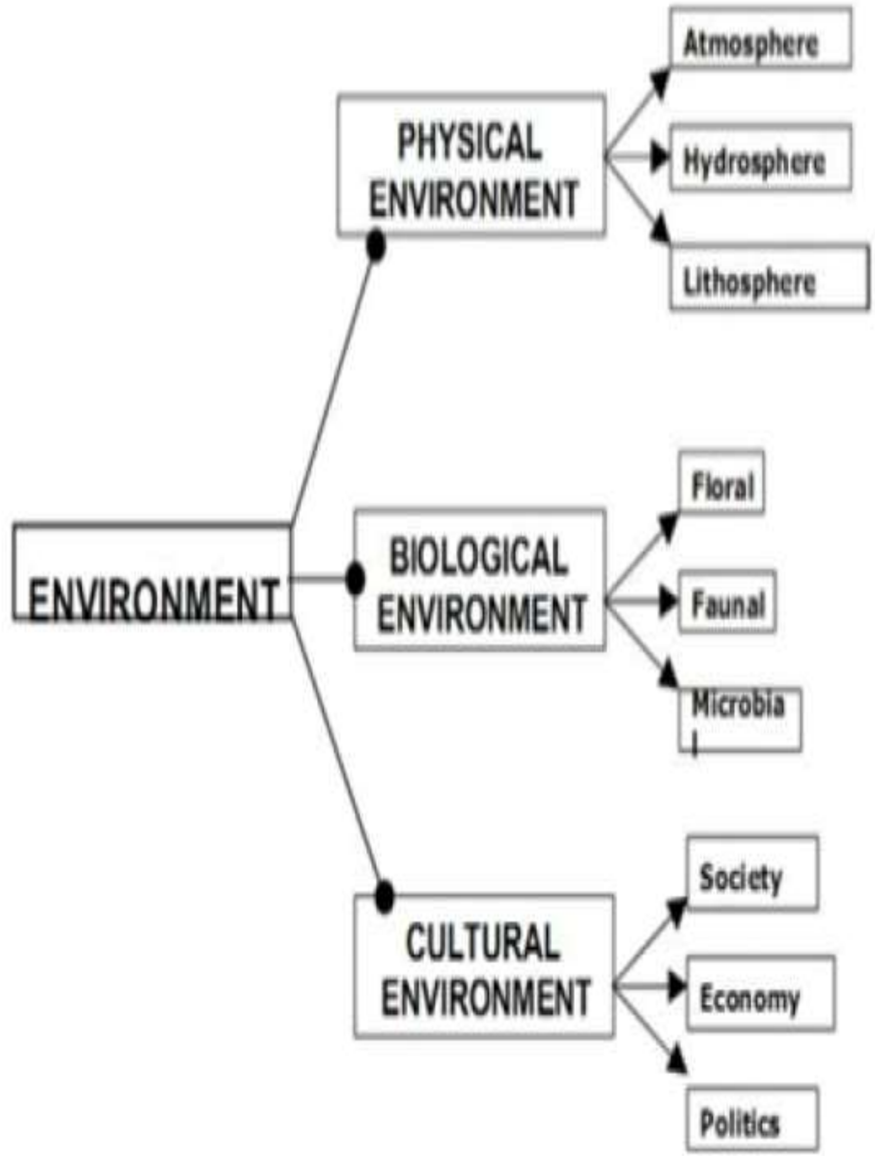
**ECOLOGY IS THE STUDY OF INTER-RELATIONSHIP OF ORGANISMS WITH PHYSICAL(ABIOTIC) AS WELL AS LIVING OR BIOTIC ENVIRONMENTS.**

## Environment :

- It is surrounding around us in which all live and operates.

- It refers to all the conditions that influence and affect the development and sustainability of life of all organisms present on the earth.

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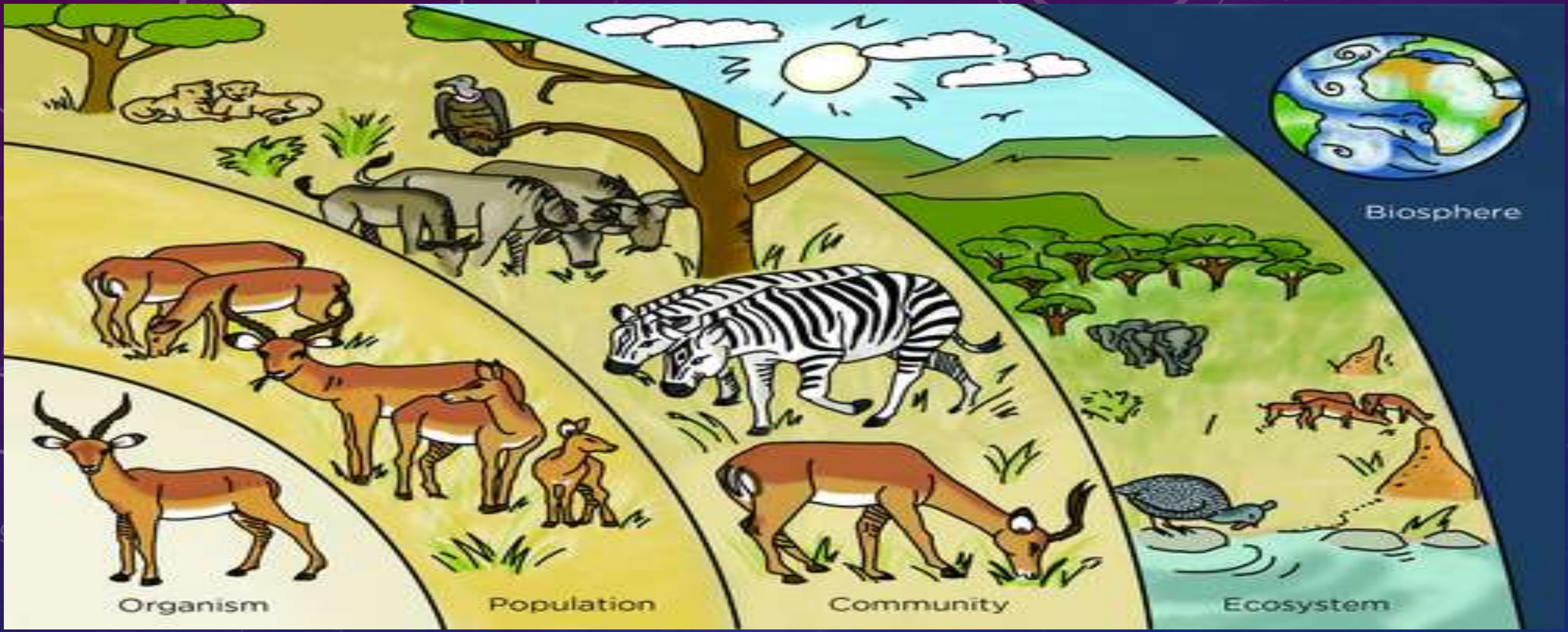


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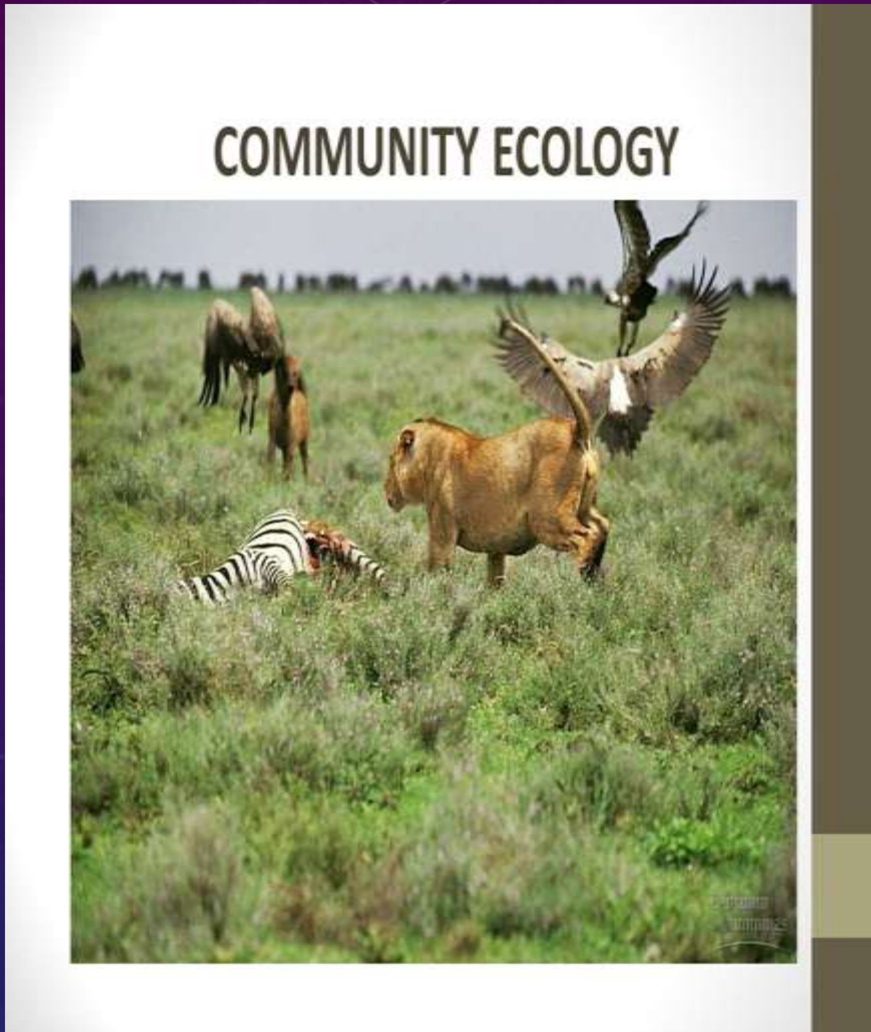



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## Ecosystem:

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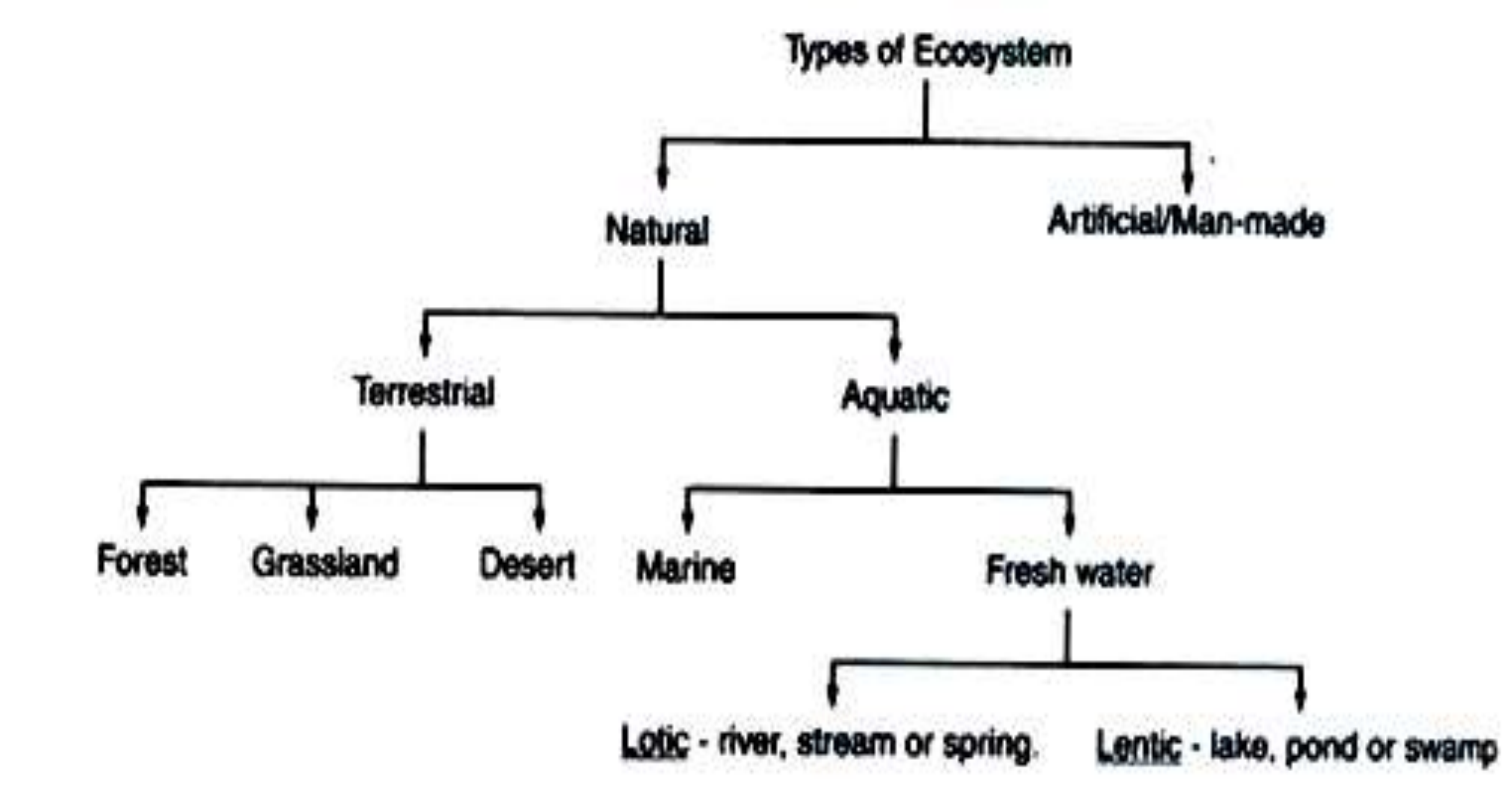

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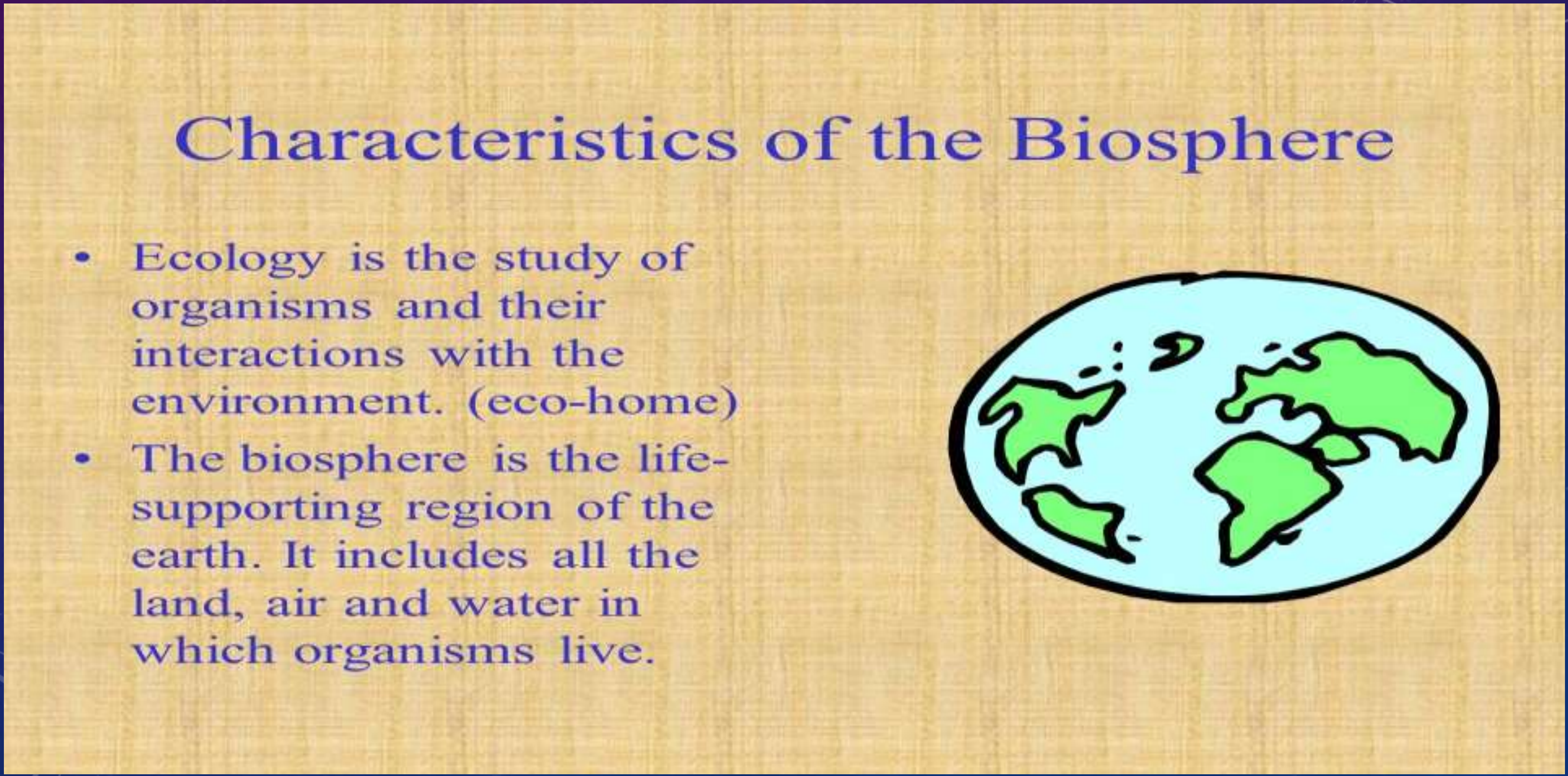

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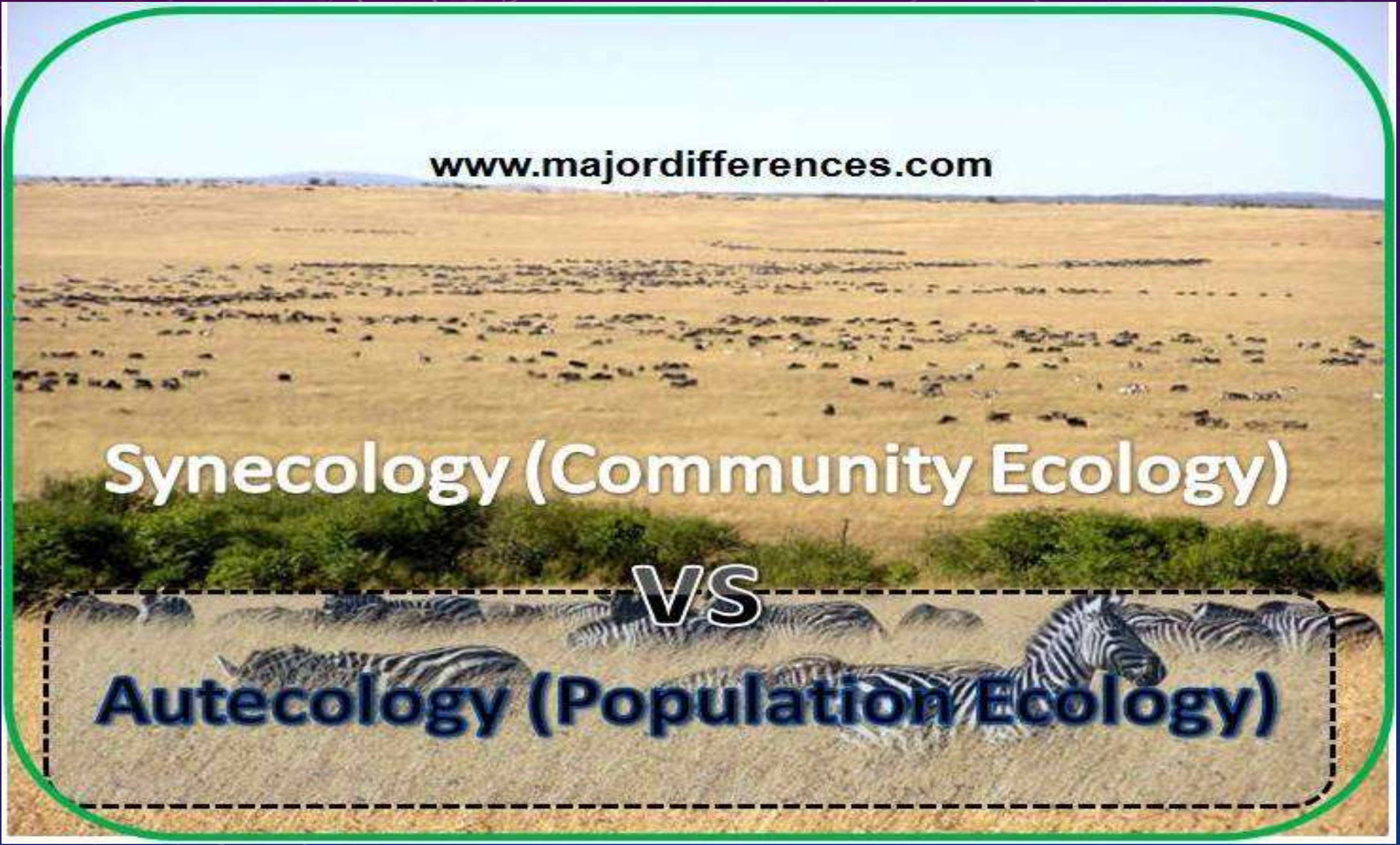
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# Chapter1 Introduction to Ecology

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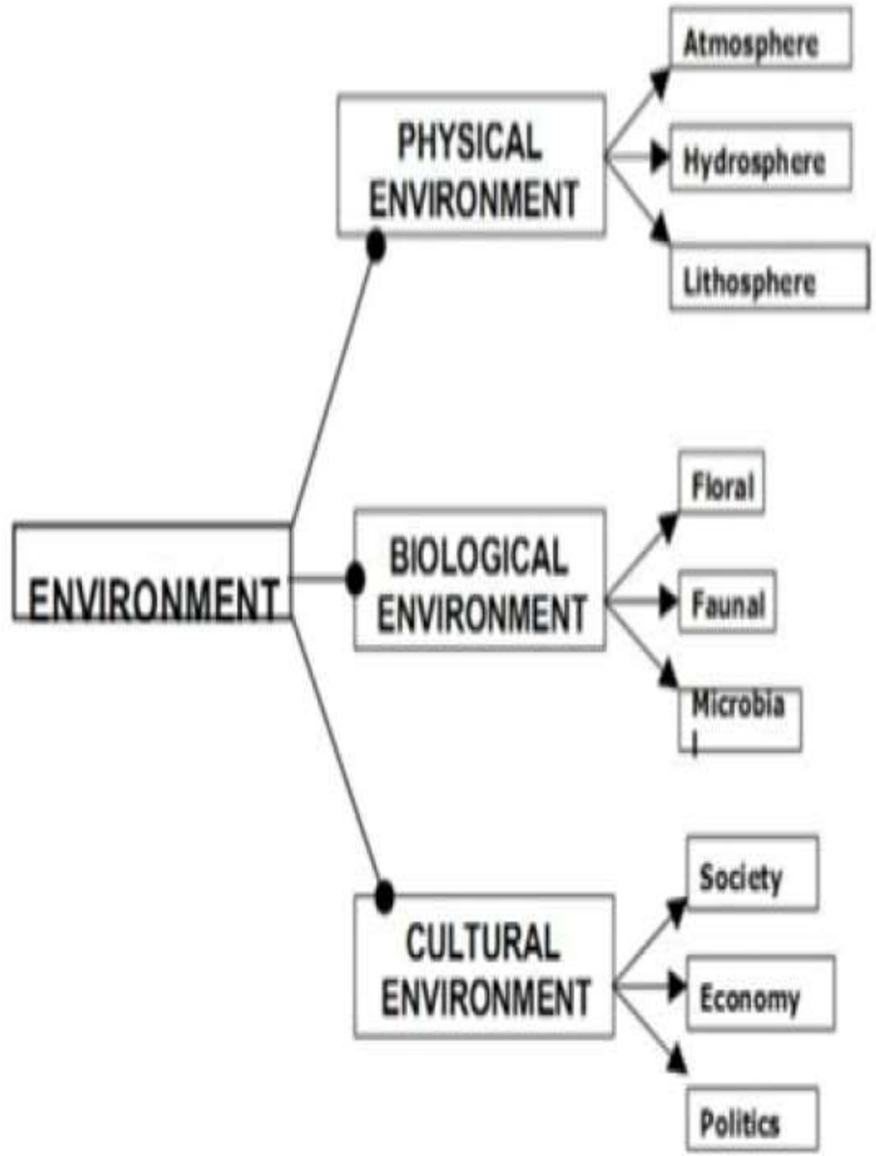


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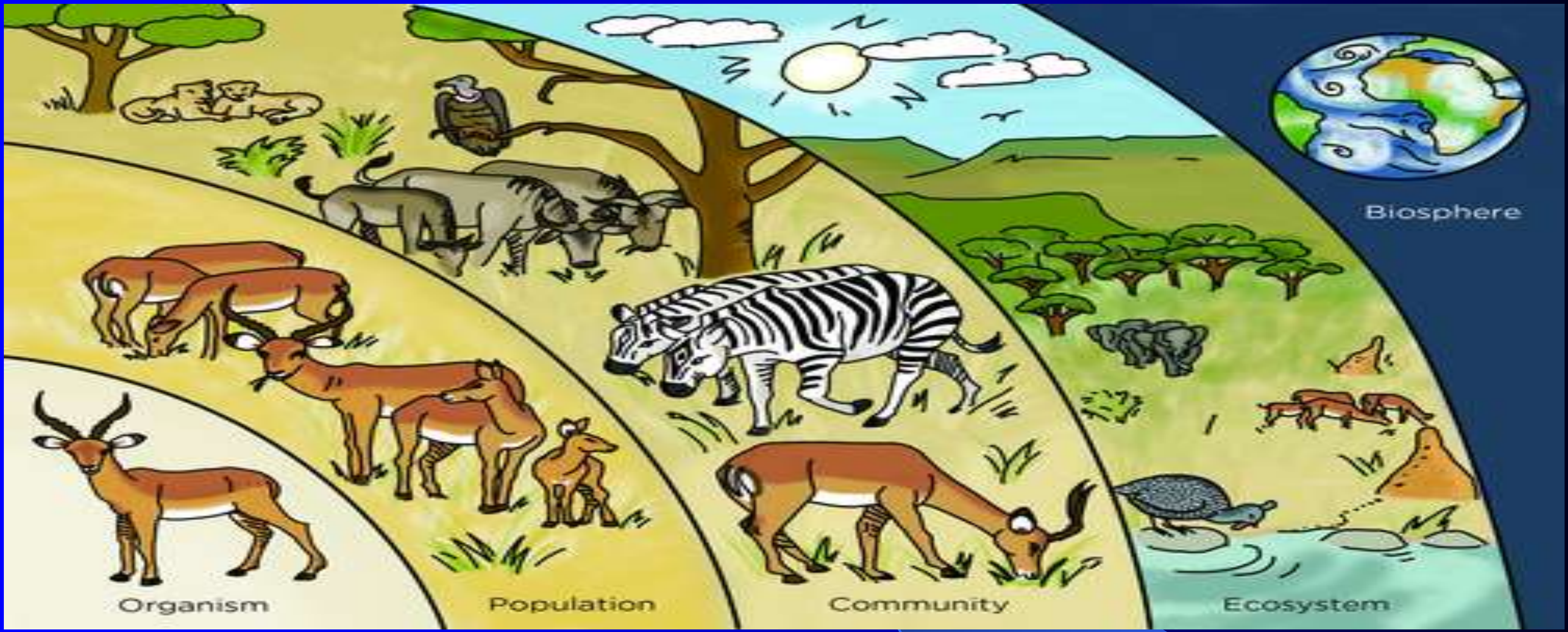


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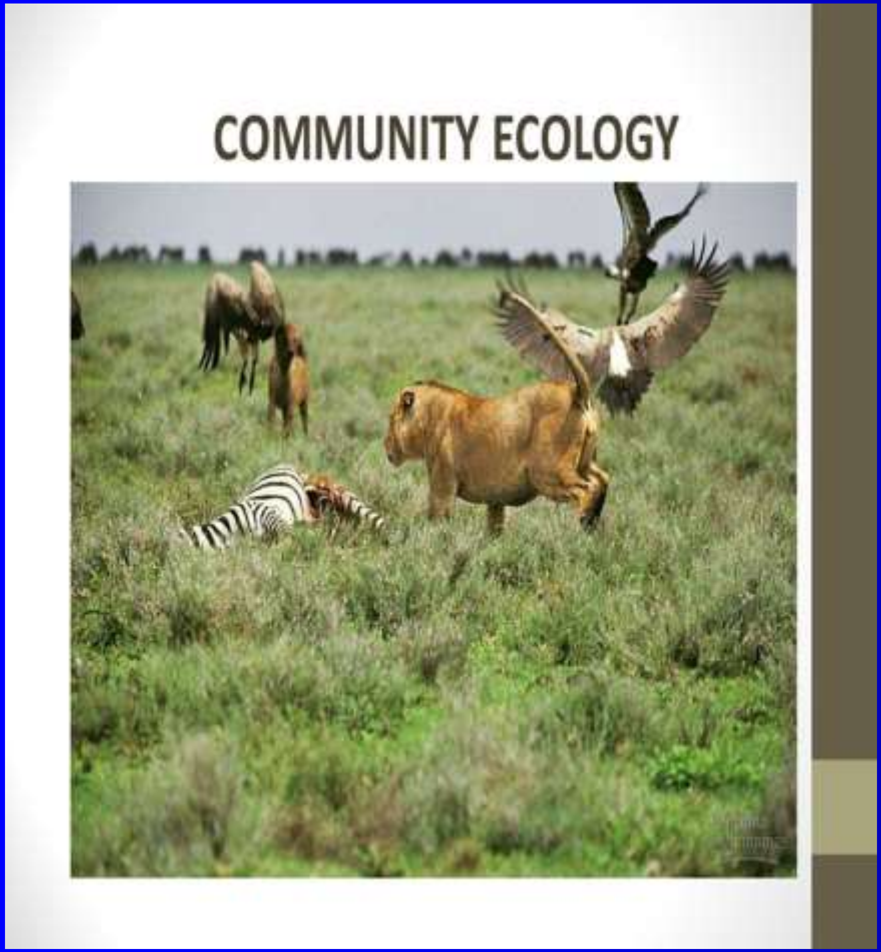


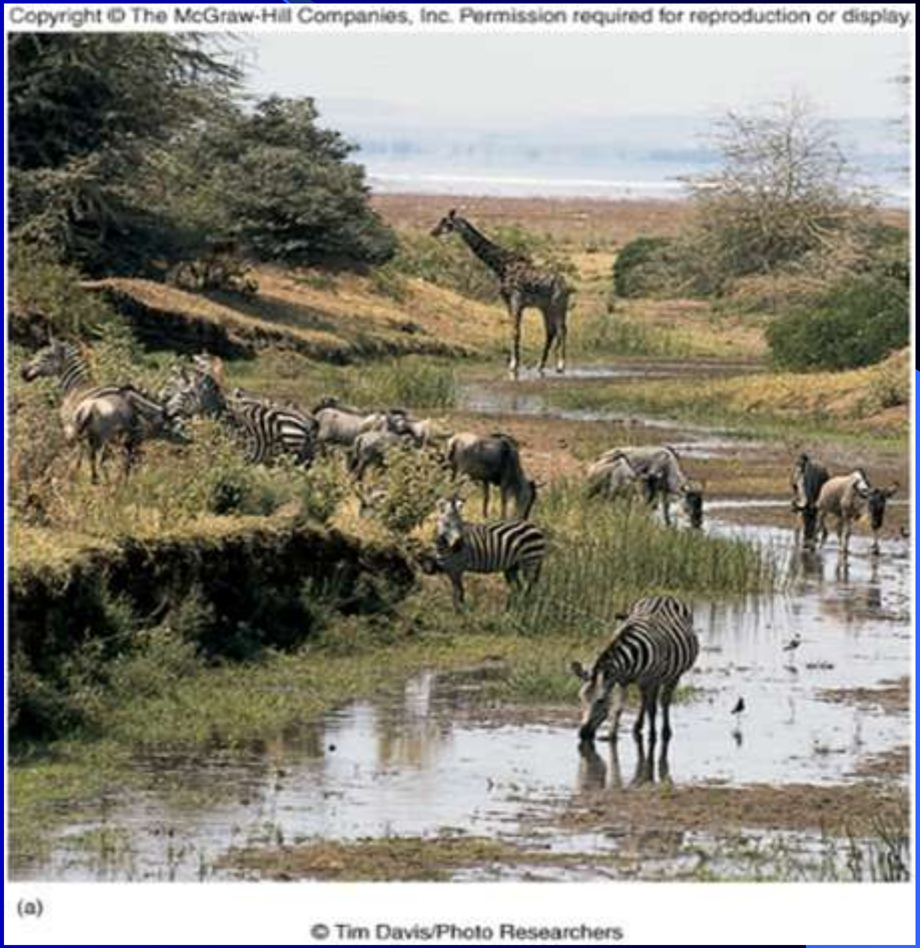

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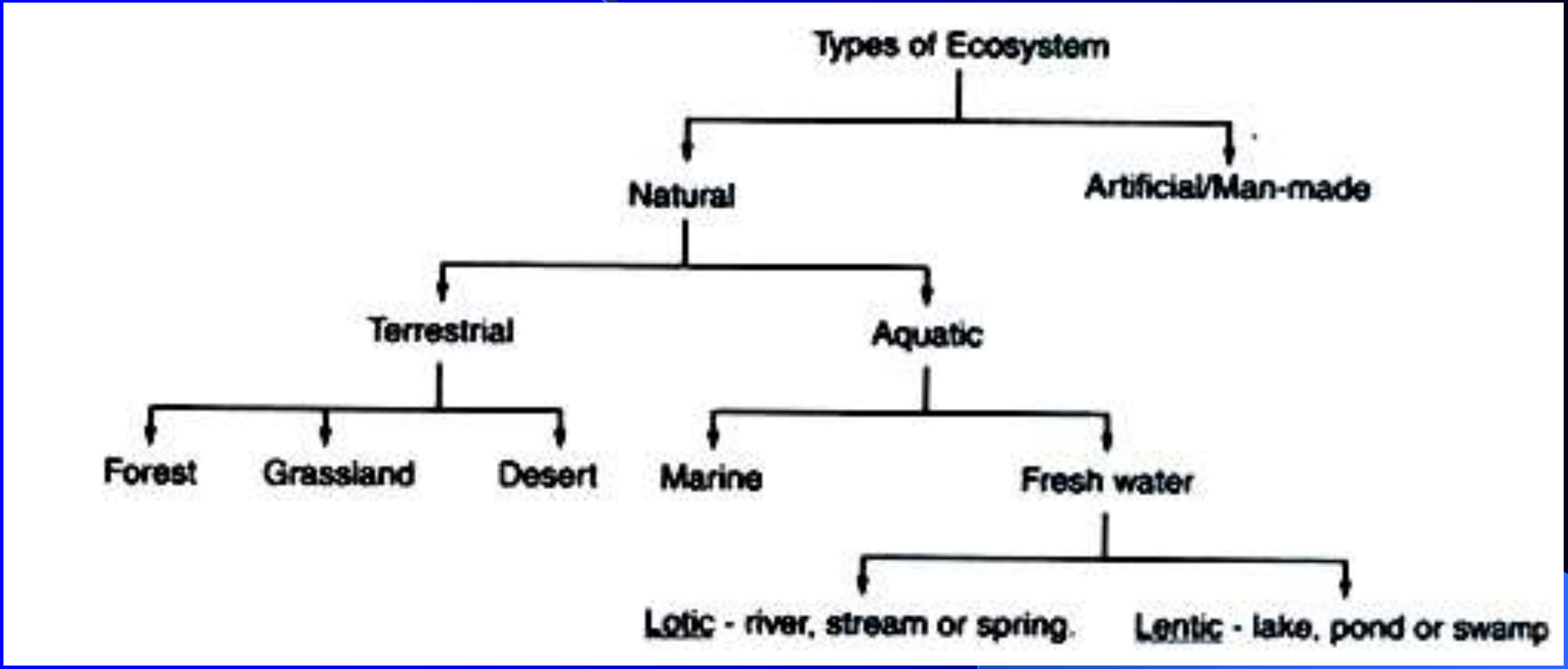

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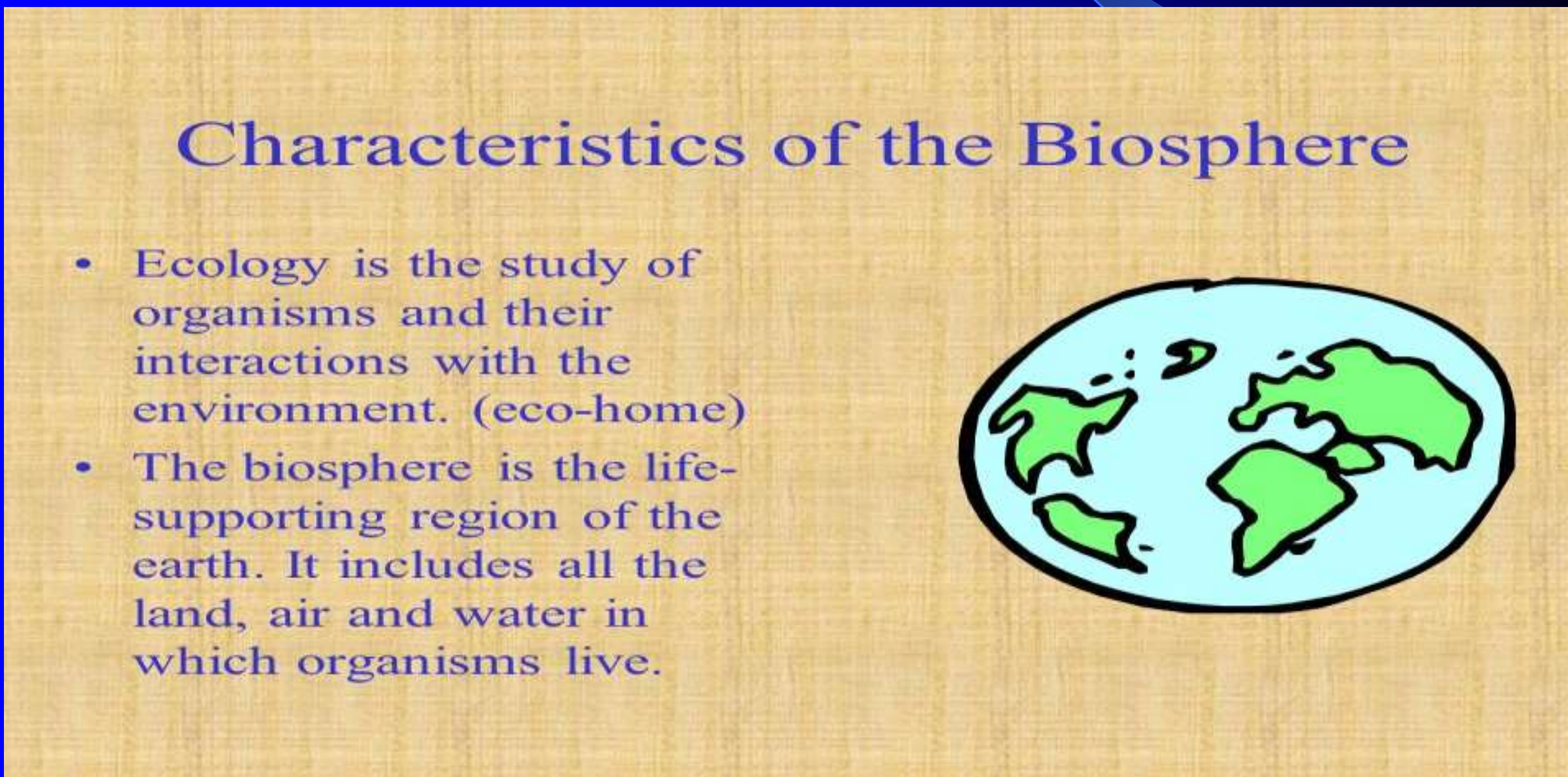

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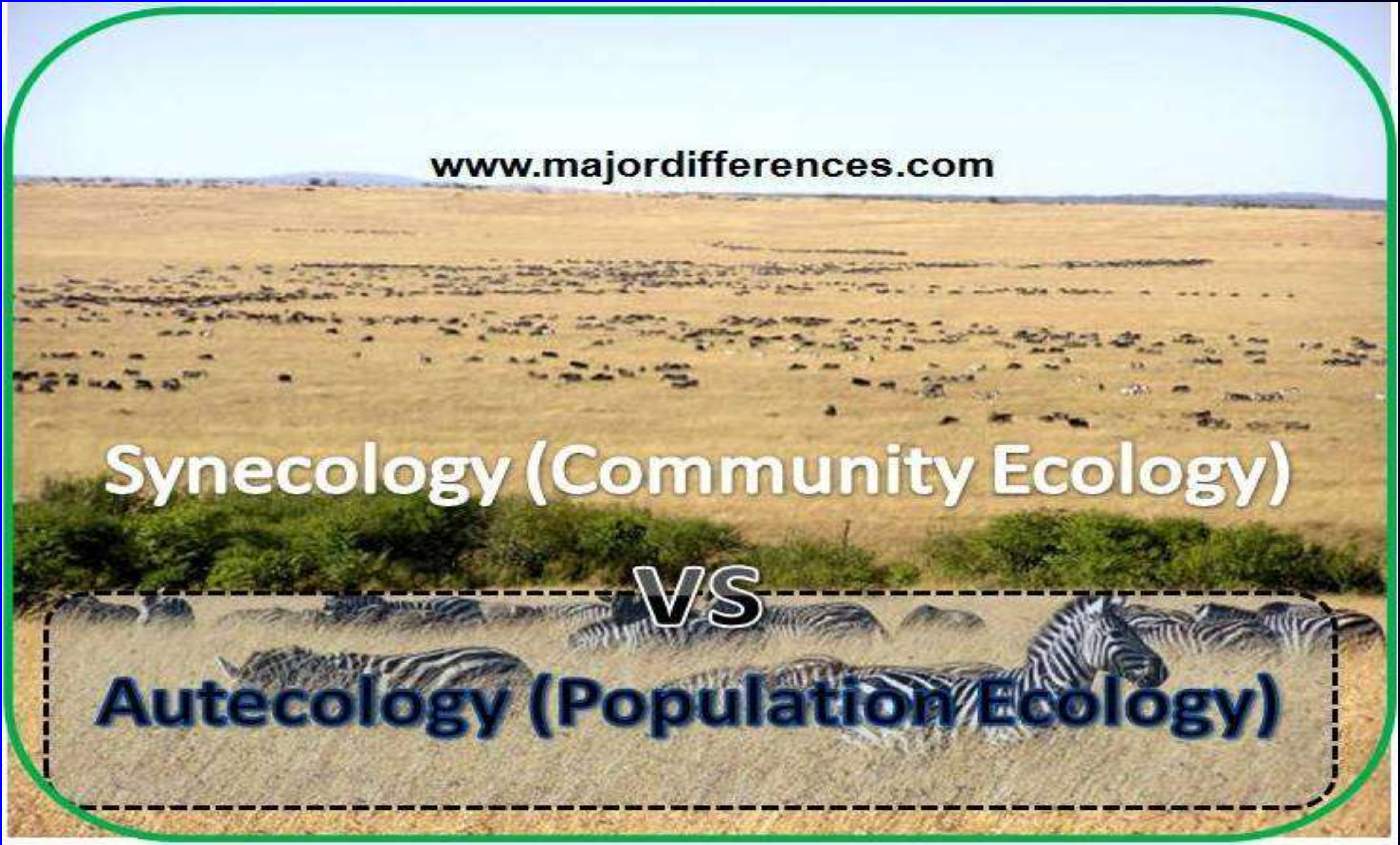
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Animal Ecology

# Food Chain- Food Web

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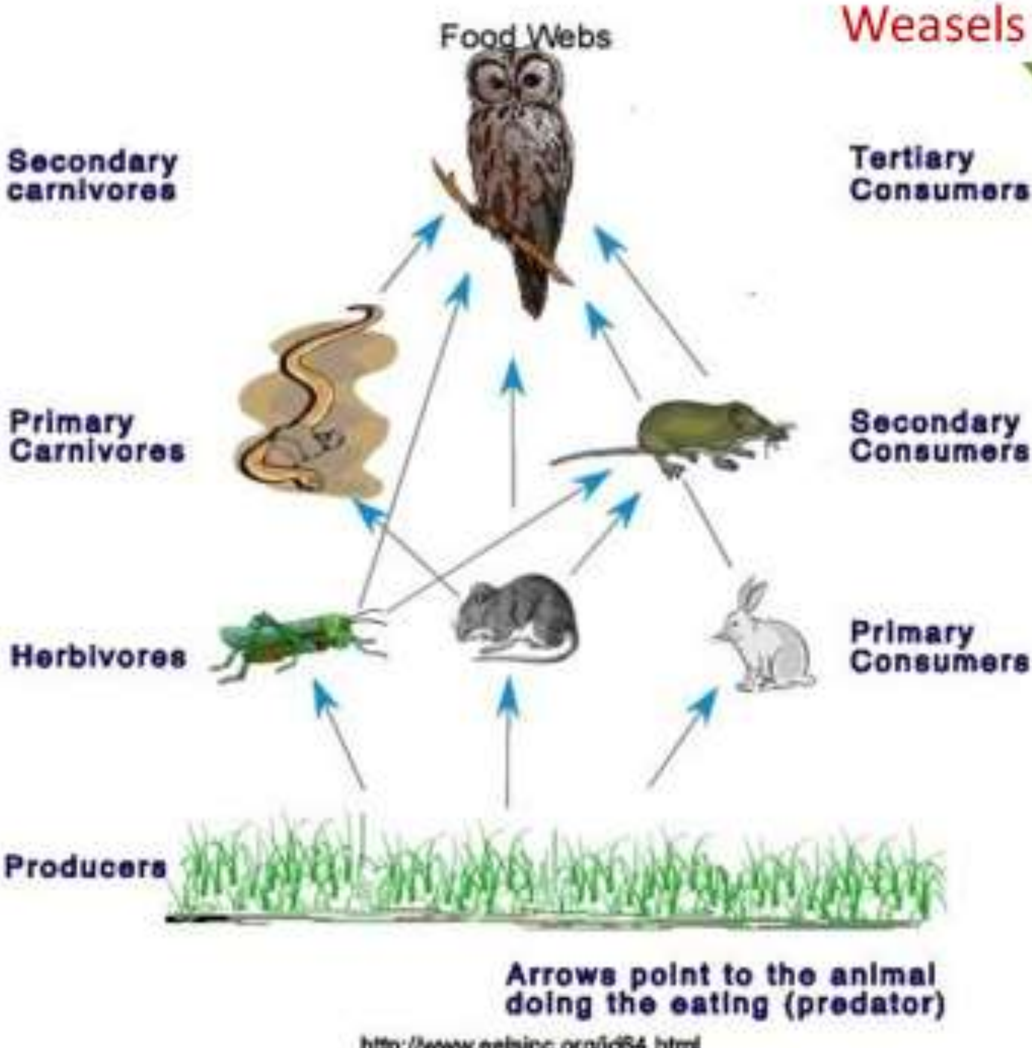
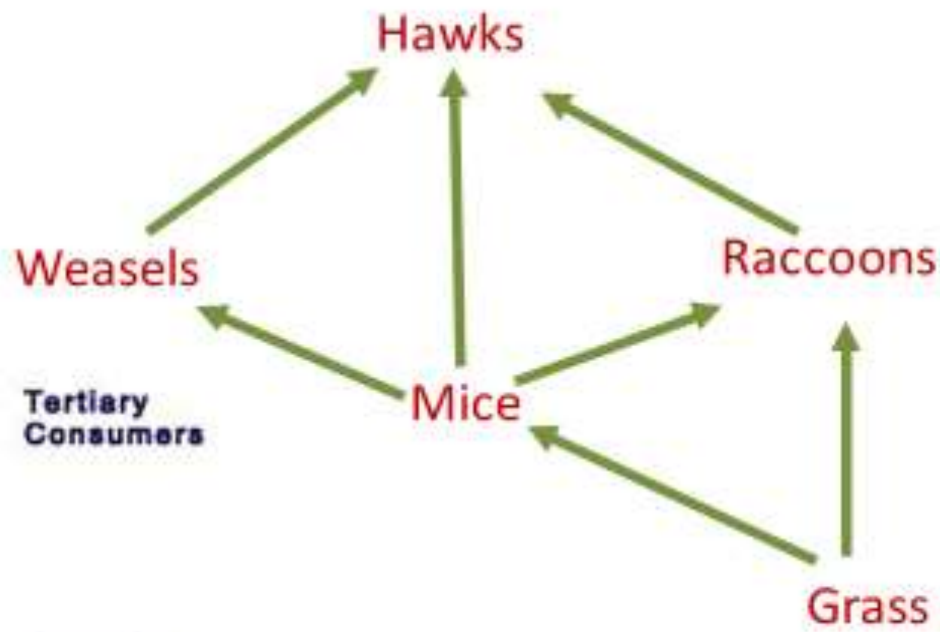
# Food Web:

- The interconnected, interlocking pattern of food chain is known as food web.
- Under natural condition of the linear arrangement of food chain  hardly occurs and they remain interconnected with each other  through different types of organisms at different levels
- Such a  interconnected and interlocking pattern of food chain is known  as food web..

# Food Webs



Food Webs
Secondary carnivores
Tertiary Consumers
Primary Carnivores
Secondary Consumers
Herbivores
Primary Consumers
Producers
Arrows point to the animal doing the eating (predator)
http://www.eelsinc.org/id64.html

Hawks
Weasels
Raccoons
Mice
Grass

# Ecological Pyramids

- The different species in a food chain are called tropic levels.
- Each food chain has 3 main trophic level, producer, consumer, and decomposers.
- Thus Graphical representation of these trophic levels is called as Ecological Pyramids.
- It was devised by an ecologist " Charles Elton" therefore this pyramid are also called Ecological pyramid or Eltonian pyramids.
- Types of Ecological Pyramids
- Ecological pyramids are of three types:
  1. Pyramid of Number
  2. Pyramid of biomass
  3. Pyramid of Energy

## 1) Pyramid of Number

- They show the relationship between producers, herbivores, and carnivores at successive tropic levels in terms of their number.
- In case of grassland ecosystem the producers are mainly grasses and are always maximum in number this number then shows a decrease towards apex as primary consumers like mice, rabbit are lesser in number than grasses, the secondary consumers like lizard, snake, are even lesser in number than the grasses, finally the top tertiary consumers like hawks are least in number.
- Thus the shape of pyramid is upright. But in case of forest ecosystem the pyramids is always inverted because the producers are mainly large trees, are lesser in numbers, the herbivores fruit eating birds are more in number than the producers, then there is gradual decrease in number of secondary consumers thus making pyramid upright again.
- Thus the pyramid of number does not give a true picture of the food chain and are not very functional.

# Energy Pyramid:

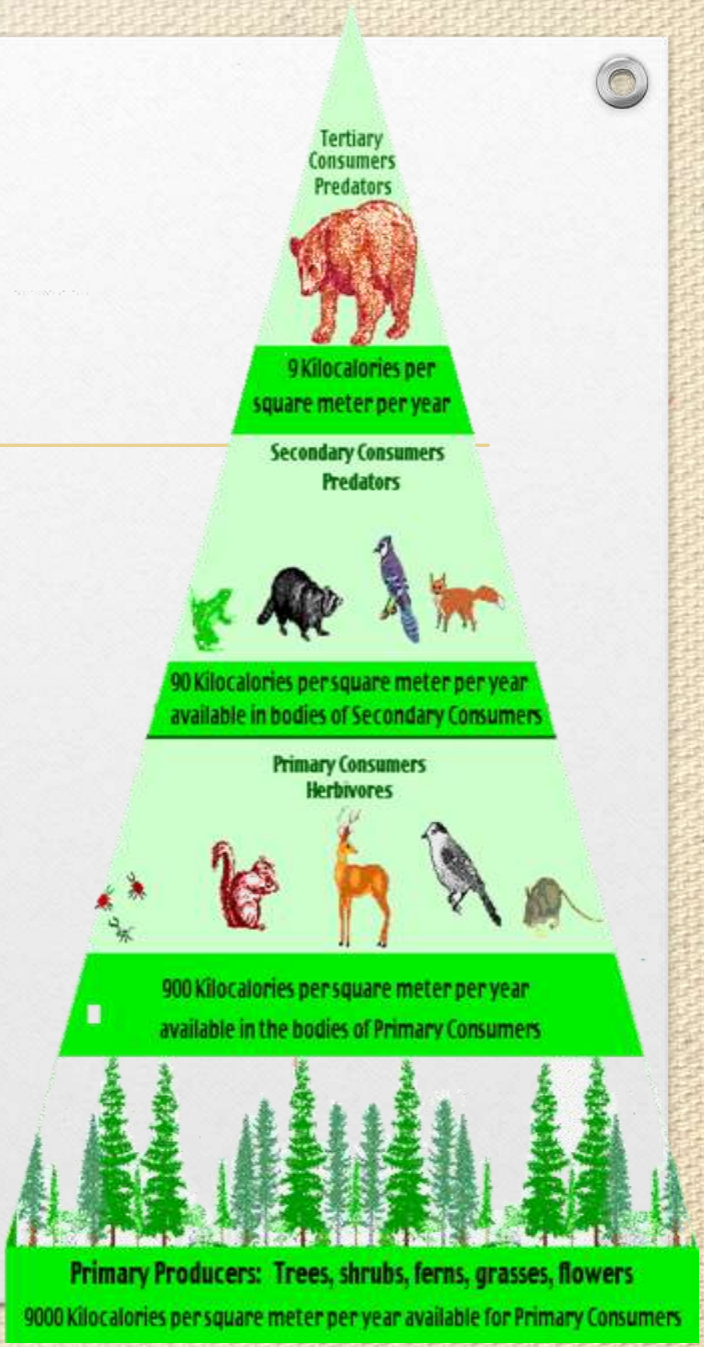
- This shows relative amount of energy available at each trophic level Organisms in a trophic level use the available energy for life processes (such as growth, photosynthesis, cellular respiration, metabolism, etc.)and release some energy as heat

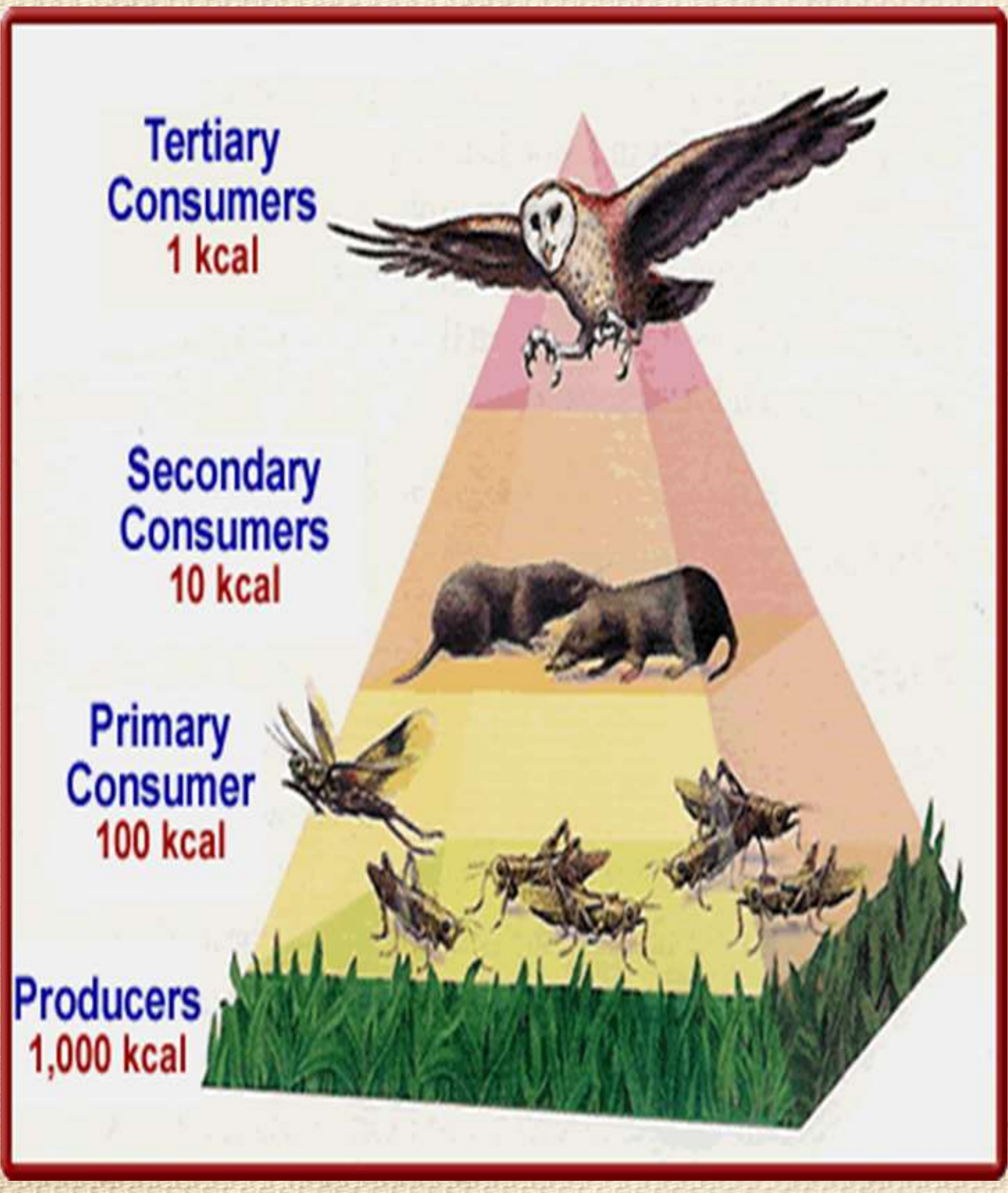
- Remember: Every chemical process that happens in your body releases heat as a byproduct (ex: burning calories).
- Rule of 10—only about 10% of the available energy within a trophic level is transferred to the next higher trophic level

- Biomass Pyramid—represents the amount of living organic matter at each trophic level

## 3) Pyramid of Energy:

- Of the 3 types of ecological pyramid the energy pyramid gives the best picture of overall nature of the ecosystem.
- In this type of pyramid the tropic level is decided depending upon the rate at which food is being produced.
- In shape it is always upright as in most of the cases there is always gradual decrease in the energy content at successive trophic level from producers to various consumers.






# Energy and Biomass Pyramid (together)

Represents amount of energy available at each level as well as amount of living tissue— both decrease with each increasing trophic level

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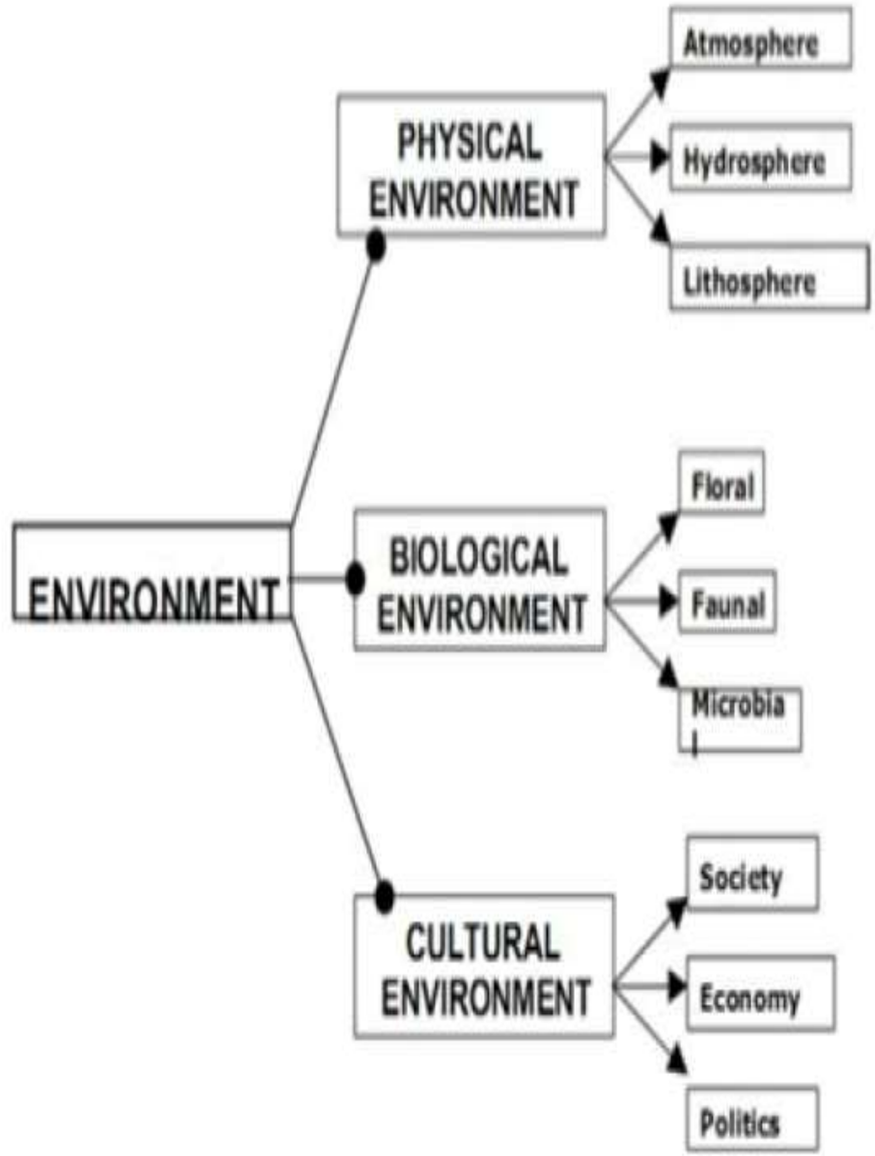


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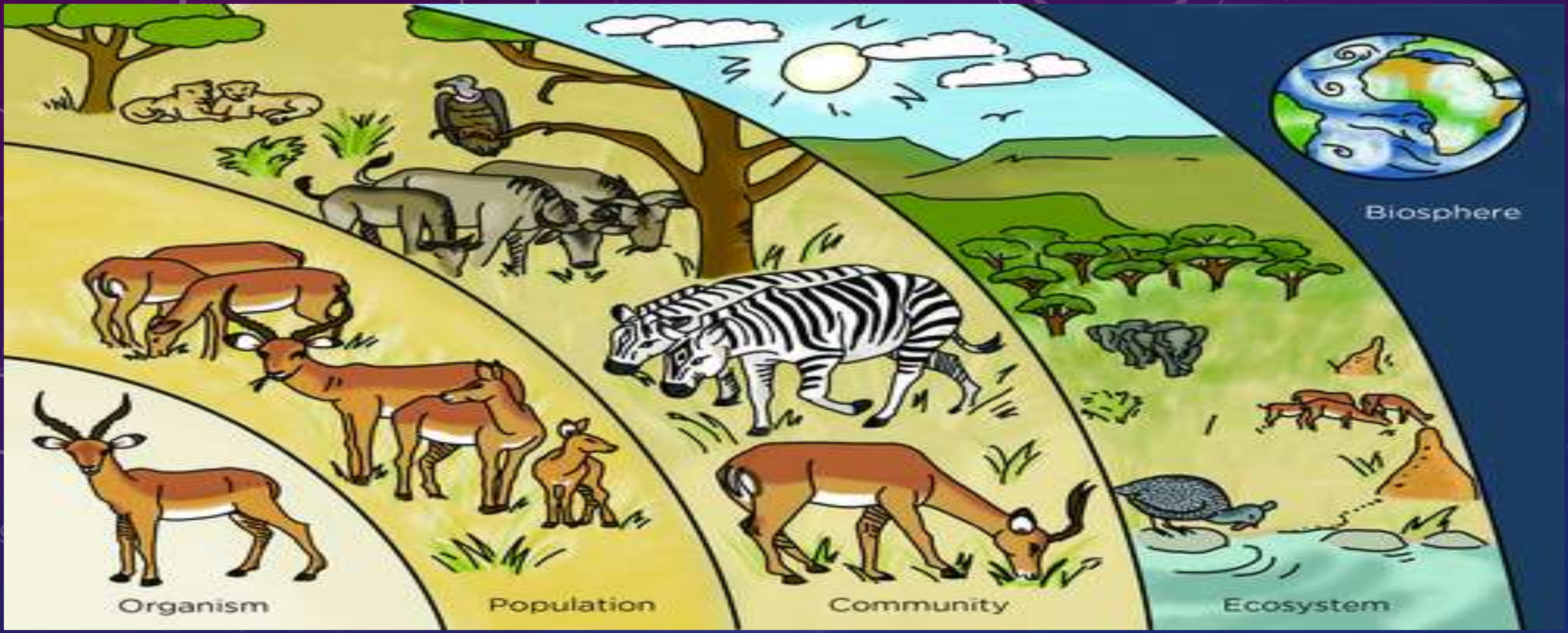


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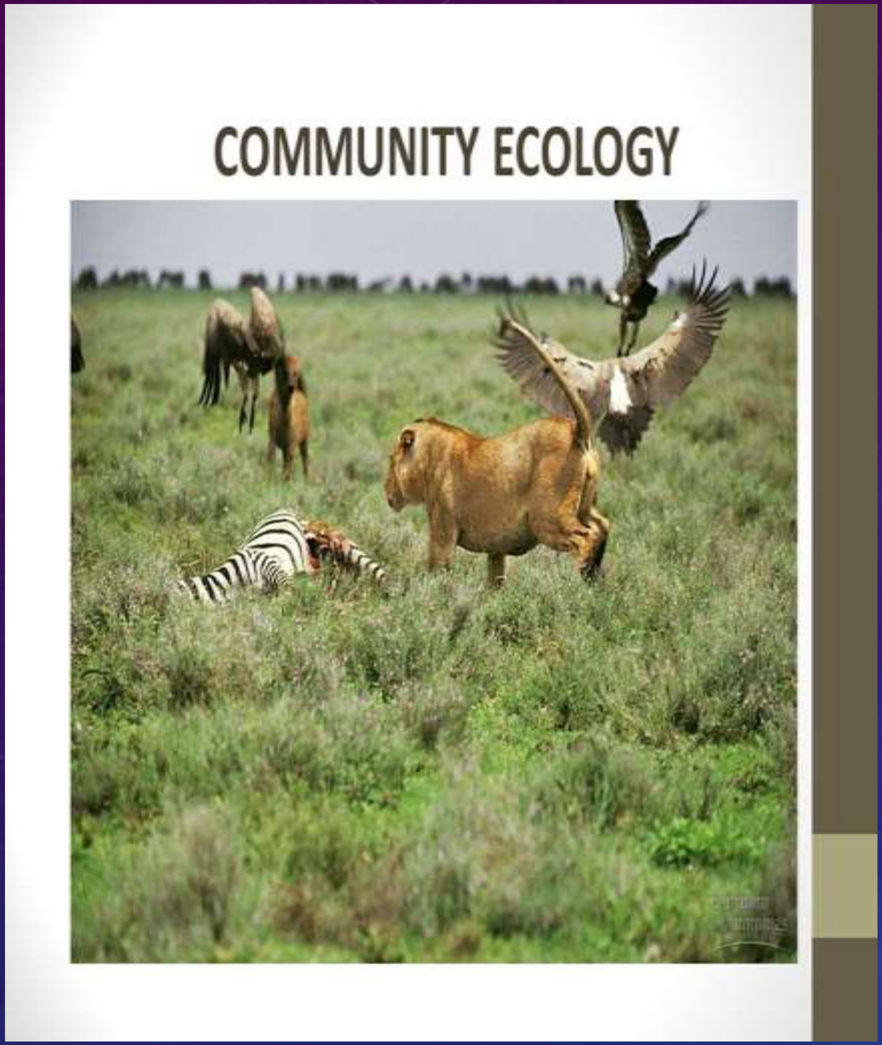


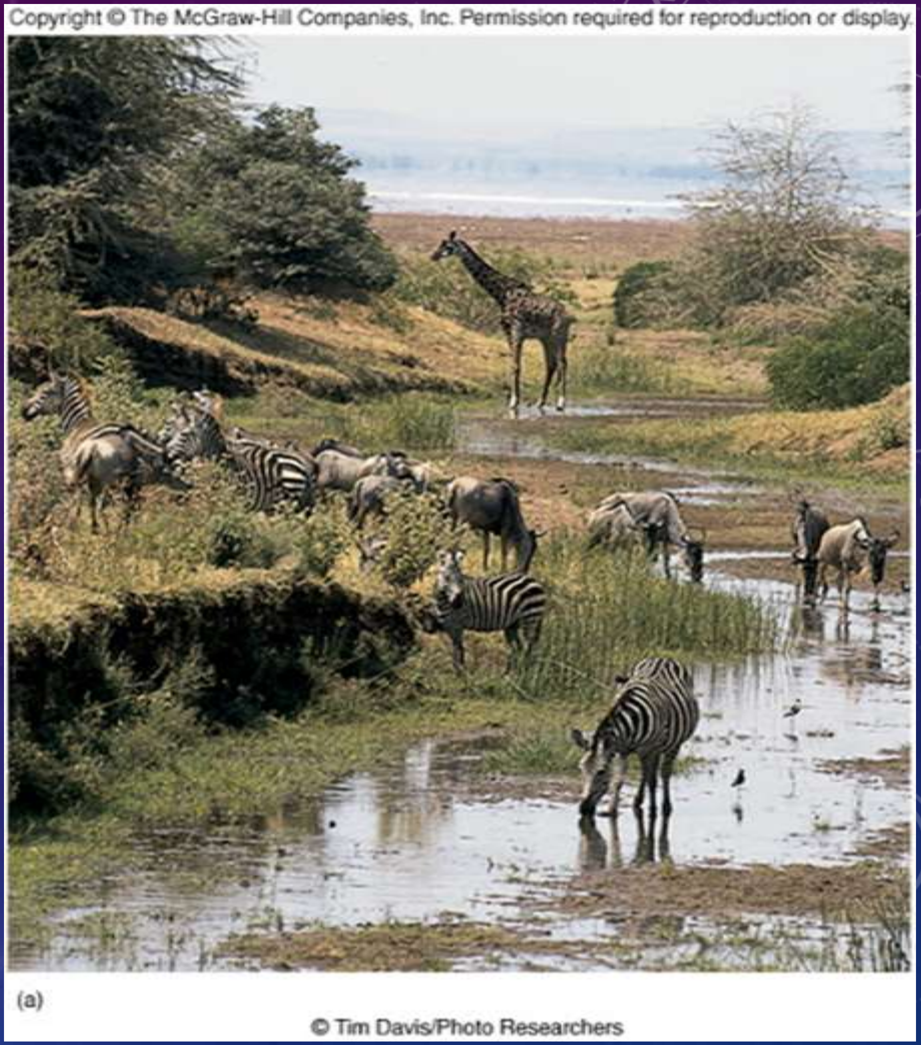


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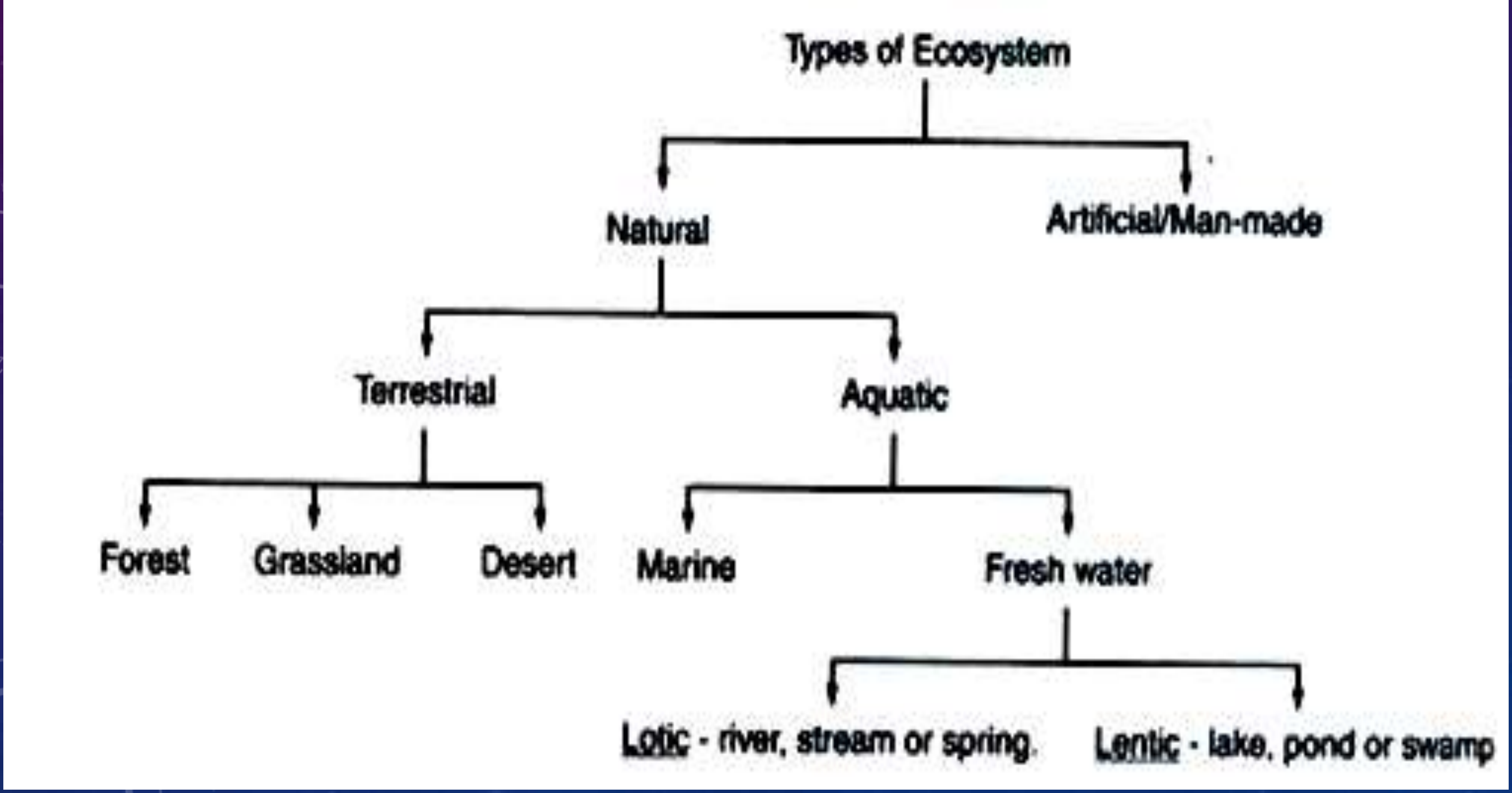

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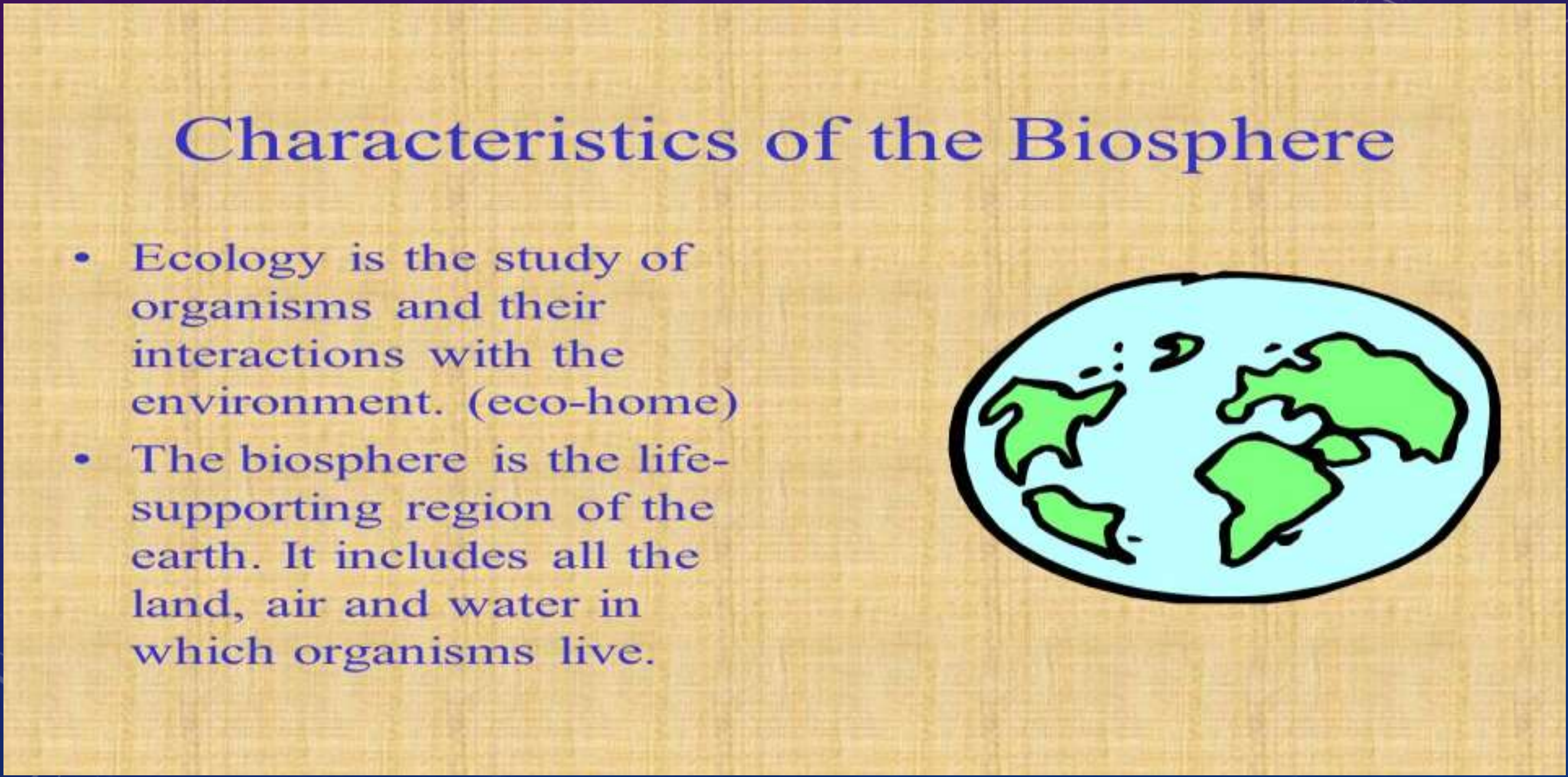

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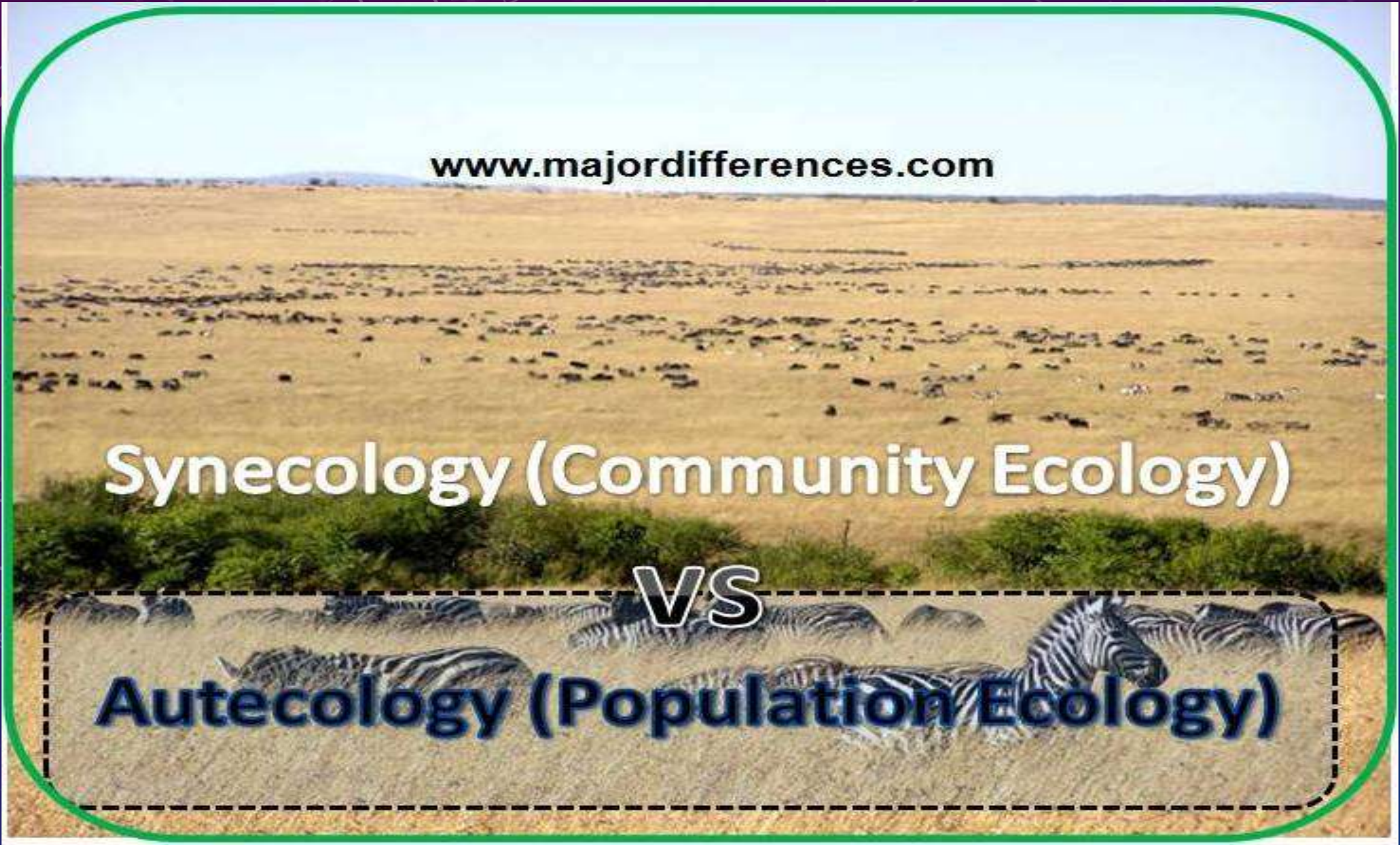
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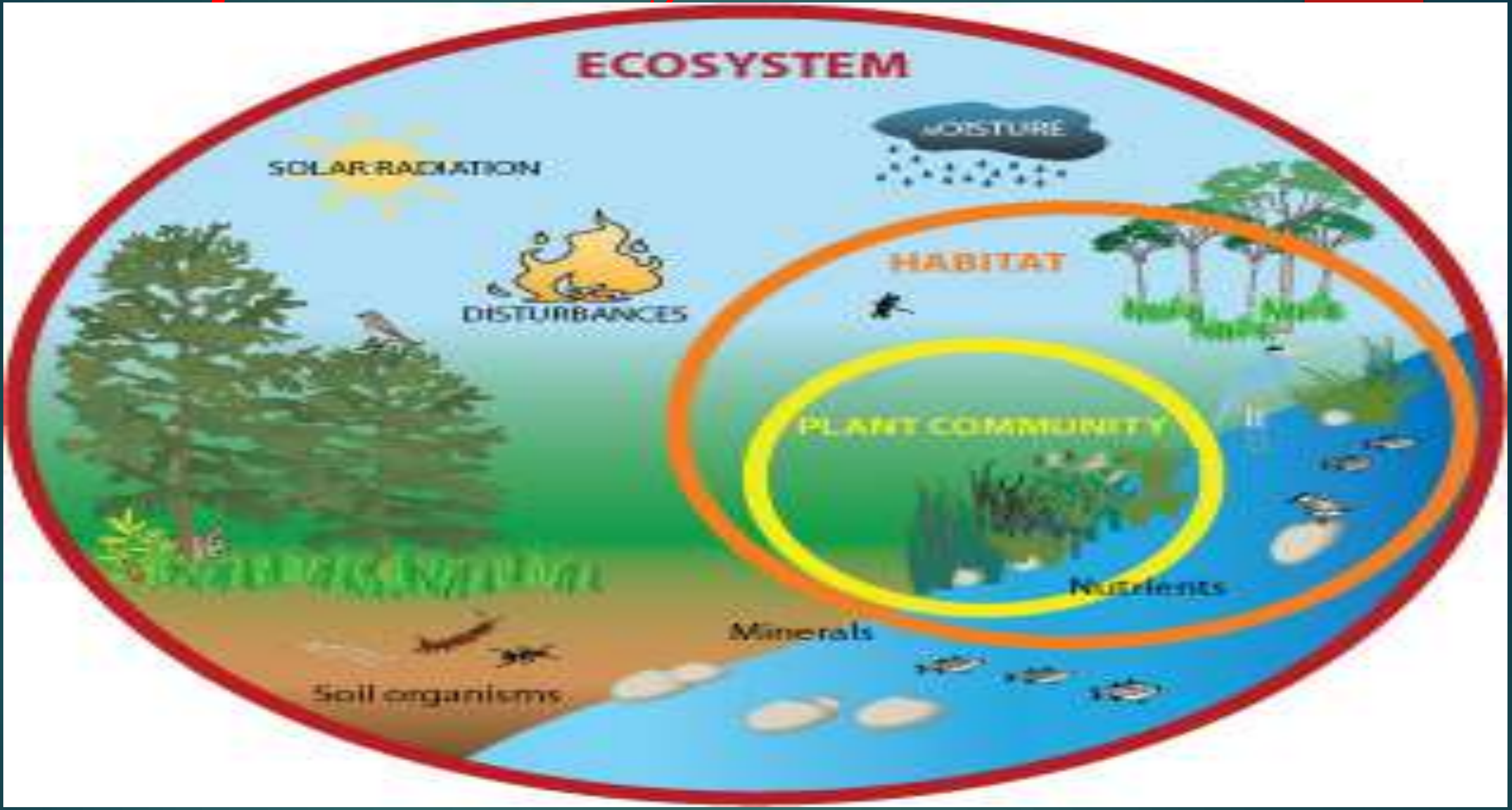
# Chapter 2 Ecosystem Structure

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# Introduction

- No living organism lives alone, they associate with each other and have the functional relationship with external factors.
- It is understood that the structural and functional systems of communities and their environment is called an Ecology and Ecosystem.
- Ecology is a branch of science that deals with the study of a biosphere.
- In the biosphere distinct kinds of plants, animals, microorganisms, and other components surround us.
- The term ecosystem was initially proposed by Arthur George Tansley in 1935.
- An ecosystem is composed of two types of components namely: Abiotic components and Biotic components

# An environment is characterized by the ABIOTIC and BIOTIC factors.

- **Abiotic** factors are *non-living*.
  - Abiotic factors include science like chemistry, physics and geology.
  - Interactions of abiotic factors result in weather, seasonal changes, tides, air quality, and water quality
- **Biotic** factors are *living* and can be categorized within an *ecosystem structure…*

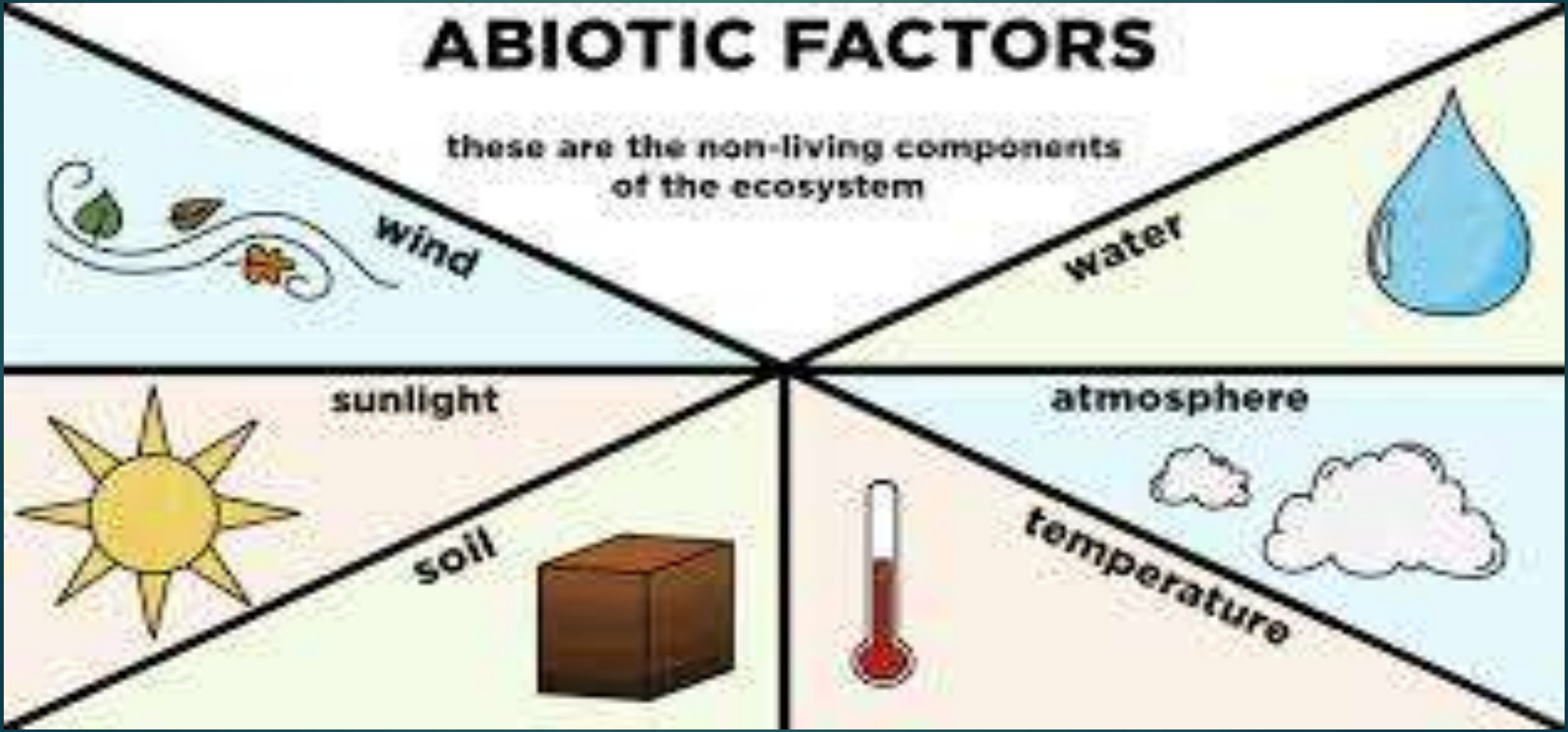
*Species* → *Population* → *Community* →

**ECOSYSTEM:** all of the communities that live in an area together with the abiotic factors in the environment

## 1) Abiotic Components-

**Inorganic substances, organic substances and climate**

**abiotic factors can include water, light, radiation, temperature, humidity, atmosphere, acidity, and soil. The macroscopic climate often influences each of the above. Pressure and sound waves may also be considered in the context of marine or sub-terrestrial environments.**



**2). Biotic components:** **The biotic components are the organic compounds and also known as living component of an ecosystem.** **There are subdivided into Producers, Consumers, Decomposers**

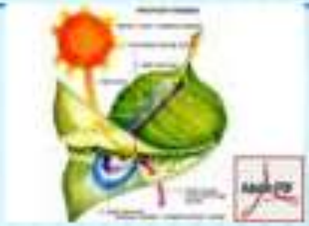
**Producers:** **These are food suppliers to all plants and green trees which are termed as producers. For example, all green plants and trees take carbon dioxide from the atmosphere, water from the soil, and sunlight from the sun. The plants undergo a chemical reaction and it is also known as photosynthesis. During photosynthesis, plants liberate oxygen into an environment which is essential for life. The below equation explains about the photosynthesis reaction and liberation of oxygen**

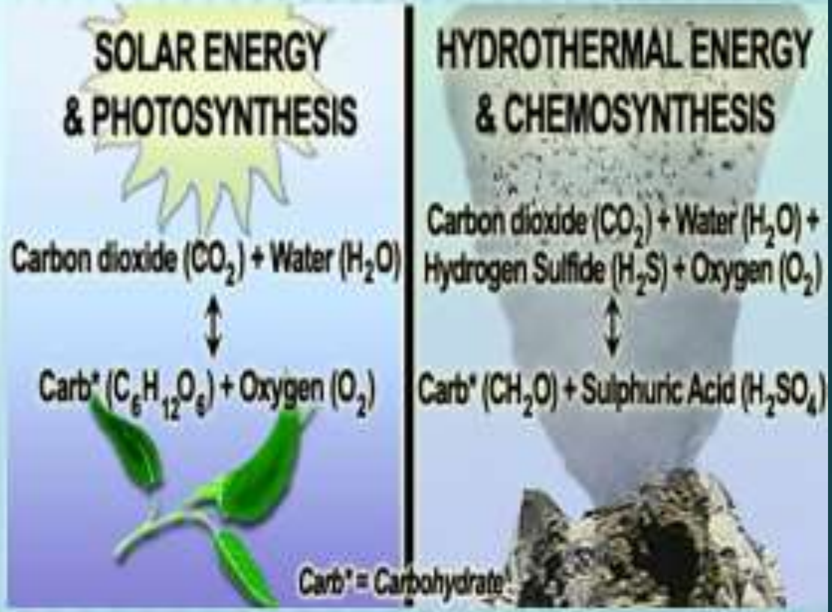
$$6CO_2 \quad + \quad 6H_2O \xrightarrow{Sunlight \,\&\, chlorophyll} C6H_{12}O_6 \quad + \quad 6O_2 \uparrow$$

# PRODUCERS

- Producers are autotrophic organisms that make their own food.
  - Phototrophic organisms use photosynthesis and contain chlorophyll

    (Carbon Dioxide + Water + Sunlight =Sugar + Oxygen)
  - Chemotrophic organisms use chemicals other than $H_2O$, such as $H_2S$





**Consumers:** Consumers are classified into four groups and they are:

**Primary consumers**, **Secondary consumers**, **Tertiary consumers**, **Omnivores**

**Primary consumers:** They depend only on plants for their food and they are called as herbivores. The examples of it are insects, flies, deer, and rabbit.

**Secondary consumers:** These are the animals which depend on herbivores for their food. The examples of it are frog, lizard, fish, and snake.

**Tertiary consumers:** Wild animals like tiger, lion, and fox feed on the animals and they are called as carnivores.

**Omnivores:** Human beings are classified as omnivores and they feed on plants and animals.

*solar energy* → *plants* → *herbivores* → *carnivores* → *human beings*




CONSUMERS!!!

# CONSUMERS

- Consumers are heterotrophic organisms that cannot make their own food. They must ingest (eat) other organisms.

  -Herbivores feed on vegetation (producers).

  -Carnivores feed on herbivores or on other carnivores.

  - *Secondary carnivores* feed on herbivores,
  - *Tertiary consumers* feed on other carnivores

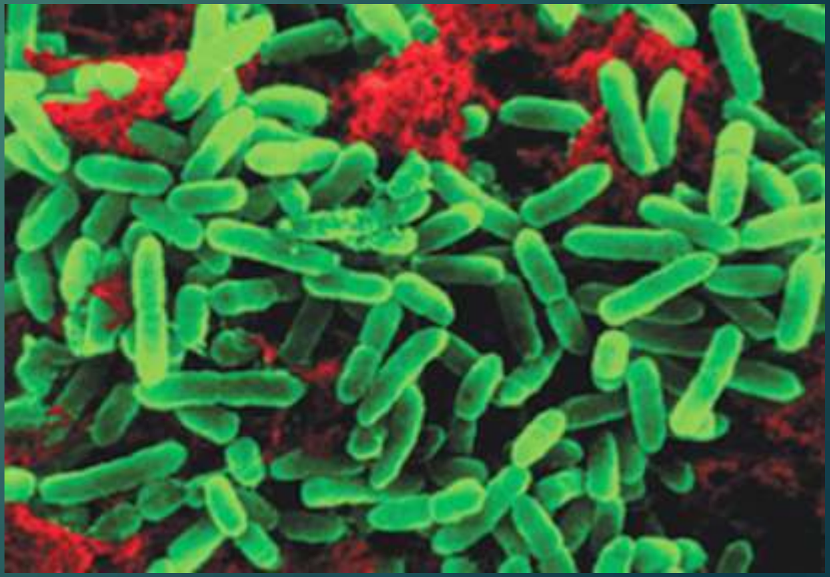
  -Omnivores feed on both producers and consumers

  -Scavengers feed on dead or decaying organisms

## Decomposers:

- Decomposers feed on the dead bodies of plants and animals and convert them back as nutrients into the soil.
- Termites, ants and some other bacteria are called as decomposers.
- Animals such as frog, dog, wolf, and eagles are termed as decomposers.
- The decomposers not only act as scavengers to clean the dead bodies but also serves as parasites, participate to clean the ecological cycles.

**DECOMPOSERS are heterotrophs that recycle small, often microscopic bits of dead organic matter into inorganic nutrients available for plants to take up from the soil.**
**Decomposers RECYCLE nutrients!**



**BACTERIA and FUNGI are decomposers…most worms are plant scavengers!**

Scavengers feed on CARRION (dead or injured animal corpses) and dead plant biomass. Scavengers reduce the size of dead organic matter…Decomposers will finish the job!

Thanks…

F Y B Sc Zoology

Paper II Sem I

# Eutrophication

By

**Dr Bhausaheb R Ghorpade**

Dept Of Zoology

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*Note: This material is only for educational purpose and is non -commercial .*

- **Eutrophication may be defined as the inorganic nutrient enrichment of natural waters, leading to an increased production of algae and macrophytes.**
- **Eutrophication is the process in which a water body becomes overly enriched with nutrients, leading to plentiful growth of simple plant life.**
- **The algal bloom formation and plankton in a water body results into the depletion of dissolved oxygen in water bodies.**
- **Eutrophic waters can eventually become "dead zones" that are incapable of supporting life.**

- Aquatic ecosystems are home to several plant and animal life forms – both simple and complex. The process of eutrophication destroys the balance in these ecosystems by favouring the growth of simple plant life.
- This greatly decreases the biodiversity of the ecosystem by killing off several desirable species.

# Causes of Eutrophication

- When water bodies are overly enriched with the nutrients like nitrogen and phosphorus there will be excess growth of algae, plankton, and other simple plants.
- Agricultural and industrial wastes are also responsible for eutrophication. .
- Phosphorus is considered one of the primary limiting factors for the growth of plant life in freshwater ecosystems.
- The availability of nitrogen is an important limiting factor for the growth of algae.
- Phosphates tend to stick to the soil and are transported along with it.
- Fertilizers ,Untreated sewage, Detergents containing phosphorus, Industrial discharge of waste.

- **When sewage pipes and industrial wastes are disposed in water bodies, the nutrients present in the sewage and other wastes increase eutrophication.**
- **Classification of Eutrophication**
- **1)Anthropogenic Eutrophication : It is caused by human activity – Agricultural practices, golf courses, lawns, etc. are supplied with fertilizers.**
- **These fertilizers are carried by rains into lakes and rivers and they are responsible for excessive growth of algae resulting in the eutrophication of the water body..**
- **2 ) Natural Eutrophication: It is the the excessive nutrient enrichment of water bodies via natural events. E.g. the nutrients carried by flood and deposited into a lake or a river.**
- **These water bodies become overly enriched with nutrients, enabling the excessive growth of algae and other simple plant life.**

# *Effects of Eutrophication*

- Phytoplanktons grow much faster in such situations.
- Frequent fish kill incidents occur and many desirable fish species are removed from the water body.
- The populations of shellfish and harvestable fish are lowered.
- When the dissolved oxygen in the water reduces to an amount below the hypoxic level, many marine animals suffocate and die.
- This reduces the effective biodiversity of the water body.

*Thanks*

## Animal Ecology

# Food Chain

By

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# Food Chain:

- In food chain each organism eats the smaller organisms and is eaten by the larger one.
- All those organisms which are interlinked with each other through food to gather constitute the ecosystem.
- The different levels in a food chain are called tropic levels, Each food chain has three main tropic levels:- Producer level, Consumer level, and decomposer level.
- If any of the intermediate stage of the food chain is removed, the succeeding links of the food chain will be affected.
- The arrangement in a food chain can be depicted as :

**B. Food Chain**—series of steps in which organisms **transfer energy** by eating and being eaten

1. Arrows go in the **direction** of how energy is **transferred**

2. Start with **producer** and end with top **consumer** or carnivore

Ex: **grass** → **cricket** → **frog** → **raccoon**

# Types of Food Chains

***1)Grazing Food Chain:*** **This type of food chain starts from living green plants goes to grazing herbivores and onto carnivores. Ecosystem with such type of food chain directly depends upon the solar energy for their food requirements. Most of the ecosystem in nature follow this type of food chain.**

***2)Detritus food Chain:*** **This type of food chain goes from dead organic matter onto microorganisms and then to the organisms feeding on detritus and their predators. Such ecosystem are less dependent on direct solar energy.**

***3) Parasitic Food Chain:*** **This type of food chain starts from big hosts and ends with parasitic organisms.**

# Ecological Pyramids

- The different species in a food chain are called tropic levels.
- Each food chain has 3 main trophic level, producer, consumer, and decomposers.
- Thus Graphical representation of these trophic levels is called as Ecological Pyramids.
- It was devised by an ecologist " Charles Elton" therefore this pyramid are also called Ecological pyramid or Eltonian pyramids.
- Types of Ecological Pyramids
- Ecological pyramids are of three types:
  1. Pyramid of Number
  2. Pyramid of biomass
  3. Pyramid of Energy

## 1) Pyramid of Number

- They show the relationship between producers, herbivores, and carnivores at successive tropic levels in terms of their number.
- In case of grassland ecosystem the producers are mainly grasses and are always maximum in number this number then shows a decrease towards apex as primary consumers like mice, rabbit are lesser in number than grasses, the secondary consumers like lizard, snake, are even lesser in number than the grasses, finally the top tertiary consumers like hawks are least in number.
- Thus the shape of pyramid is upright. But in case of forest ecosystem the pyramids is always inverted because the producers are mainly large trees, are lesser in numbers, the herbivores fruit eating birds are more in number than the producers, then there is gradual decrease in number of secondary consumers thus making pyramid upright again.
- Thus the pyramid of number does not give a true picture of the food chain and are not very functional.

## Energy Pyramid:

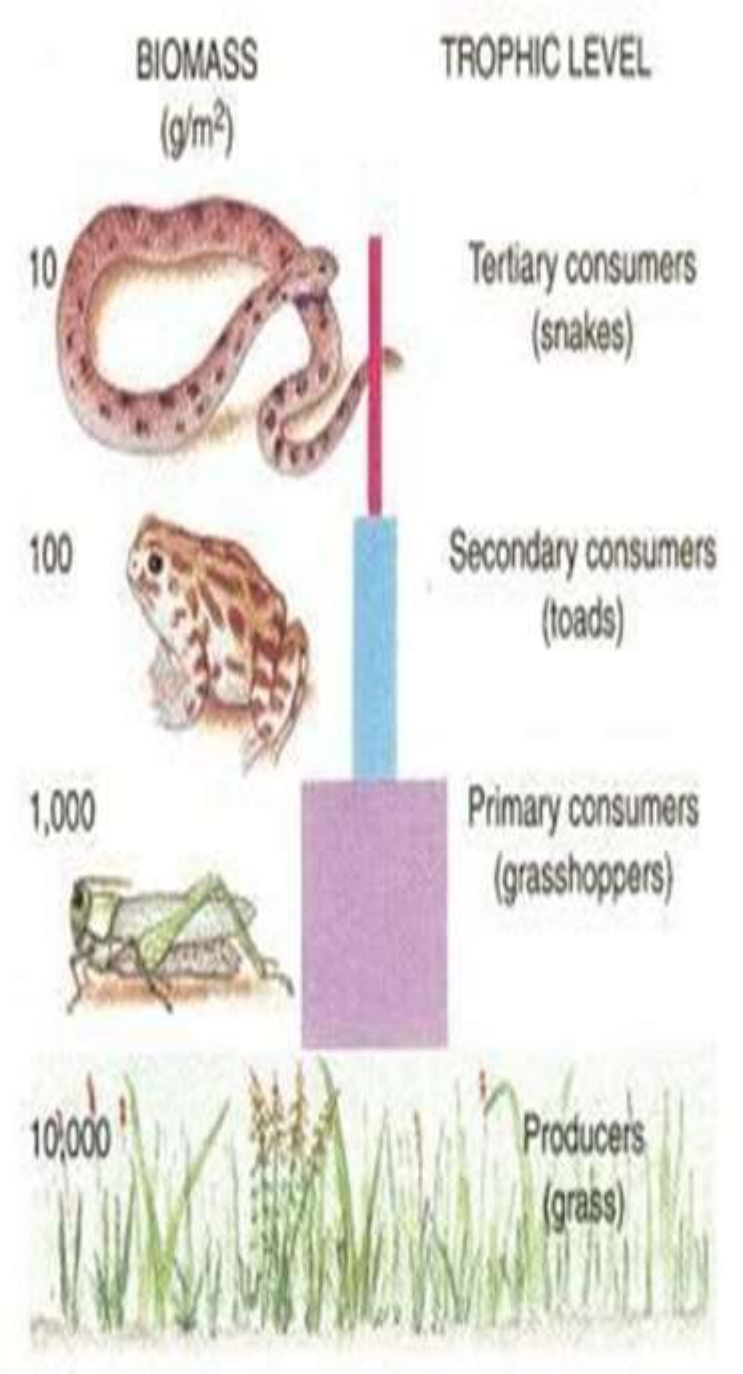
- This shows relative amount of energy available at each trophic level Organisms in a trophic level use the available energy for life processes (such as growth, photosynthesis, cellular respiration, metabolism, etc.)and release some energy as heat

- Remember: Every chemical process that happens in your body releases heat as a byproduct (ex: burning calories).
- Rule of 10—only about 10% of the available energy within a trophic level is transferred to the next higher trophic level

- Biomass Pyramid—represents the amount of living organic matter at each trophic level

## 2) Pyramid of Biomass

- The pyramid of biomass represents the relationship between different tropic levels in terms of biomass.
- There is generally gradual decrease in biomass of organisms at successive levels from the producers to the top carnivores.
- Thus pyramid of biomass is upright for grassland ecosystem.
- However in case of a pond as the producers are algae, are least in number and this value gradually shows an increase towards the apex of pyramid thus making the pyramid inverted in shape.



# F Y B Sc Zoology

## Paper II Sem I

# Types of Ecosystem

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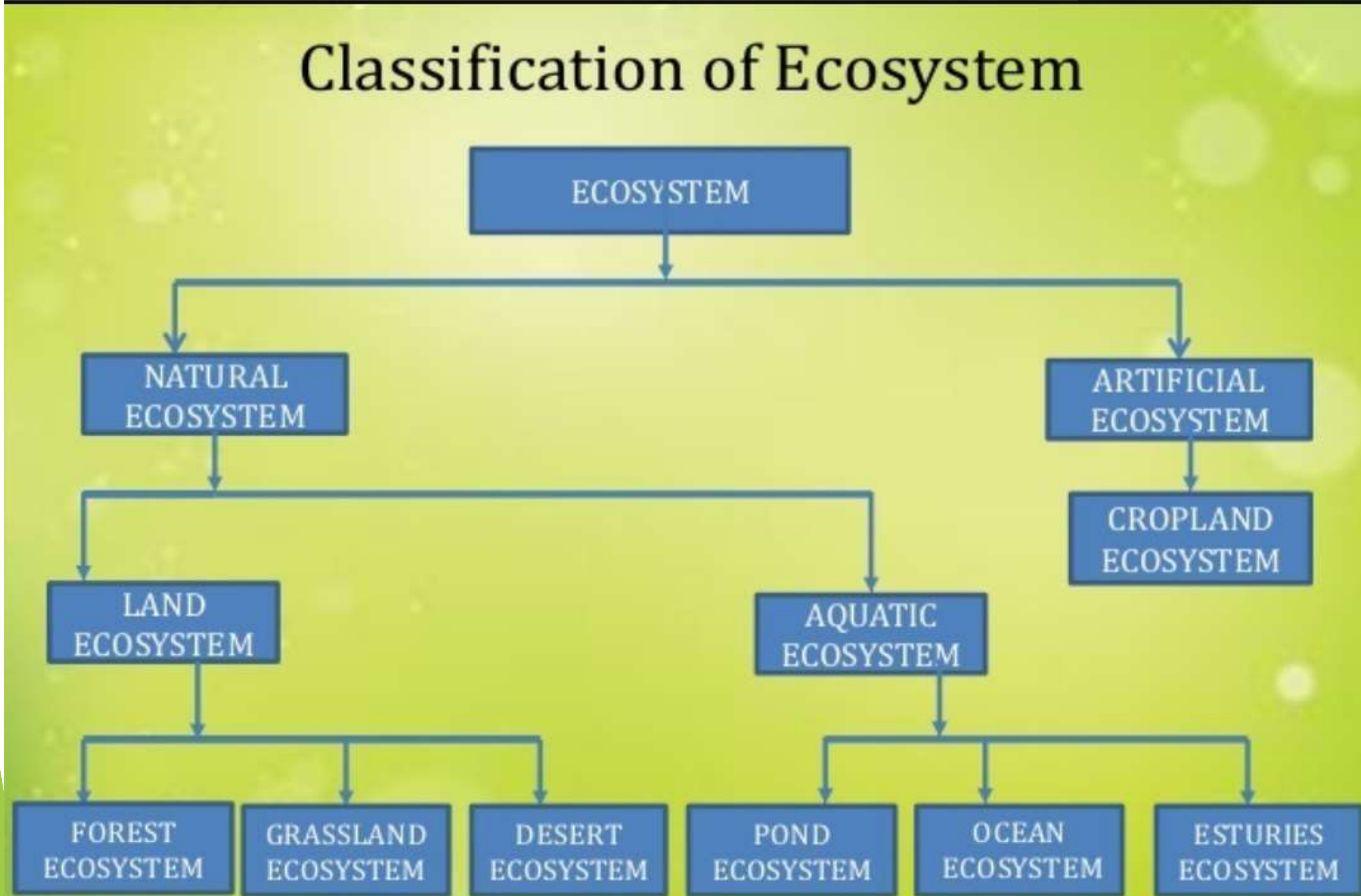
- ***The term 'ecosystem' was proposed by a british ecology A.G.Tansley in the year 1953.***
- ***"The ecosystem represents the basic functional unit of ecology which comprises of the biotic communities mutually related with their noliving or abiotic environment."***
- ***An ecosystem is a biological environment consisting of all the organisms living in a particular area, as well as all the non-living***
- **According to E.P. Odum, an American Ecologist , the ecosystem is the basic functional unit of organism and their environment interacting with each and with their one components.**
- **e.g. Grassland, forest, Aquarium, Pond, Lake, River and Ocean.**

Cont…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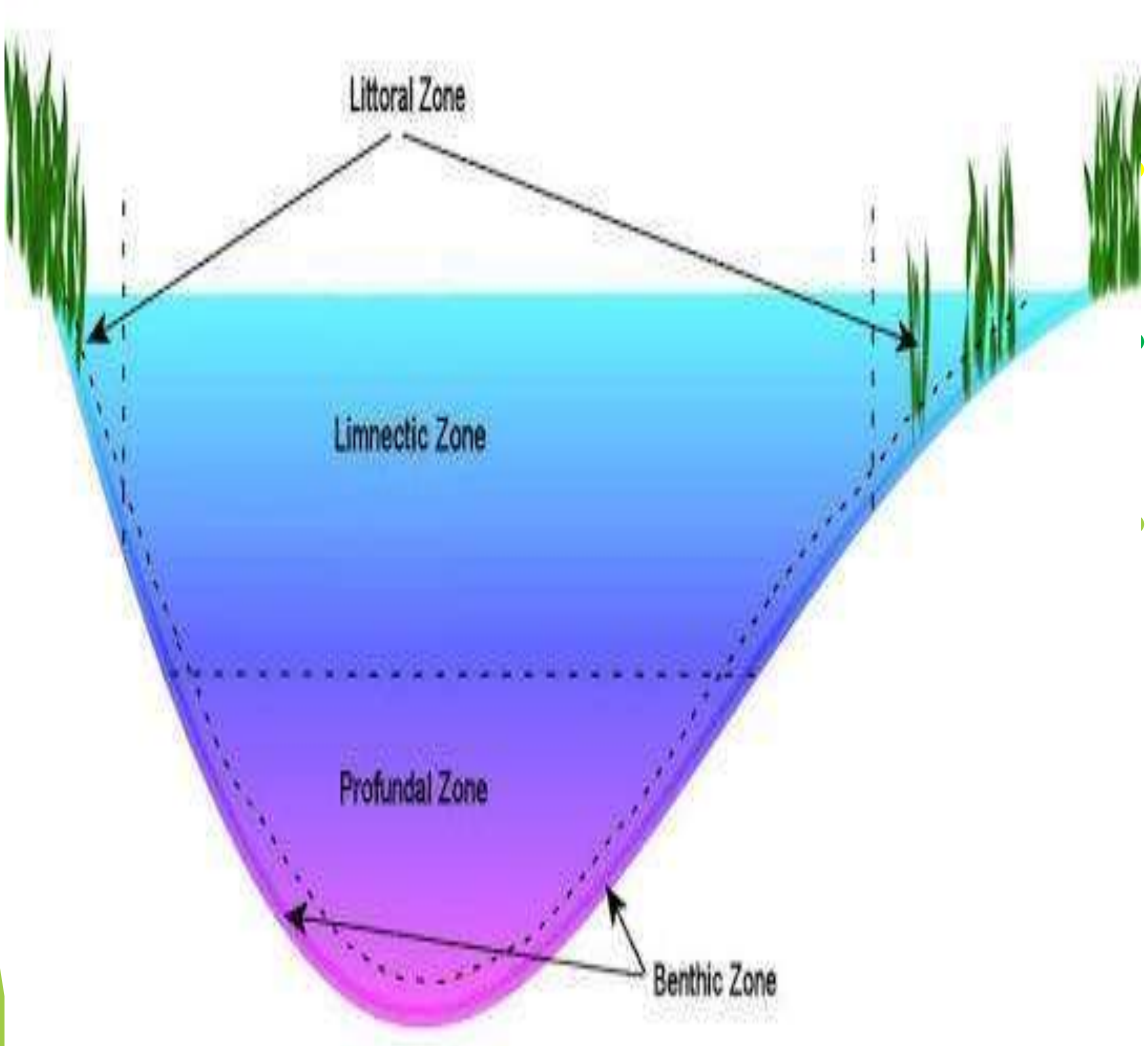
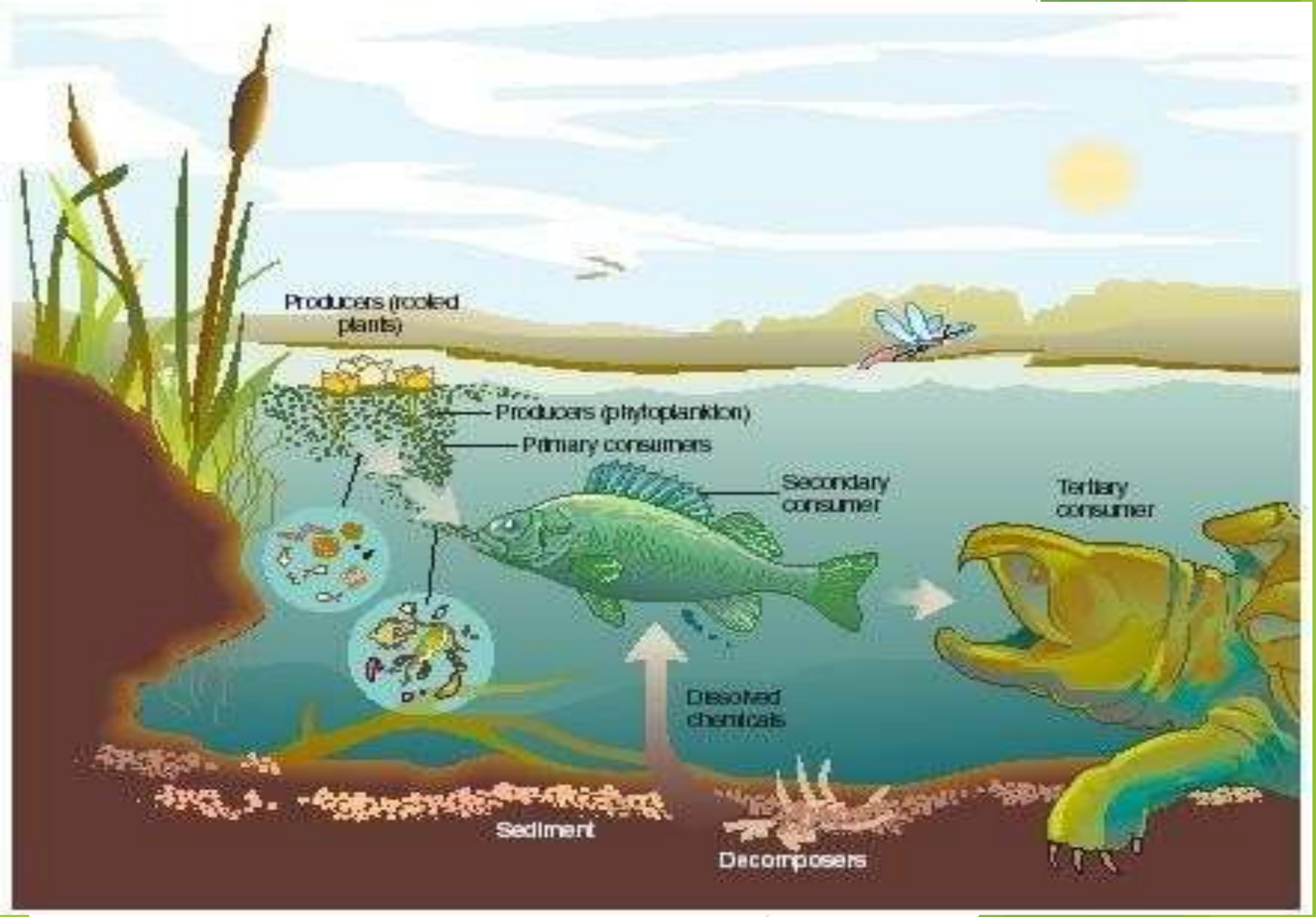
# (1) FRESH WATER ECOSYSTEM




- A) Lentic Ecosystem
- Pond Ecosystem
- Abiotic component
- Biotic component.

# Pond Ecosystem



- ***Producers***

- ***Macrophytes:*** **large rooted plants, which include partly or completely submerged hydrophytes, eg *Hydrilla, Trapha, Typha.***
- ***Phytoplankton:*** **minute floating or submerged lower plants eg algae.**
- ***Consumers:*** **heterotrophs which depends for their nutrition on the organic food manufactured by producers.**
- ***Primary Consumers*: *Benthos*: animals associated with living plants ,detrivores and some other microorganisms *Zooplanktons:* chiefly rotifers, protozoans, they feed on phytoplankton**
- ***Secondary Consumers:*** **They are the Carnivores which feed on herbivores, these are chiefly insect and fish, most insects & water beetles, they feed on zooplanktons.**
- ***Tertiary Consumers:*** **These are some large fish as game fish, turtles, which feed on small fish and thus become tertiary consumers.**
- ***Decomposers:*** **They are also known as micro-consumers. They decompose dead organic matter of both producers and animal to simple form. Thus they play an important role in the return of minerals again to the pond ecosystem, they are chiefly bacteria, & fungi.**

## B) Lotic Ecosystem River Ecosystem

- As Compared with lentic freshwater (Ponds & lakes), lotic waters such as streams, and river have been less studied. However, the various components of an riverine and stream ecosystem can be arranged as follows.
- **Producers:** The chief producers that remain permanently attached to a firm substrata are green algae as Cladophora, and aquatic mosses.
- **Consumers:** The consumers show certain features as permanent attachment to firm substrata, presence of hooks & suckers, sticky undersurface, streamline bodies, flattened bodies.. Thus a variety of animal are found, which are fresh spongy and caddis- fly larvae, snails, flat worms etc.
- **Decomposers:** Various bacteria and fungi like actinomycetes are present which acts as decomposers.

# Species in Riverine Ecosystem

- ***A) ABIOTIC COMPONENT:-***
- ***Abiotic component of pond consists of water, dissolved minerals, oxygen and carbon dioxide.***
- ***Solar radiation are the main source of energy***
- ***B) BIOTIC COMPONENT:-***
  - ***producers.***
  - ***consumers.***
  - ***Decomposers and transformers.***

# i) PRODUCERS:-

- *The main producers in pond or lake ecosystem are algae and other aquatic plants.*
- *eg :- such as azolla, hydrilla, lemna,nymphaea,etc..*
- *These are either floating or rooted at the bottom.*
- *The green plants convers the radiant energy into chemical energy throgh photosynthetisis.*
- *The chemical energy stored in the form of food.*

## ii) CONSUMERS:-

- In a pond ecosystem the primary consumers are tadpole, larvae of frogs, fishes and other and other aquatic animals which consumer green plant and algae as their food.
- E.G:- frogs, big fishes, water snakes, etc..
- In the pond, besides the secondary consumers of highest order, such as water birds etc...

# iii)DECOMPOSERSAND RANSFORMERS:-

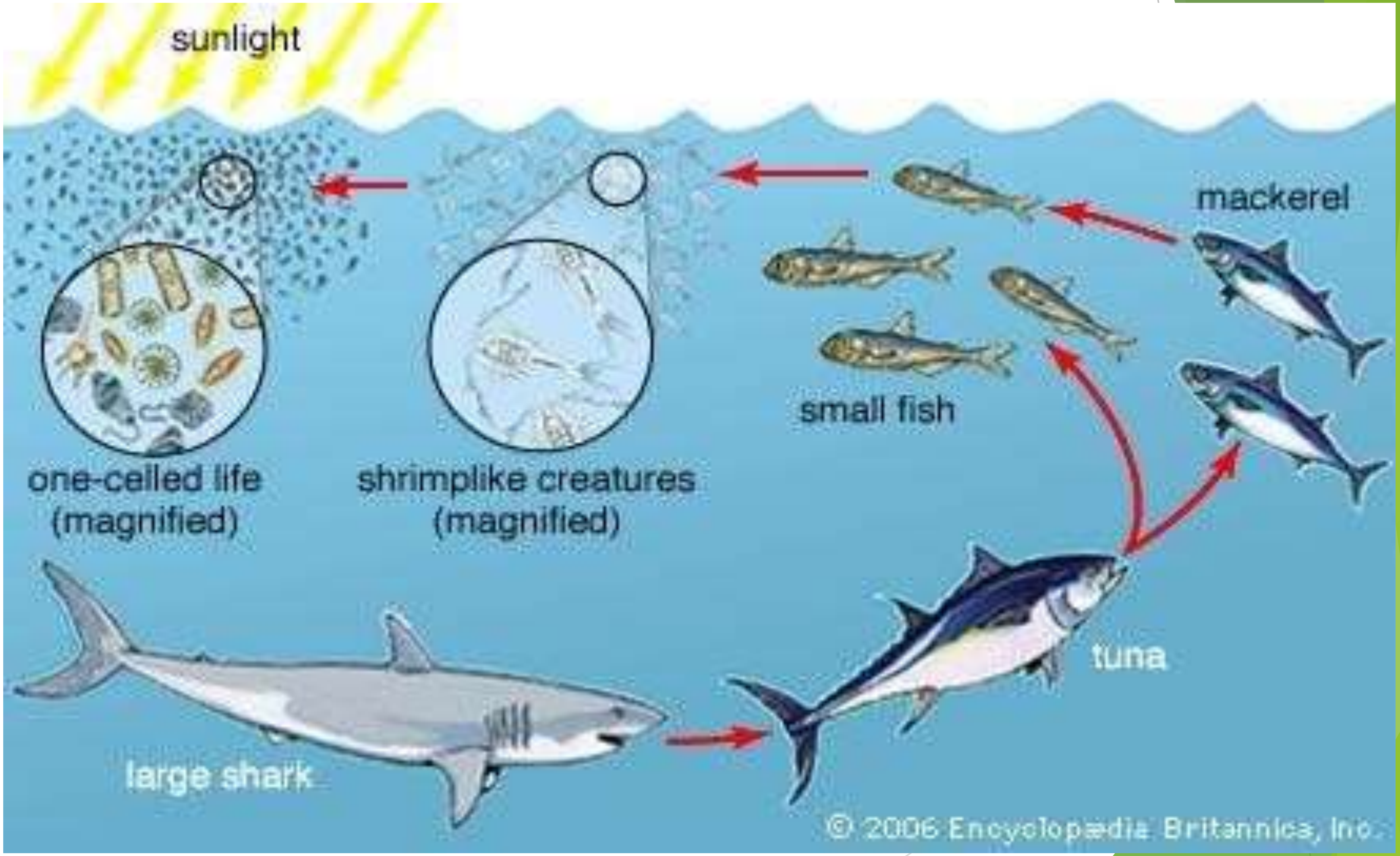
- When aquatic plant and animals die, large numbers of bacteria and fungi attach their dead bodies and convert the complex arganic substance into simple inorganic compounds and elements.
- These micro organismare called decomposers.

- e.g:- saprophytic bacteria and fungi.

# Marine Ecosystem

- Ocean Ecosystem are more stable than pond ecosystem, they occupy 70 % of the earth surface.
- *Abiotic Components*: Dissolved oxygen, light, temperature, minerals.
- Biotic Components:
- *Producers:* These are autotrophs and are also known Primary producers. They are mainly, some microscopic algae (phyto-planlanktons) besides them there are mainly, seaweeds, as brown and red algae also contribute to primary production.
- *Consumers:* They are all heterotrophic macro consumers
- *Primary Consumer:* Theherbivores,that feed on producers are shrimps, Molluscs, fish, etc.
- *Secondary Consumers:* These are carnivores fish as Herring, Shad, Mackerel, feeding on herbivores.
- *Tertiary Consumers:* These includes, other carnivores fishes like, COD, Halibut, Sea Turtle, Sharks etc.
- *Decomposers*: The microbes active in the decay of dead organic matter of producers, and animals are chiefly, bacteria and some fungi.

# Ocean Ecosystem



# i) PRIMARY PRODUCERS:-

- ***These are diatoms, dinoflagellates, few microscopic and unicellular algae, weeds and brown and red algae.***
- ***These form the basic of all other life found in sea.***

## ii) SECONDARY CONSUMERS:-

- ***Also known as the primary consumers of the sea these are certain large sized fish.***
- ***e.g. :- marckerel, herring, shark, etc..***
- **Certain fish feed primary upon smaller members of their own class and the growth of shark represent a food chain of five or more links.**

## DECOMPOSERS AND TRANSFORMERS:-

- The decomposers of sea are marine bacteria.

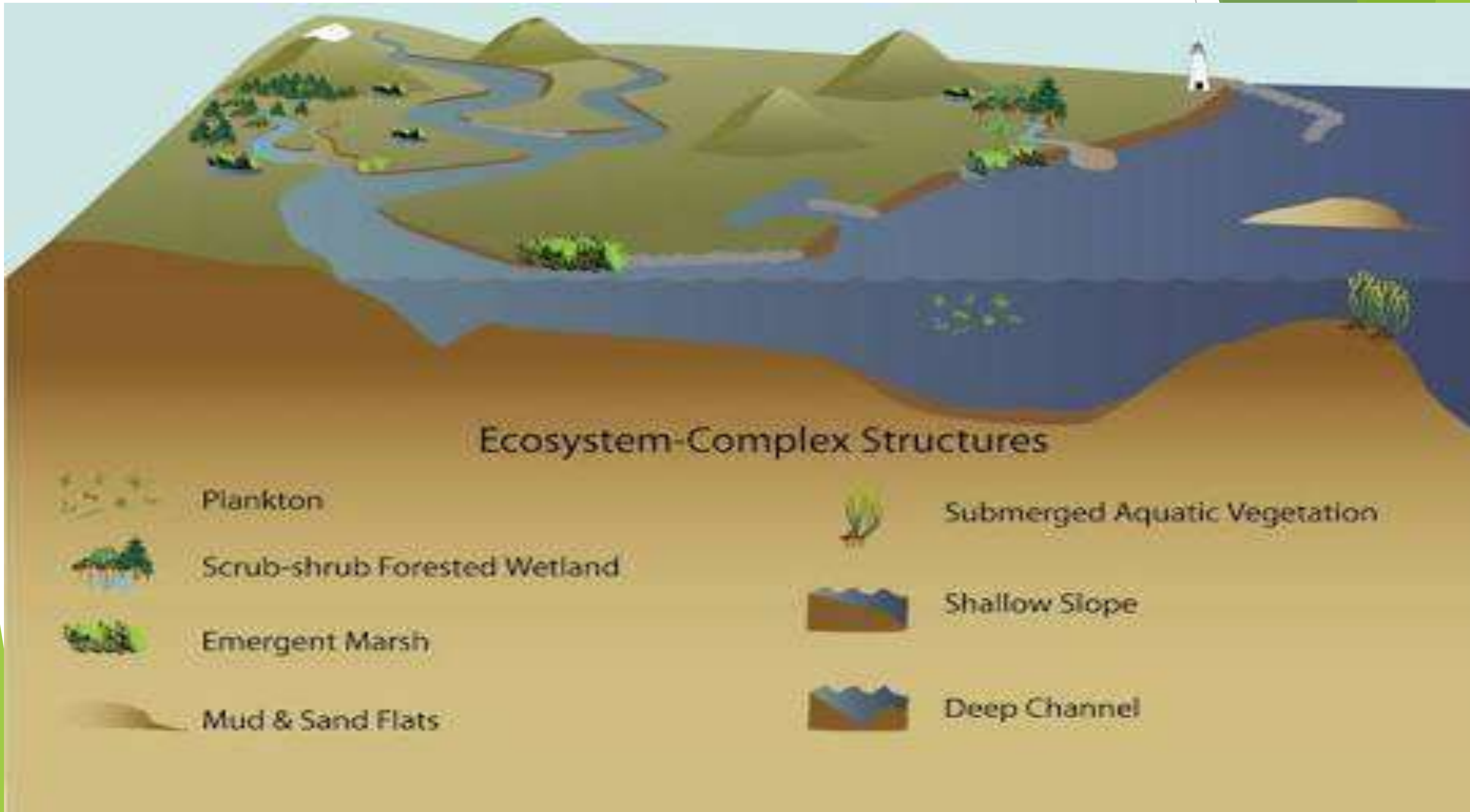
- The soluble and decomposed material is now attached by other type of bacteria, the transformers, and converted to forms to be reused by the green plants.

# (3) ESTUARINE ECOSYSTEM

- **There are two main components.**
  - **Abiotic components:- such as phosphorus and nitrogen, temperature, light,pH.**
  - **Biotic components:-**
- **producers:- these micro-organism manufacture food by photosynthesis and absorb nutrients.**
- **primary consumers:- zooplanktons that feed  on phytoplankton, besides them some small  micro-organisms that feed on producers.**

iii) **Secondary consumers:-** Include shellsish, small fish, feeding on zooplanktons.

iv) **Decomposers:-** fungi & bacteria are the chief microbes active of dead organic matter.



# FUNCTION:-

- ***Aquatic ecosystem perform many important enviromental function.***
- ***They recycle nutrients, purify water, recharge ground water and provide habitats for wildlife.***
- ***Aquatic ecosystem are also used for human recreation, and are very important to the tourism industry.***

- **A stress on an aquatic ecosystem can be a result of physical, chemical or biological alterations of the environment.**

- ***Biological organism found in aquatic ecosystem are either autotropic or heterotropic.***

- **Physical alterations include changes in water temperature, water flow.**

- **Abiotic enviromental factors of aquatic ecosystem include temperature, salinity and flow.**

## Estuarine Ecosystem

- **An estuary is a partially enclosed body of water along the coast where fresh water from river and streams meet and mix with salt water from oceans. This Ecosystems are considered as most fertile ecosystem.**
- **Abiotic Components: Nutrients such as phosphorus and nitrogen, temperature, light, salinity, pH.**
- **This ecosystem experience wide daily and seasonal fluctuations in temperature and Salinity level because of variation in freshwater in flow.**
- ***Biotic Components:***
- ***Producers: Phyplanktons*- these micro-organisms manufacture food by photosynthesis and absorb nutrients such as phosphorous and nitrogen, besides them, mangroves, sea grass, weeds, and salt marshes.**
- ***Consumers: Primary consumers*, Zooplanktons that feed on Phytoplankton, besides them some small microorganisms that feed on producers.**
- ***Secondary Consumer:* Include worms, shellfish, small fish, feeding on Zooplanktons**
- ***Tertiary Consumer* :Fishes, turtles, crabs, starfishes feeding on secondary consumers.**
- ***Decomposers:* Fungi & Bacteria are the chief microbes active in decay of dead organic matter.**

## Terrestrial Ecosystem

1) **Forest ecosystem**

**It is the best example of a terrestrial ecosystem. Like other ecosystems, there are two main components of the forest ecosystem:**

1. **A biotic component.**
2. **Biotic component.**

**(1) A biotic component: In a forest ecosystem soil, moisture, air and sun light from the a biotic or physical component.**

**(2) Biotic component: There are three important classes of biotic components:**

**I. Producers II. Consumers III.Decomposers**

# 1. Producers:

- All the green plants of forest are producers. They are the main sources of food for all the animals. There are several layers of vegetation in the forest.
- The plants of top stratum are angiospermous and gymnospermous trees.
- These plant utilize radiant energy of sun to the greatest extent.
- Below the level of tree there is layer of shrubs which consume light energy of intensity coming through trees.
- Just below the shrubs there are gasses, herbs, lichens and mosses.

- 2. Consumers :
- There are a number of consumers in an old dense forest.
- Consumers of first order in the forest are grasshoppers, rabbit, deer, monkey and many other wild herbivorous animals which utilize plants directly as their food.
- Secondaryconsumersare wolves, pythons consume the flesh of herbivores. etc.
- Lion, Which Tiger,Hawks are the consumers of top level.

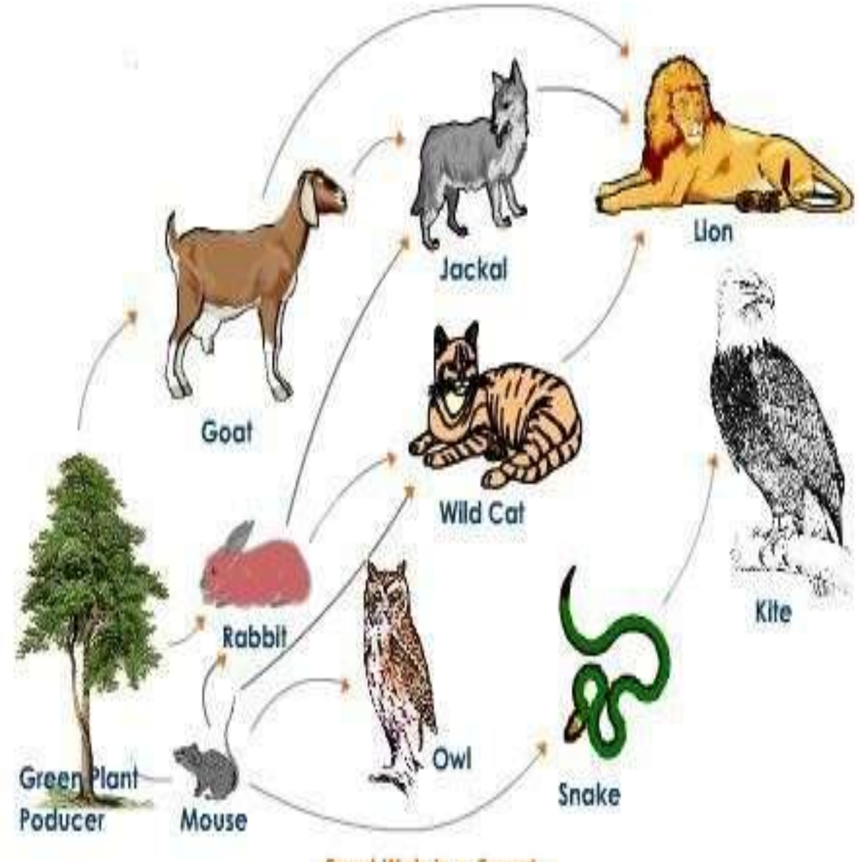
## 3.Decomposers and Transformers

- **These are micro- organisms, chiefly bacteria and fungi which attack dead bodies or producers and consumers and convert complex organic compounds into simpler in organic compounds and elements.**
- **These free elements again return to the a biotic component and are re-utilised by producers in their nutrition.**

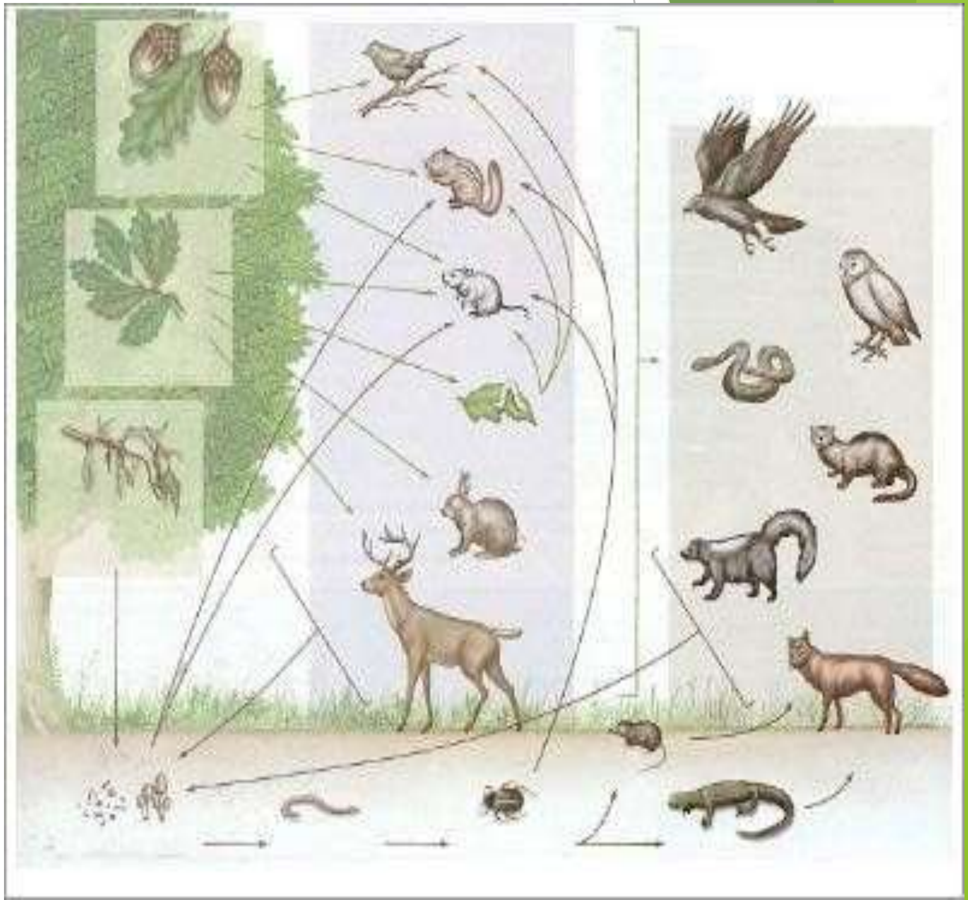
Cont…

- **Forest Ecosystem**
- **Forest Occupy roughly 40 % of the land. The different components of forest ecosystem are as follows:**
- ***Abiotic Components:*** **These are organic & inorganic substances present in the soil and atmosphere. In addition to minerals present in forest we find the dead organic debris, moreover light conditions are different due to complex stratification in the plants.**
- ***Biotic Components:***
- **Producers These are mainly trees that show much species and greater degree of stratification. Besides trees there are also present shrubs, and ground vegetation.**
- ***Consumers:*** **Primary Consumers: These are herbivores that include animals feeding on tree leaves, ants, beetles, grass hoppers, etc., and large elephants, dears, squirrels, etc.**
- ***Secondary Consumers:*** **These are carnivores, like snakes, birds, lizards, fox, etc. feeding on herbivores.**
- ***Tertiary consumers:*** **These are top carnivores like lion tiger, etc. that eat carnivores of secondary level.**
- ***Decomposers:*** **These are wide variety of micro organisms including, fungi, bacteria.**

# Forest Ecosystem



Food Web in a Forest



- **2. Grassland Ecosystem:**
- **Grassland occupy about 19% of the earth's surface.**
- **The major grassland ecosystem of the world are the great plains of Canada and United states, South Argentina to Brazil and south Asia to central Asia.**
- **The various components of a grassland ecosystem areas fellows:**
- **(1) A biotic components: The nutrients present in soil and the areal environment are the a biotic components are supplied by CO2, water, nitrates, Phosphates and sulpltates).**

(2)Biotic components:

(a) grasses,likeDichanthium cynodon,Desmodium, Digitaria,Ddactyloctenium, Setaria etc. as

a)producers;

(b)Animals like Cow, Buffaloes, Deers, Sheep, mouse and many insects as consumers,

(c)fungi like Mucor, Asperillus, Pencillium, Cladosporium, fusarium and,

(d)bacteria as the decomposers.

Cont…

- **Producers:**
- **These are mainly grasses of the family**
- **Graminae, a large variety of herbs, some shrubs Scattered trees.**
- **Consumers:**
- **herbivores such as grazing mammals(e.g. cows,sheeps, rabbits etc.)**
- **Insects(e.g. Dysdercus, Coccinella, Leptocorise, etc.)**
- **some terminates and millipendes are the primary consumers.**

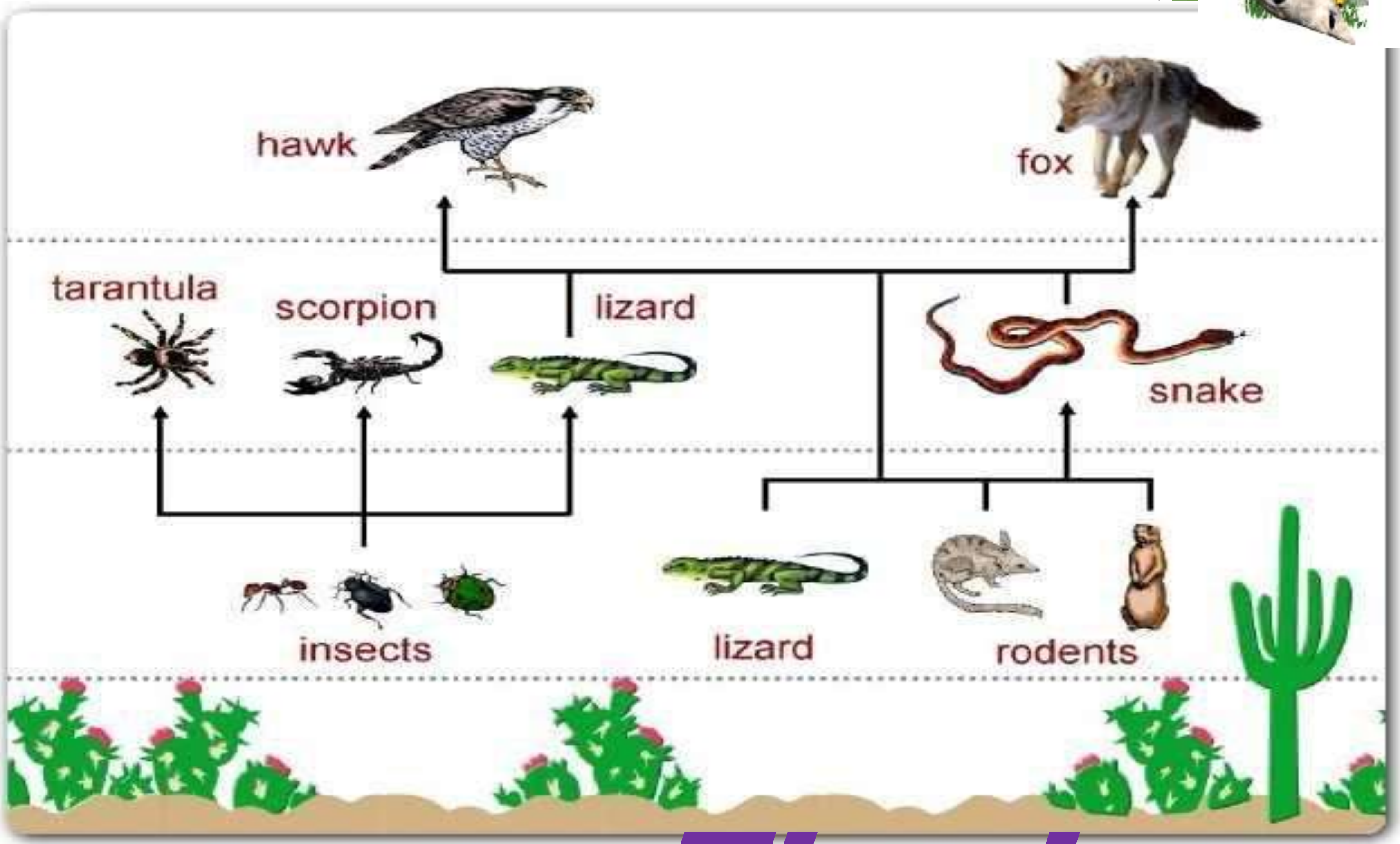
- **The animals like Fox, Jackals, Snakes, Birds etc. are the camivores feeding on herbivores.**
- **These are the secondary consumers of the grassland ecosystems.**
- **Hawks occupy the territory trophic level as these feed on the secondary consumers.**

- **Decomposers :**
- **These include bacteria of death and decay, moulds and fungi(e.g. Mucor, Pencillium, Aspergillus, Rhizopus etc.)**
- **These buing the minerals back to the soil to be available to the producers again.**

## Desert Ecosystem

- Desert occupy 17 % of land.
- Abiotic components include, light, temperature, minerals.
- Biotic Components:
- Producers : These are shrubs, especially bushes, some grasses, and few trees.
- E.g. Cacti, Xerophytes, mosses
- Consumers: The most common animals are reptiles, and insects, there are some rodents, and birds, and above all ship of desert camels, feed on tender plants.
- Decomposers: These are very few as due to poor vegetation the amount of dead organic matter is less. They are some fungi and bacteria.

# Desert Ecosystem




**Thanks….**

# F Y B Sc Zoology

## Paper II Sem I

# 2.2.1 Terrestrial Ecosystem

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Dist Ahmednagar (MS)

- The term 'ecosystem' was proposed by a british ecology A.G.Tansley (1953.)
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- An ecosystem is a biological environment consisting of all the organisms living in a particular area, as well as all the non-living
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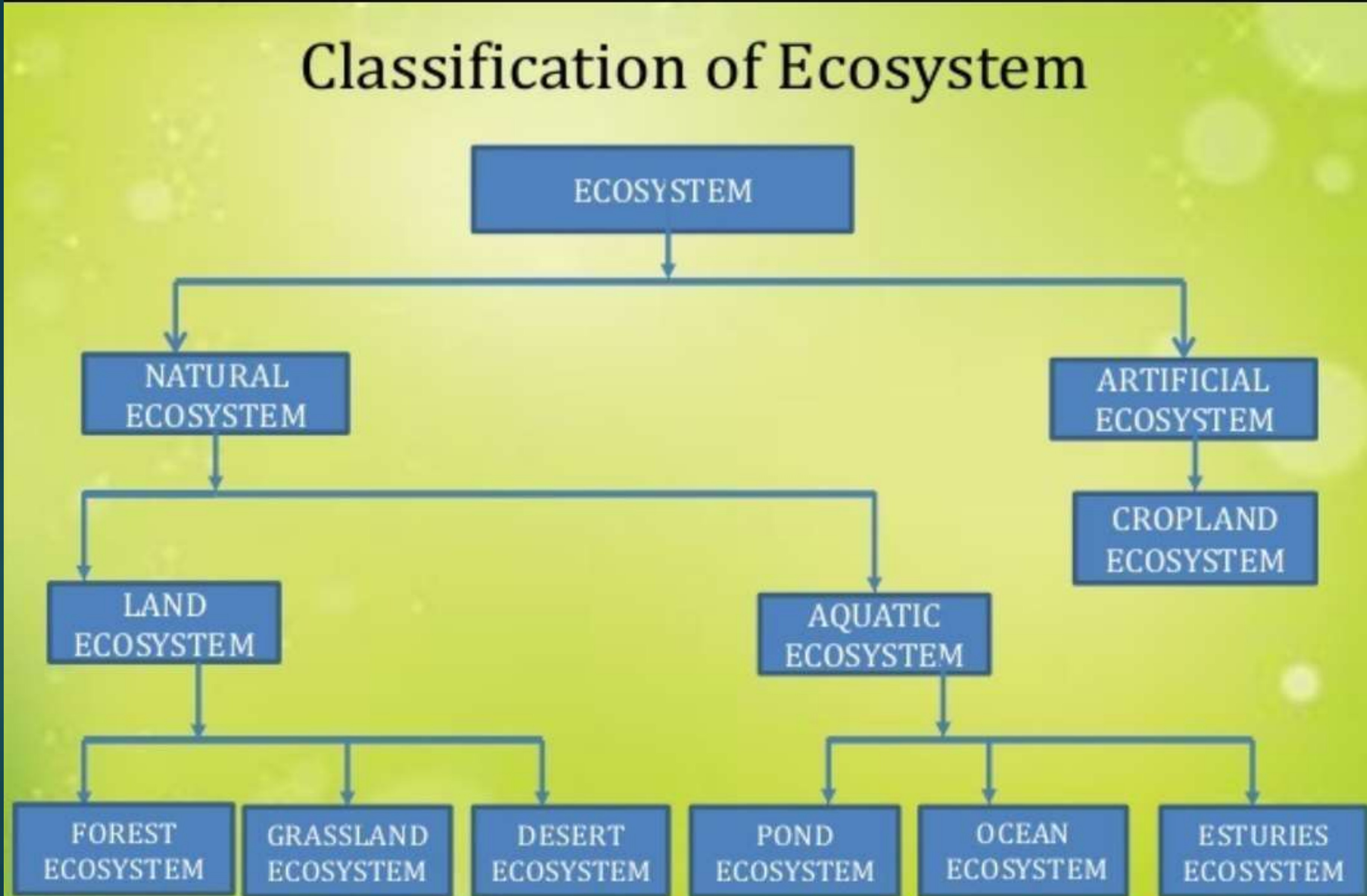
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OCEAN ECOSYSTEM
ESTURIES ECOSYSTEM

# Terrestrial Ecosystems

Forests, Deserts, Grasslands, Mountains

# Terrestrial Ecosystem

1) **Forest ecosystem**

**It is the best example of a terrestrial ecosystem. Like other ecosystems, there are two main components of the forest ecosystem:**

**A) A biotic component.**

**B) Biotic component.**

**A) A biotic component:** **In a forest ecosystem soil, moisture, air and sun light from the a biotic or physical component.**

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- Below the level of tree there is layer of shrubs which consume light energy of intensity coming through trees.
- Just below the shrubs there are gasses, herbs, lichens and mosses.

<u>**_Producers: Different tree species_**</u>

<u>**_Consumers in a Forest Ecosystem_**</u>

<u>**_Decomposers in a Forest ecosystem_**</u>

2. **Consumers :**

- **There are a number of consumers in an old dense forest.**
- **Consumers of first order in the forest are grasshoppers, rabbit, deer, monkey and many other wild herbivorous animals which utilize plants directly as their food.**
- **Secondary consumers are wolves, pythons consume the flesh of herbivores.**
- **While lion, tiger and Hawks are the consumers of top level.**

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- These are micro- organisms, chiefly bacteria and fungi which attack dead bodies or producers and consumers and convert complex organic compounds into simpler in organic compounds and elements.
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# Forest Ecosystem

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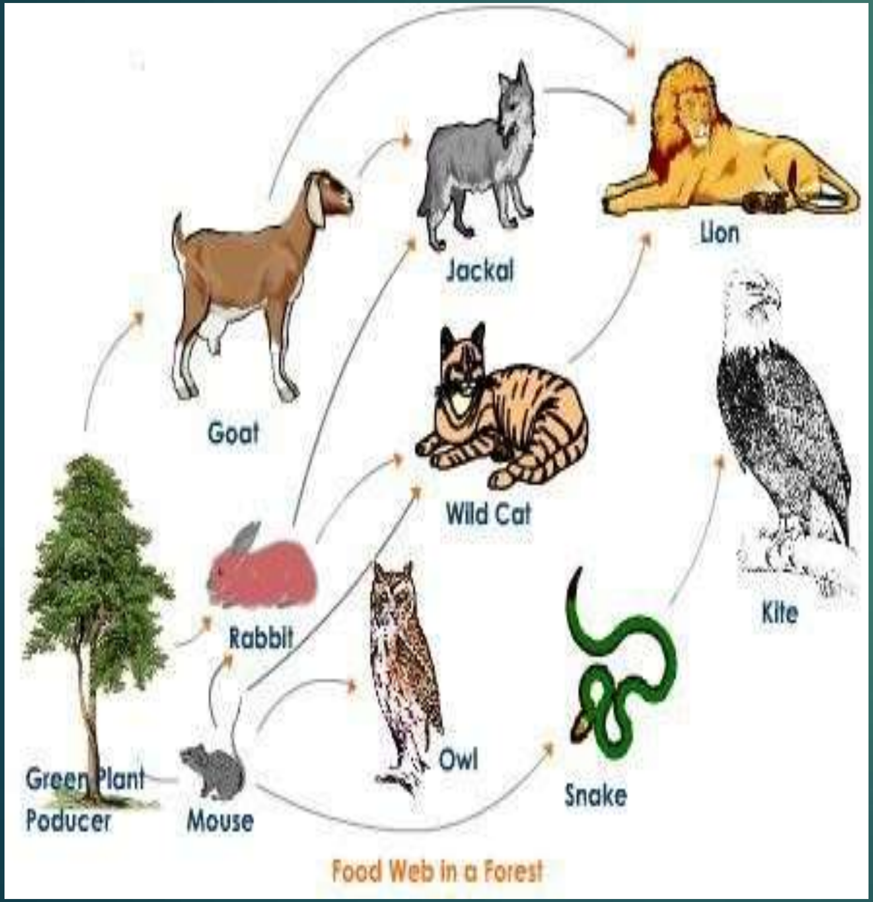
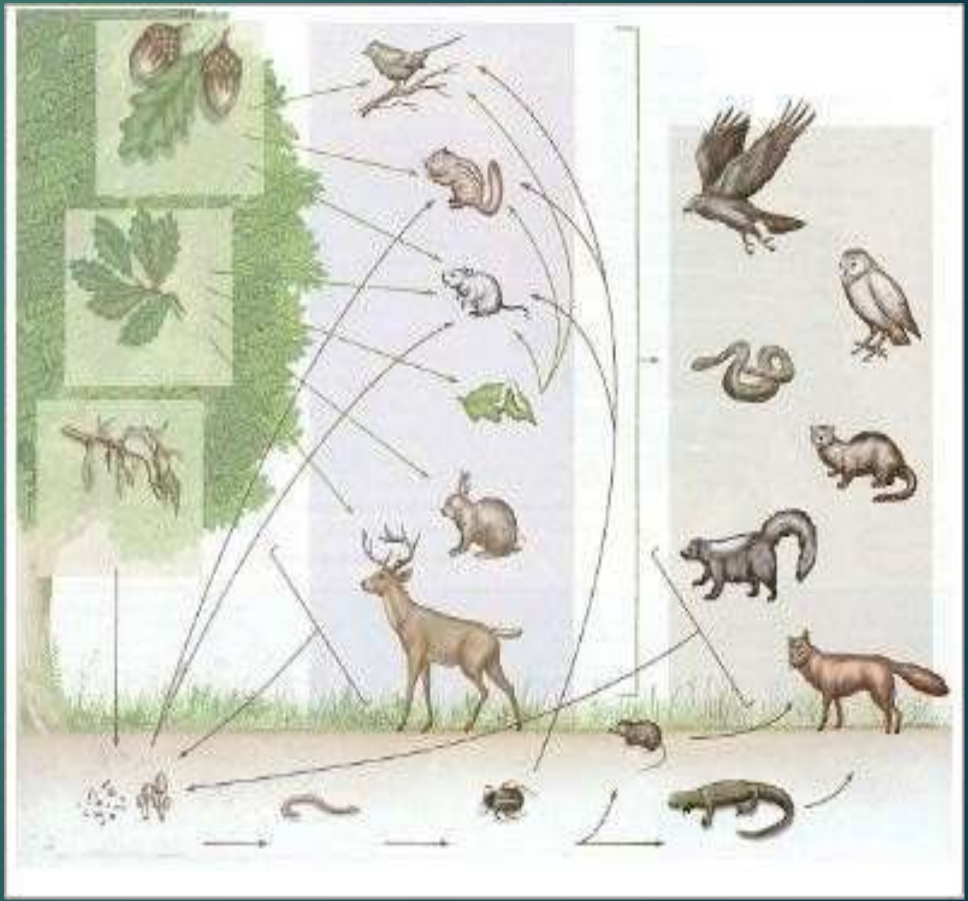
- *Tertiary consumers:* These are top carnivores like lion tiger, etc. that
- eat carnivores of secondary level.
- *Decomposers:* These are wide variety of micro organisms including, fungi, bacteria.

# Forest Ecosystem



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**Producers :** These are grasses, like Dichanthium, Cynodon, DesmodiumDactyloctenium, Setaria etc.

**Consumers :** Animals like Cow, Buffaloes, Deers, Sheep mouse and insects..,

**Decomposers:** fungi like Mucor, Asperillus, Pencillium, Cladosporium, fusarium and bacteria

Cont...

- **Producers:**

These are mainly grasses of the family Graminae, a large variety of herbs, some shrubs and scattered trees

**Consumers:**

herbivores such as grazing mammals(e.g. cows,sheeps, rabbits etc.) Insects(e.g. Dysdercus, Coccinella, Leptocorise, etc.) some terminates and millipendes are the primary consumers.

The animals like Fox, Jackals, Snakes, Birds etc. are the carnivores feeding on herbivores. These are the secondary consumers of the grassland ecosystems.

Hawks occupy the territory trophic level as these feed on the secondary consumers.

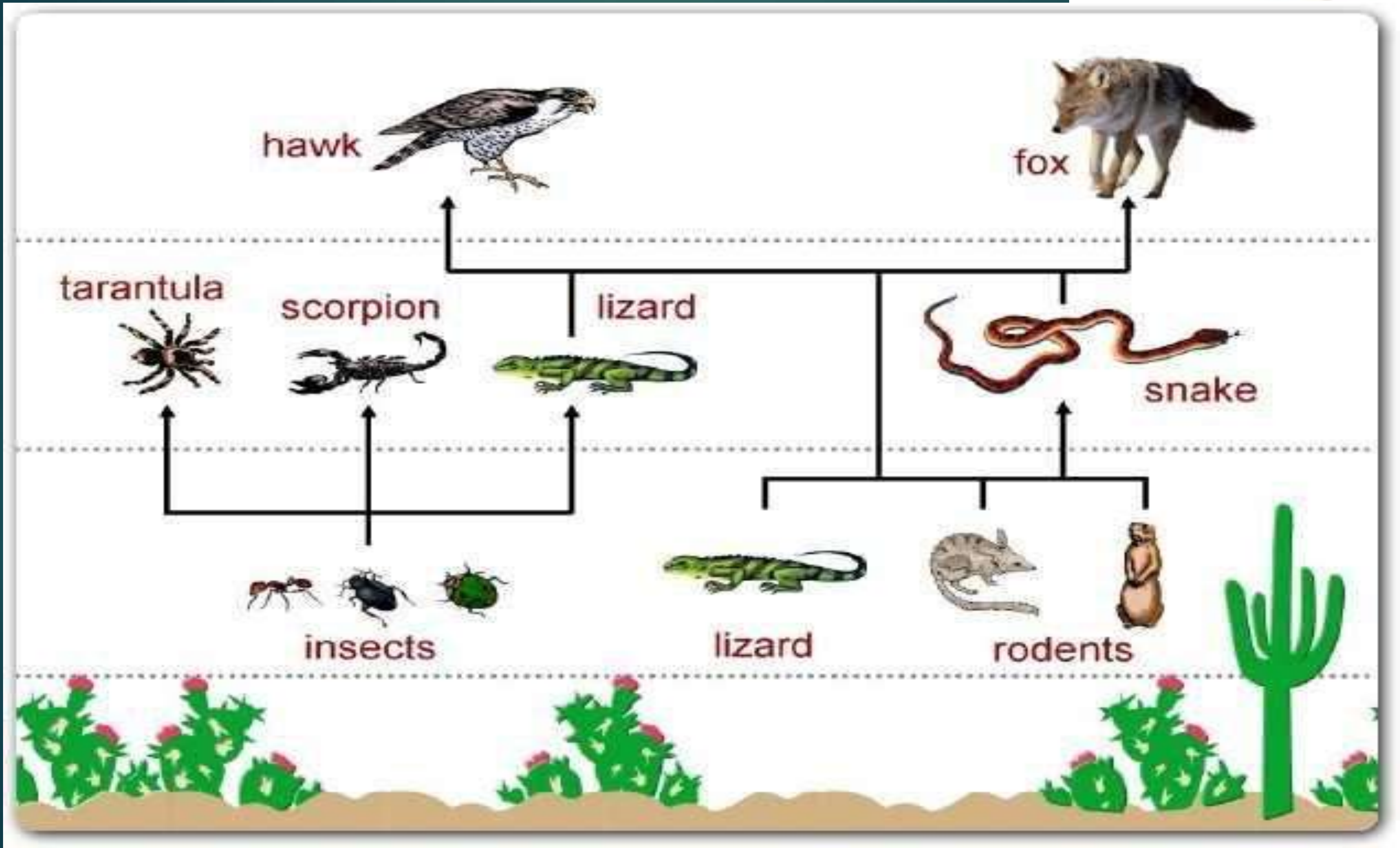
## Decomposers :

- These include bacteria of death and decay, moulds and fungi(e.g. Mucor, Pencillium, Aspergillus, Rhizopus etc.)
- These bring the minerals back to the soil to be available to the producers again.

- *(3) Desert Ecosystem*

- Desert occupy 17 % of land.
- *Abiotic components* include, light, temperature, minerals.
- *Biotic Components:*
- *Producers :* These are shrubs, especially bushes, some grasses, and few trees.
- E.g. Cacti, Xerophytes, mosses
- *Consumers:* The most common animals are reptiles, and insects, there are some rodents, and birds, and above all ship of desert camels, feed on tender plants.
- *Decomposers:* These are very few as due to poor vegetation the amount of dead organic matter is less. They are some fungi and bacteria.

# Desert Ecosystem



F Y B Sc Zoology

Paper II Sem I

# Types of Ecosystem

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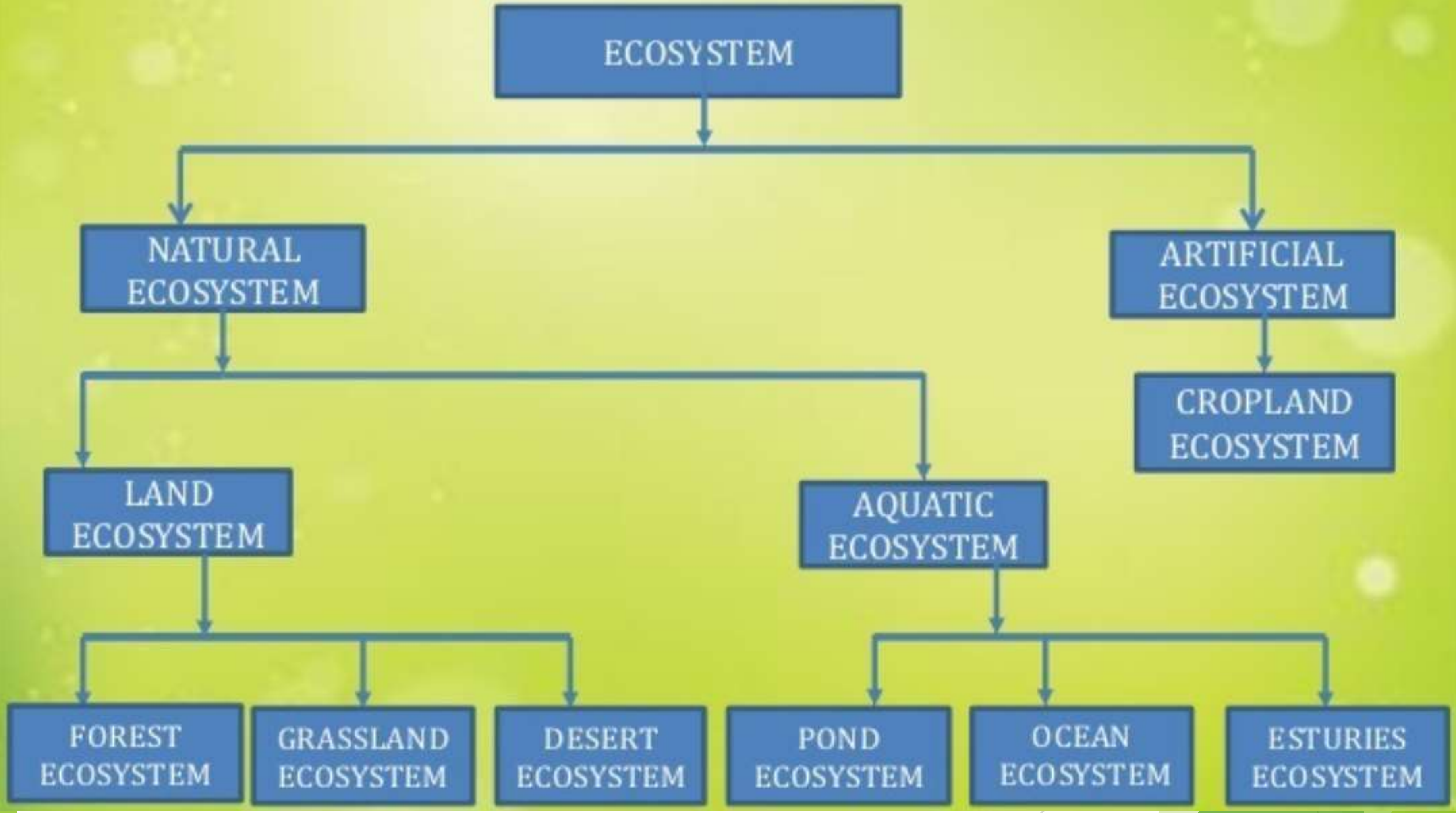
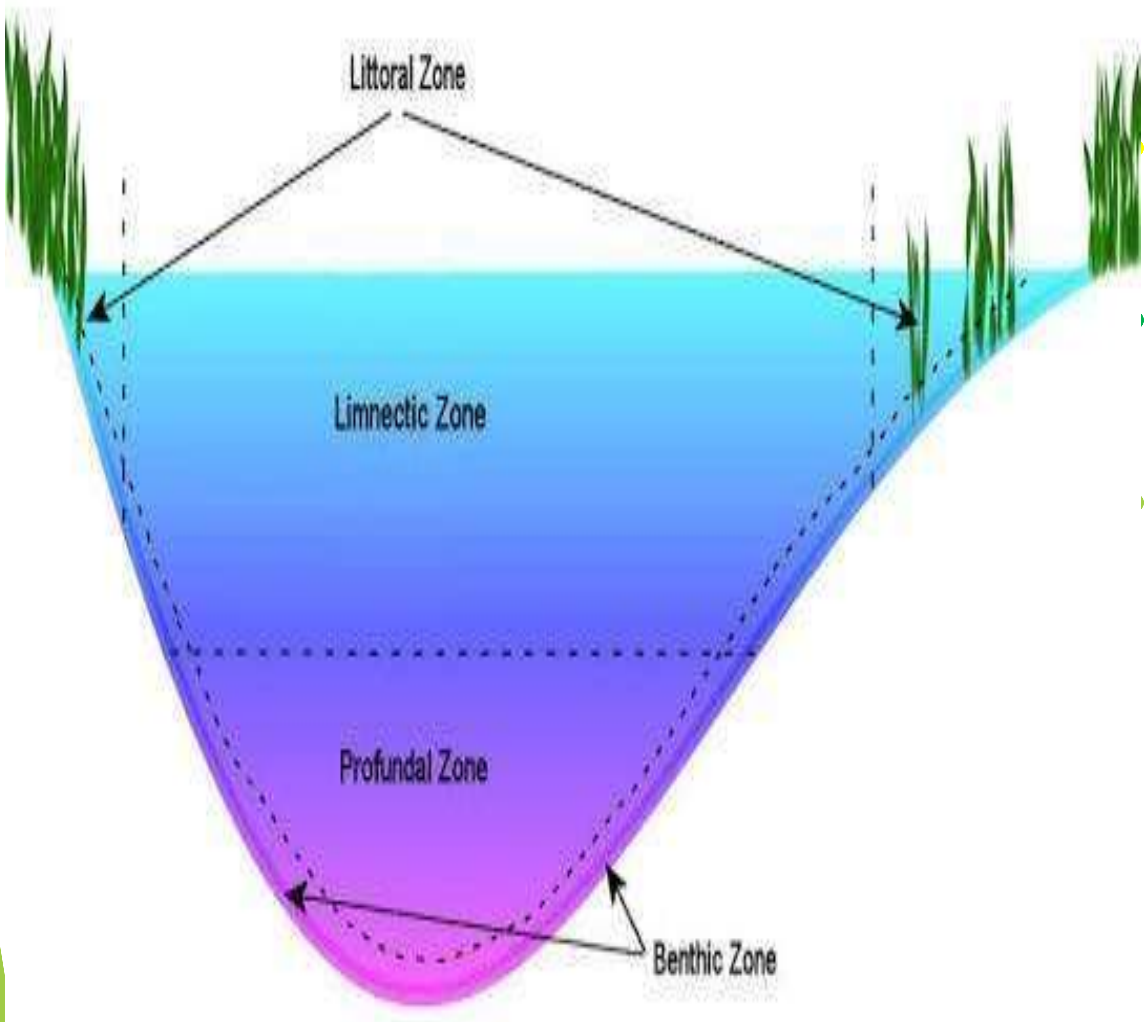
*Note: This material is only for educational purpose and is non - commercial .*

- ***The term 'ecosystem' was proposed by a british ecology A.G.Tansley in the year 1953.***
- ***"The ecosystem represents the basic functional unit of ecology which comprises of the biotic communities mutually related with their noliving or abiotic environment."***
- ***An ecosystem is a biological environment consisting of all the organisms living in a particular area, as well as all the non-living***
- **According to E.P. Odum, an American Ecologist , the ecosystem is the basic functional unit of organism and their environment interacting with each and with their one components.**
- **e.g. Grassland, forest, Aquarium, Pond, Lake, River and Ocean.**

# Classification of Ecosystem

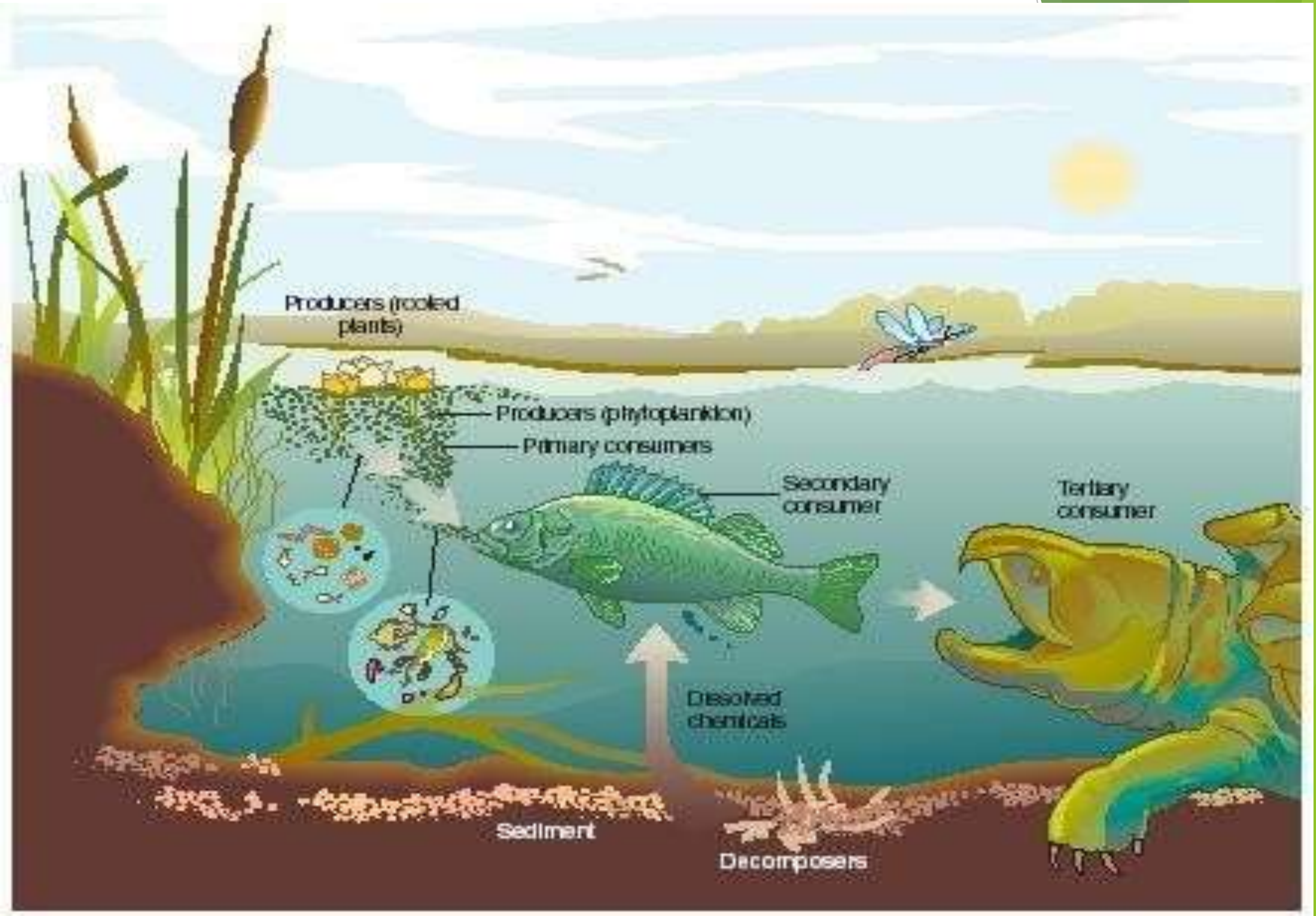


# (1) FRESH WATER ECOSYSTEM




- A) Lentic Ecosystem
- Pond Ecosystem
- Abiotic component
- Biotic component.

# Pond Ecosystem



- ***Producers***

- ***Macrophytes:*** **large rooted plants, which include partly or completely submerged hydrophytes, eg *Hydrilla, Trapha, Typha.***
- ***Phytoplankton:*** **minute floating or submerged lower plants eg algae.**
- ***Consumers:*** **heterotrophs which depends for their nutrition on the organic food manufactured by producers.**
- ***Primary Consumers***: ***Benthos***: **animals associated with living plants ,detrivores and some other microorganisms** ***Zooplanktons:*** **chiefly rotifers, protozoans, they feed on phytoplankton**
- ***Secondary Consumers:*** **They are the Carnivores which feed on herbivores, these are chiefly insect and fish, most insects & water beetles, they feed on zooplanktons.**
- ***Tertiary Consumers:*** **These are some large fish as game fish, turtles, which feed on small fish and thus become tertiary consumers.**
- ***Decomposers:*** **They are also known as micro-consumers. They decompose dead organic matter of both producers and animal to simple form. Thus they play an important role in the return of minerals again to the pond ecosystem, they are chiefly bacteria, & fungi.**

## B) Lotic Ecosystem River Ecosystem

- As Compared with lentic freshwater (Ponds & lakes), lotic waters such as streams, and river have been less studied. However, the various components of an riverine and stream ecosystem can be arranged as follows.
- **Producers:** The chief producers that remain permanently attached to a firm substrata are green algae as Cladophora, and aquatic mosses.
- **Consumers:** The consumers show certain features as permanent attachment to firm substrata, presence of hooks & suckers, sticky undersurface, streamline bodies, flattened bodies.. Thus a variety of animal are found, which are fresh spongy and caddis- fly larvae, snails, flat worms etc.
- **Decomposers:** Various bacteria and fungi like actinomycetes are present which acts as decomposers.

# Species in Riverine Ecosystem

- ***<u>A) ABIOTIC COMPONENT:-</u>***
- ***Abiotic component of pond consists of water, dissolved minerals, oxygen and carbon dioxide.***
- ***Solar radiation are the main source of energy***
- ***<u>B) BIOTIC COMPONENT:-</u>***
  - ***producers.***
  - ***consumers.***
  - ***Decomposers and transformers.***

## i) PRODUCERS:-

- ***The main producers in pond or lake ecosystem are algae and other aquatic plants.***
- ***eg :- such as azolla, hydrilla, lemna,nymphaea,etc..***
- ***These are either floating or rooted at the bottom.***
- ***The green plants convers the radiant energy into chemical energy throgh photosynthetisis.***
- ***The chemical energy stored in the form of food.***

## ii) CONSUMERS:-

- In a pond ecosystem the primary consumers are tadpole, larvae of frogs, fishes and other and other aquatic animals which consumer green plant and algae as their food.
- E.G:- frogs, big fishes, water snakes, etc..
- In the pond, besides the secondary consumers of highest order, such as water birds etc...

# iii)DECOMPOSERSAND RANSFORMERS:-

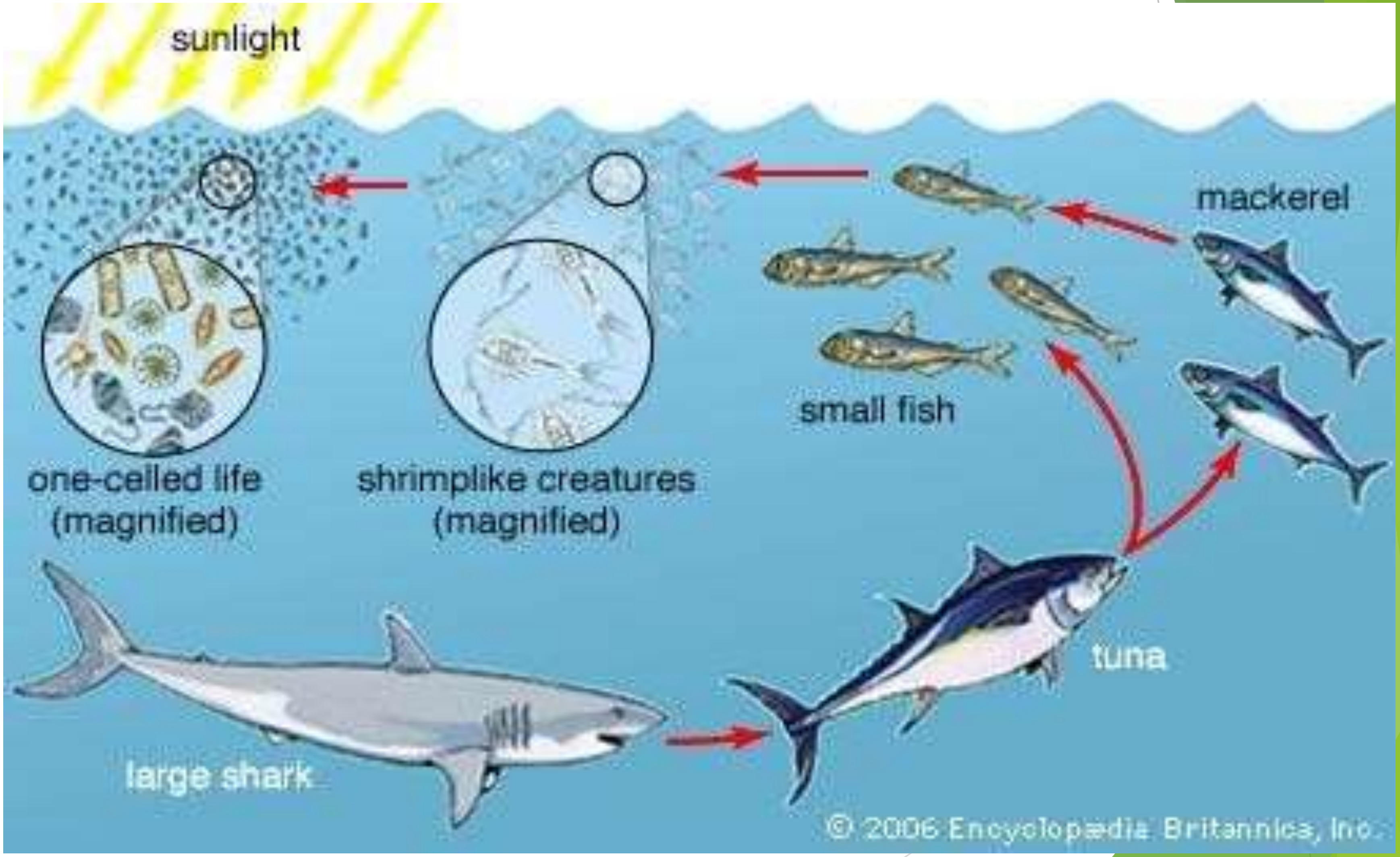
- When aquatic plant and animals die, large numbers of bacteria and fungi attach their dead bodies and convert the complex arganic substance into simple inorganic compounds and elements.
- These micro organismare called decomposers.

- e.g:- saprophytic bacteria and fungi.

# Marine Ecosystem

- Ocean Ecosystem are more stable than pond ecosystem, they occupy 70 % of the earth surface.
- ***Abiotic Components:*** **Dissolved oxygen, light, temperature, minerals.**
- **Biotic Components:**
- ***Producers:*** **These are autotrophs and are also known Primary producers. They are mainly, some microscopic algae (phyto-planlanktons) besides them there are mainly, seaweeds, as brown and red algae also contribute to primary production.**
- ***Consumers:*** **They are all heterotrophic macro consumers**
- ***Primary Consumer:*** **Theherbivores,that feed on producers are shrimps, Molluscs, fish, etc.**
- ***Secondary Consumers:*** **These are carnivores fish as Herring, Shad, Mackerel, feeding on herbivores.**
- ***Tertiary Consumers:*** **These includes, other carnivores fishes like, COD, Halibut, Sea Turtle, Sharks etc.**
- ***Decomposers:*** **The microbes active in the decay of dead organic matter of producers, and animals are chiefly, bacteria and some fungi.**

# Ocean Ecosystem



## i) PRIMARY PRODUCERS:-

- ***These are diatoms, dinoflagellates, few microscopic and unicellular algae, weeds and brown and red algae.***
- ***These form the basic of all other life found in sea.***

## ii) SECONDARY CONSUMERS:-

- ***Also known as the primary consumers of the sea these are certain large sized fish.***
- ***e.g. :- marckerel, herring, shark, etc..***
- **Certain fish feed primary upon smaller members of their own class and the growth of shark represent a food chain of five or more links.**

## DECOMPOSERS AND TRANSFORMERS:-

- The decomposers of sea are marine bacteria.

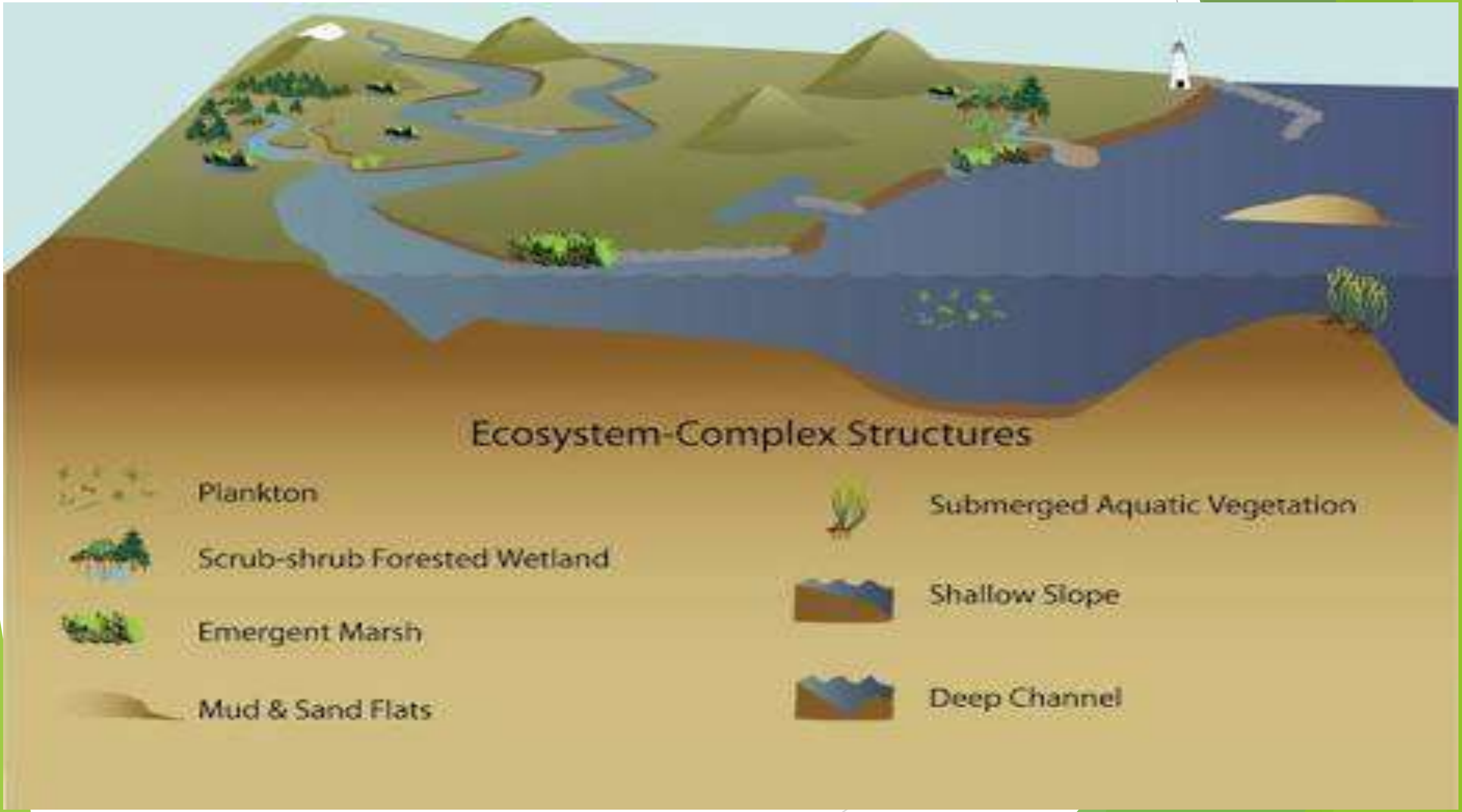
- The soluble and decomposed material is now attached by other type of bacteria, the transformers, and converted to forms to be reused by the green plants.

# (3) ESTUARINE ECOSYSTEM

- **There are two main components.**
  - **<u>Abiotic components</u>:- such as phosphorus and nitrogen, temperature, light,pH.**
  - **<u>Biotic components</u>:-**
- **<u>producers</u>:- these micro-organism manufacture food by photosynthesis and absorb nutrients.**
- **<u>primary consumers</u>:- zooplanktons that feed on phytoplankton, besides them some small micro-organisms that feed on producers.**

iii) **Secondary consumers:-** Include shellsish, small fish, feeding on zooplanktons.

iv) **Decomposers:-** fungi & bacteria are the chief microbes active of dead organic matter.



# FUNCTION:-

- ***Aquatic ecosystem perform many important enviromental function.***
- ***They recycle nutrients, purify water, recharge ground water and provide habitats for wildlife.***
- ***Aquatic ecosystem are also used for human recreation, and are very important to the tourism industry.***

- **A stress on an aquatic ecosystem can be a result of physical, chemical or biological alterations of the environment.**
- ***Biological organism found in aquatic ecosystem are either autotropic or heterotropic.***
- **Physical alterations include changes in water temperature, water flow.**
- **Abiotic enviromental factors of aquatic ecosystem include temperature, salinity and flow.**

## Estuarine Ecosystem

- **An estuary is a partially enclosed body of water along the coast where fresh water from river and streams meet and mix with salt water from oceans. This Ecosystems are considered as most fertile ecosystem.**
- **Abiotic Components: Nutrients such as phosphorus and nitrogen, temperature, light, salinity, pH.**
- **This ecosystem experience wide daily and seasonal fluctuations in temperature and Salinity level because of variation in freshwater in flow.**
- ***Biotic Components:***
- ***Producers: Phyplanktons*- these micro-organisms manufacture food by photosynthesis and absorb nutrients such as phosphorous and nitrogen, besides them, mangroves, sea grass, weeds, and salt marshes.**
- ***Consumers: Primary consumers*, Zooplanktons that feed on Phytoplankton, besides them some small microorganisms that feed on producers.**
- ***Secondary Consumer:* Include worms, shellfish, small fish, feeding on Zooplanktons**
- ***Tertiary Consumer* :Fishes, turtles, crabs, starfishes feeding on secondary consumers.**
- ***Decomposers:* Fungi & Bacteria are the chief microbes active in decay of dead organic matter.**

## Terrestrial Ecosystem

### 1) Forest ecosystem

It is the best example of a terrestrial ecosystem. Like other ecosystems, there are two main components of the forest ecosystem:

1. A biotic component.
2. Biotic component.

(1) A biotic component: In a forest ecosystem soil, moisture, air and sun light from the a biotic or physical component.

(2) Biotic component: There are three important classes of biotic components:

I. Producers II. Consumers III.Decomposers

# 1. Producers:

- All the green plants of forest are producers. They are the main sources of food for all the animals. There are several layers of vegetation in the forest.
- The plants of top stratum are angiospermous and gymnospermous trees.
- These plant utilize radiant energy of sun to the greatest extent.
- Below the level of tree there is layer of shrubs which consume light energy of intensity coming through trees.
- Just below the shrubs there are gasses, herbs, lichens and mosses.

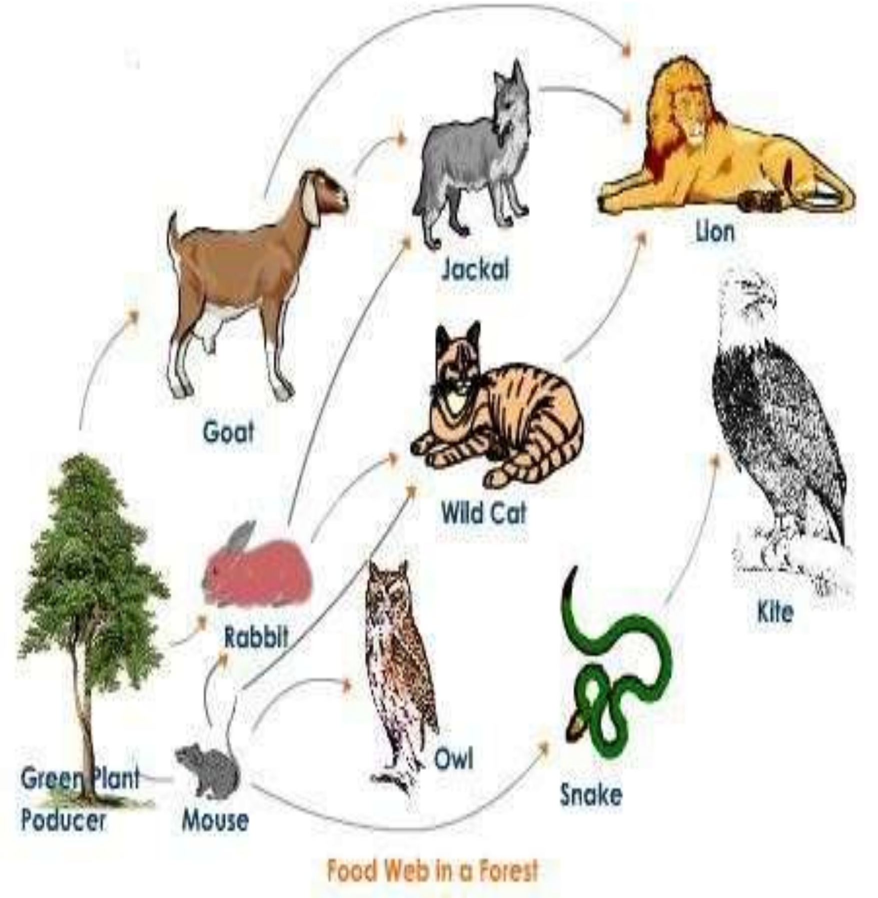
- 2. Consumers :
- There are a number of consumers in an old dense forest.
- Consumers of first order in the forest are grasshoppers, rabbit, deer, monkey and many other wild herbivorous animals which utilize plants directly as their food.
- Secondaryconsumersare wolves, pythons consume the flesh of herbivores. etc.
- Lion, Which Tiger,Hawks are the consumers of top level.

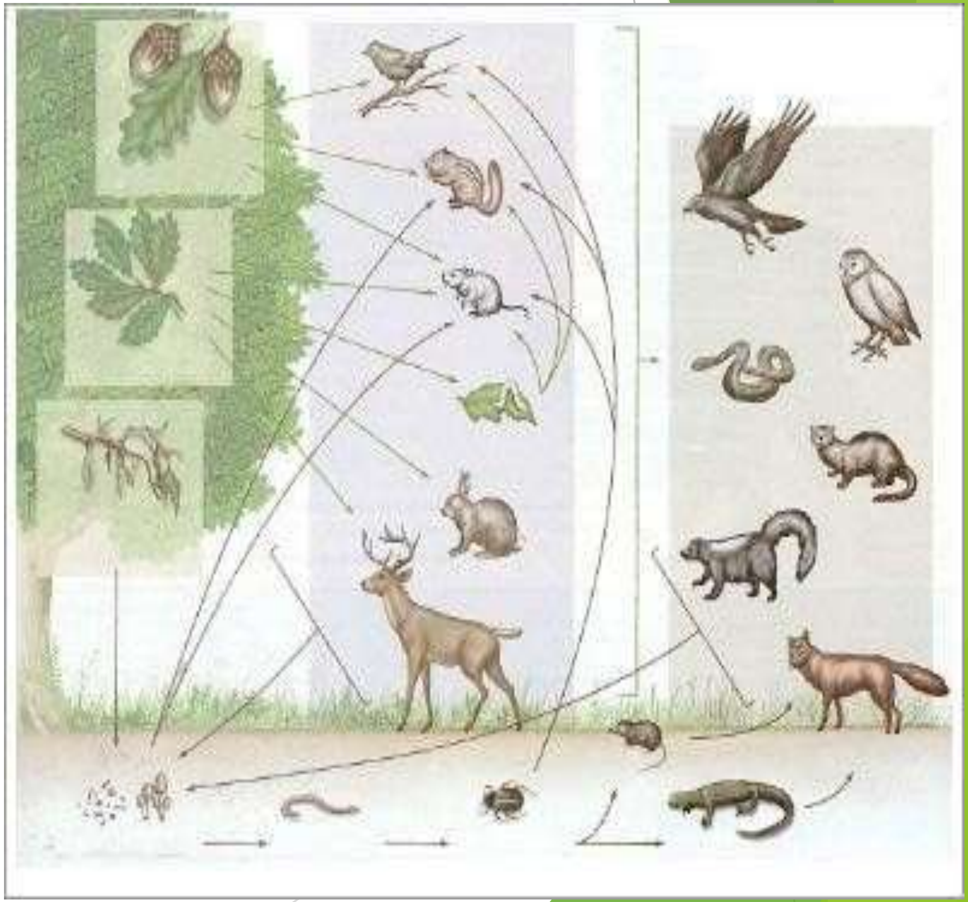
- ## 3.Decomposers and Transformers
- These are micro- organisms, chiefly bacteria and fungi which attack dead bodies or producers and consumers and convert complex organic compounds into simpler in organic compounds and elements.
- These free elements again return to the a biotic component and are re-utilised by producers in their nutrition.

Cont…

- **Forest Ecosystem**
- **Forest Occupy roughly 40 % of the land. The different components of forest ecosystem are as follows:**
- ***Abiotic Components:*** **These are organic & inorganic substances present in the soil and atmosphere. In addition to minerals present in forest we find the dead organic debris, moreover light conditions are different due to complex stratification in the plants.**
- ***Biotic Components:***
- **Producers These are mainly trees that show much species and greater degree of stratification. Besides trees there are also present shrubs, and ground vegetation.**
- ***Consumers:*** **Primary Consumers: These are herbivores that include animals feeding on tree leaves, ants, beetles, grass hoppers, etc., and large elephants, dears, squirrels, etc.**
- ***Secondary Consumers:*** **These are carnivores, like snakes, birds, lizards, fox, etc. feeding on herbivores.**
- ***Tertiary consumers:*** **These are top carnivores like lion tiger, etc. that eat carnivores of secondary level.**
- ***Decomposers:*** **These are wide variety of micro organisms including, fungi, bacteria.**

# Forest Ecosystem



- **2. Grassland Ecosystem:**
- **Grassland occupy about 19% of the earth's surface.**
- **The major grassland ecosystem of the world are the great plains of Canada and United states, South Argentina to Brazil and south Asia to central Asia.**
- **The various components of a grassland ecosystem areas fellows:**
- **(1) A biotic components: The nutrients present in soil and the areal environment are the a biotic components are supplied by CO2, water, nitrates, Phosphates and sulpltates).**

(2)Biotic components:

(a) grasses,likeDichanthium cynodon,Desmodium, Digitaria,Ddactylocteniu m, Setaria etc. as

a)producers;

(b)Animals like Cow, Buffaloes, Deers, Sheep, mouse and many insects as consumers,

(c)fungi like Mucor, Asperillus, Pencillium, Cladosporium, fusarium and,

(d)bacteria as the decomposers.

Cont…

- **Producers:**
- These are mainly grasses of the family
- Graminae, a large variety of herbs, some shrubs Scattered trees.
- **Consumers:**
- herbivores such as grazing mammals(e.g. cows,sheeps, rabbits etc.)
- Insects(e.g. Dysdercus, Coccinella, Leptocorise, etc.)
- some terminates and millipendes are the primary consumers.

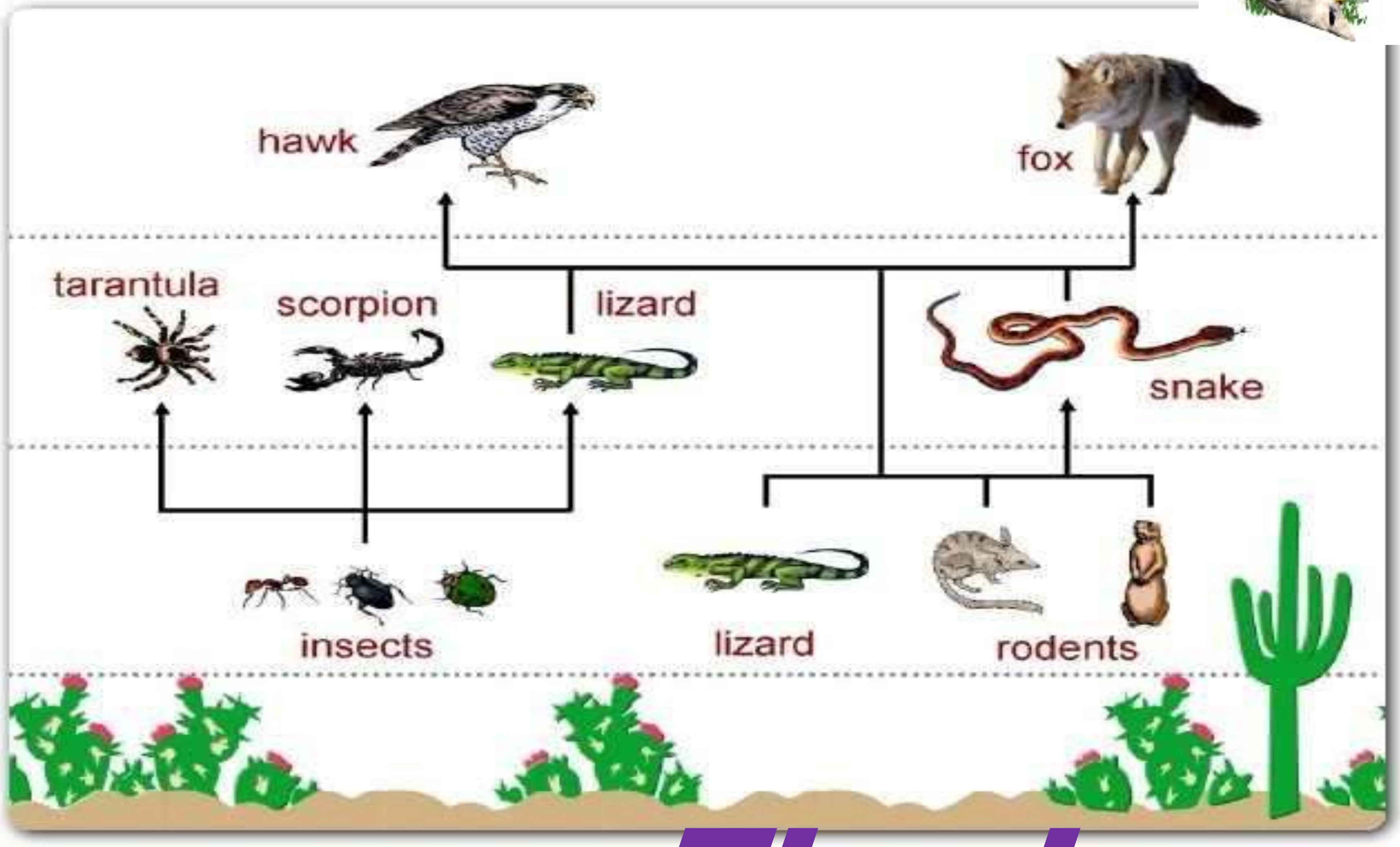
- **The animals like Fox, Jackals, Snakes, Birds etc. are the camivores feeding on herbivores.**
- **These are the secondary consumers of the grassland ecosystems.**
- **Hawks occupy the territory trophic level as these feed on the secondary consumers.**

- **Decomposers :**
- **These include bacteria of death and decay, moulds and fungi(e.g. Mucor, Pencillium, Aspergillus, Rhizopus etc.)**
- **These buing the minerals back to the soil to be available to the producers again.**

# Desert Ecosystem

- Desert occupy 17 % of land.
- Abiotic components include, light, temperature, minerals.
- Biotic Components:
- Producers : These are shrubs, especially bushes, some grasses, and few trees.
- E.g. Cacti, Xerophytes, mosses
- Consumers: The most common animals are reptiles, and insects, there are some rodents, and birds, and above all ship of desert camels, feed on tender plants.
- Decomposers: These are very few as due to poor vegetation the amount of dead organic matter is less. They are some fungi and bacteria.

# Desert Ecosystem




# Thanks....

# F Y B Sc Zoology

## Paper II Sem I

# (3.1) Population

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**Note:** *This material is only for educational purpose and is non -commercial .*

**Chapter 3 Population (08 Lectures)**

**3.1Characteristic of population: Density, Natality, Mortality, Fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion.**

**3.2Exponential and logistic growth,**

**3.3 Population regulation – density-dependent and independent factors. Population interactions, Gause's Principle with laboratory and field interactions,**

**3.4 Quadrate, line and belt transect methods.**

- **INTRODUCTION**
- **A population is a group of individuals of a particular species or kind present at a particular area at a specific given time.**

- **Monospecific (containing individuals of only one species)**
- **Polyspecific (individuals of many species).**
- **They have similar gene pool.**
- **For example, we may study the fish population of the river Ganga, the lion population of the Gir forest or the peacock population of India.**
- **The study of population dynamics (changes in population sizes) is called demography.**





# CHARACTERISTICS OF POPULATION Density

- **Population density can be defined as total number of individuals inhabiting specific area of the habitat for particular time period or density of a population refers to its size in relation to some unit of space on observed time or density is the number of individuals per unit area, at a given time.**
- **For example, number of micro-organisms per liter of water; for larger animals or plants, the acre or square kilometer may be the unit, for plants per acre of land or number of people per square kilometer.**
- **Density can mathematically be calculated as follows:**

$$D = nla\ t$$

**Where, D = density**

**n = number of individuals**

**a = area**

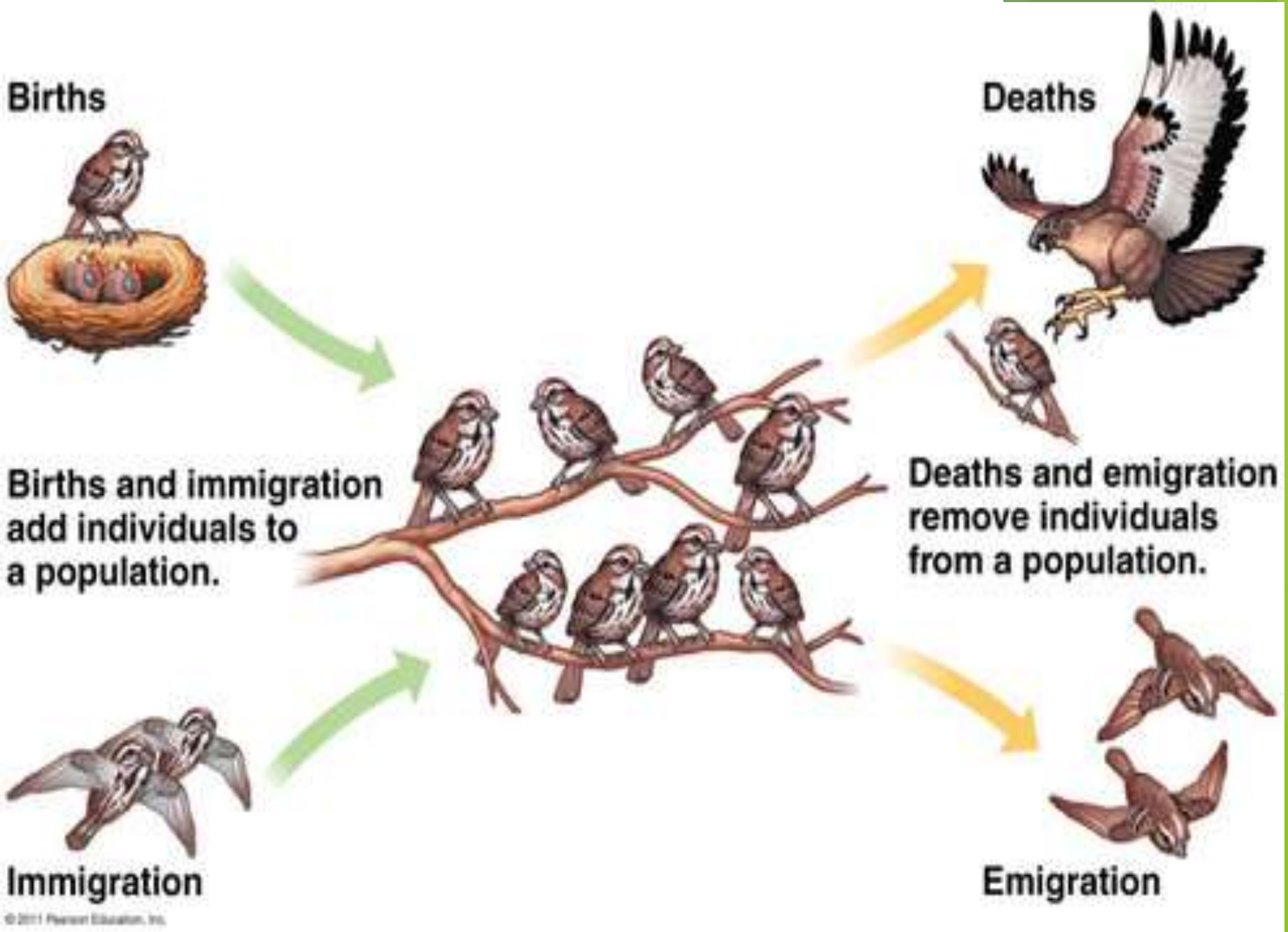
**t = time unit**

## Natality

- The natality or Birth rate of a population is defined as the number of new individuals produced by birth, hatching, germination, multiplication or fission in per unit time.
- It varies among different organisms.
- Some species breed once a year, some breed several times a year, and others breed continuously.
- When the conditions are ideal the natality will be maximum. This is called as Potential natality or Absolute natality. Factors like nutrition, capacity of reproduction etc. reduce the rate of addition of new individuals.
- So in a specific environment the birth rate (actual) is always less than the potential natality. This actual birth rate is called as Specific natality or Realized natality.
- Natality of a population can be calculated by the formula:

$Natality$ or $B = nt$ Where, B = Birth rate per unit of time

n = new individuals in a population t = time


Births
Deaths
Births and immigration
add individuals to
a population.
Deaths and emigration
remove individuals
from a population.
Immigration
Emigration

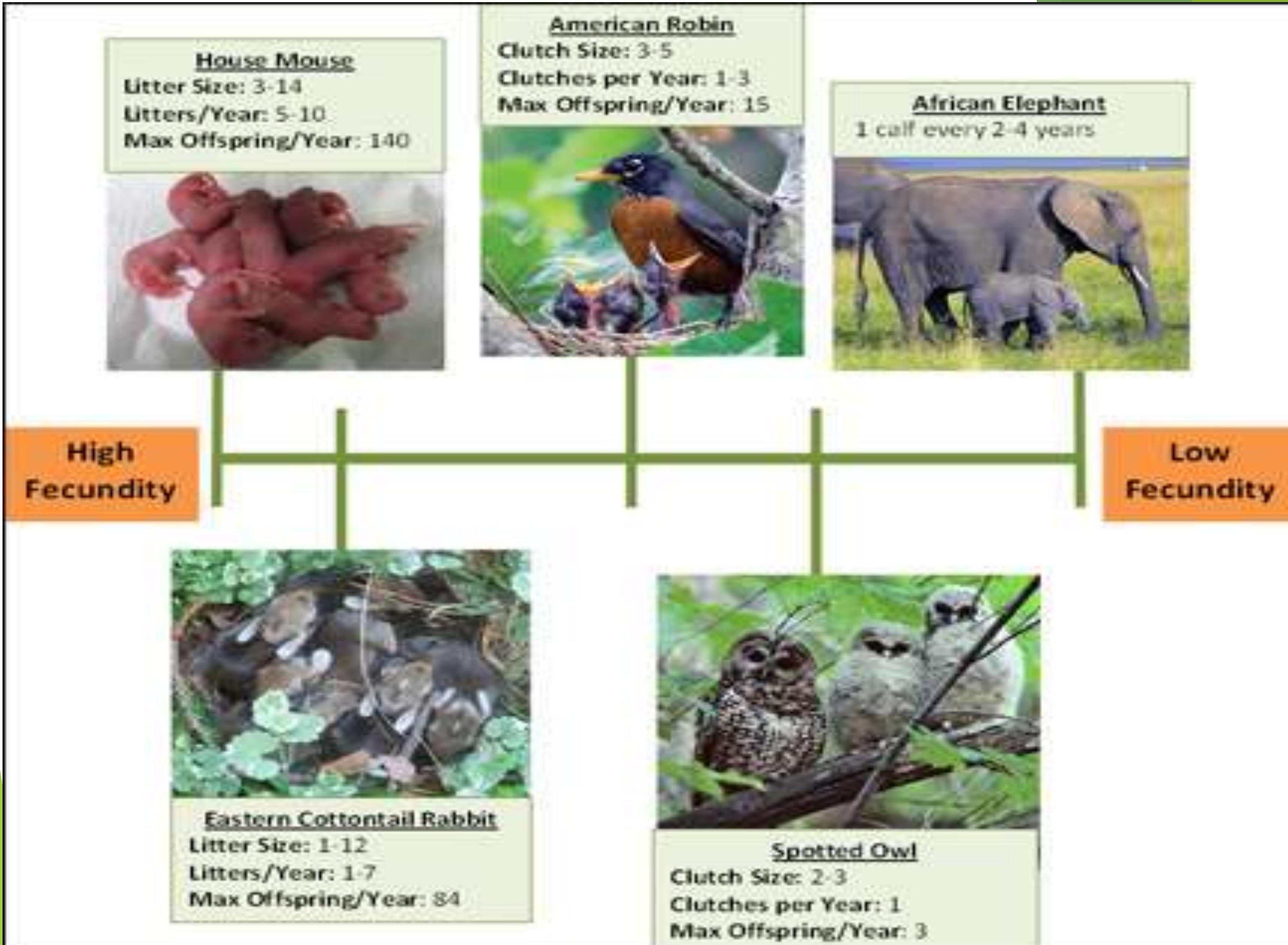
## Mortality

- **Mortality or death rate may be defined as the number of individuals that die in a population in given area in a given period of time.**
- **If the mortality is less than natality, naturally there will be an increase in the number of individuals in a given population.**
- **This minimum mortality is called the Specific or Potential mortality and its rate is constant for a given population.**
- **The mortality rate can be calculated by the following formula:**

- $\text{Death rate } (d) = \text{Number of deaths per unit time}$

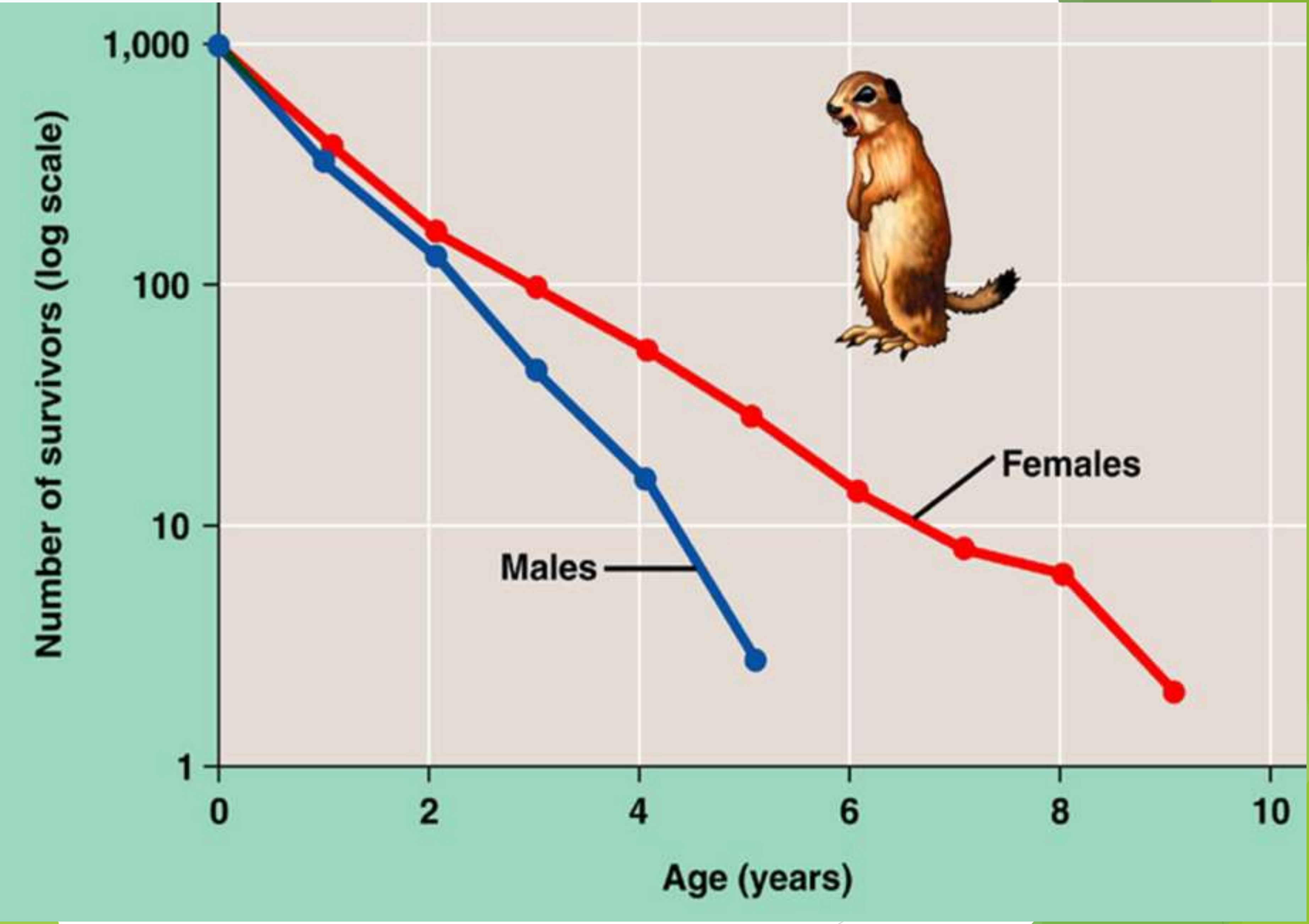
# Fecundity

- **Fecundity is the ability to produce offspring.**
- **It can also describe the reproductive rate of an individual organism.**
- **Animals with high fecundity spend their energy in the production of many offspring that do not require much care.**
- **Protozoans often divide as rapidly as they produce a new generation every few hours.**
- **Plankton organisms less fecund may produce a new generation every few days.**
- **Many vertebrates breed once a year, some large animals only once every two or three years.**
- **The number of eggs or young produced per litter is correlated inversely with the amount of parental care that they require.**
- **When parental care is altogether lacking, invertebrates may lay 1000 to 50 million eggs at one maturation and where protection is afforded by brood pouches, they lay about 100 to 1000 eggs.**
- **Some mammals may give birth to more than a dozen young in a single litter and large species usually only one.**

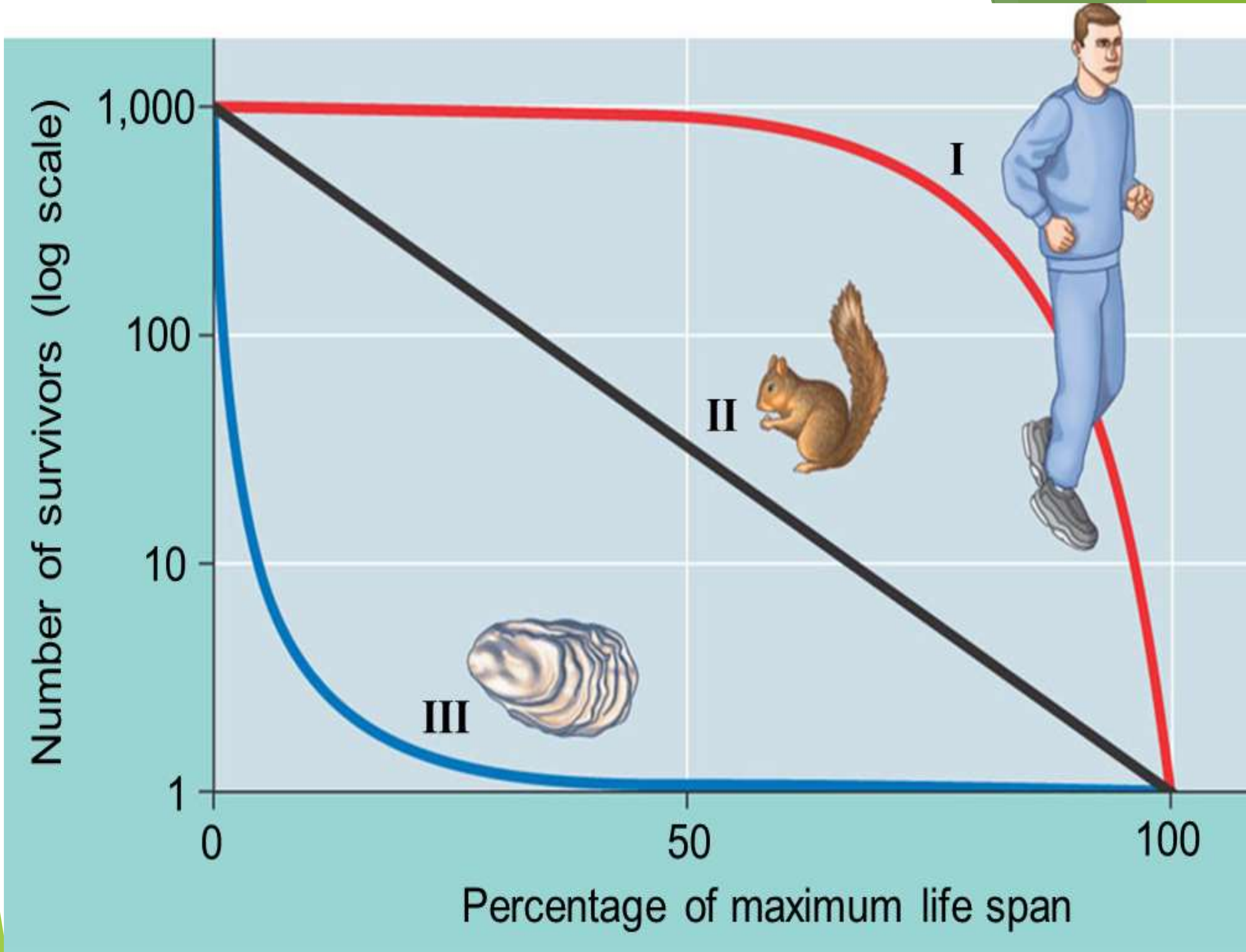

House Mouse
Litter Size: 3-14
Litters/Year: 5-10
Max Offspring/Year: 140
American Robin
Clutch Size: 3-5
Clutches per Year: 1-3
Max Offspring/Year: 15
African Elephant
1 calf every 2-4 years
High Fecundity
Low Fecundity
Eastern Cottontail Rabbit
Litter Size: 1-12
Litters/Year: 1-7
Max Offspring/Year: 84
Spotted Owl
Clutch Size: 2-3
Clutches per Year: 1
Max Offspring/Year: 3

## Survivorship Curves

- A graph obtained when number of survivors in a population is plotted against time is called as survivorship curve.
- A vital thing for a population is how many members survive but not which members die. Consequently, specific mortality rate of a population is expressed by survivorship curve. There are three types of survivorship curves:
- a) Diagonal Curve: When mortality rate remain constant at all ages i.e. in embryonic, young, adult, the curve appears in a straight diagonal line Example: Hydra, Birds etc.
- b) Convex Curve: When most of the individuals live at their potential life span and die in old age and curve appears convex in nature. Example: Man, Deer, Rabbit etc.
- c) Concave Curve: In this extremely heavy mortality appears in early life and curve appears concave in nature. Exmple: Oyster, Snails etc.



Number of survivors (log scale)
1,000
100
10
1
0
2
4
6
8
10
Age (years)
Females
Males


1,000
100
10
1
Number of survivors (log scale)
I
II
III
0
50
100
Percentage of maximum life span

## Age Ratio

Age distribution is an important characteristic of population which affects both natality and mortality. The ratio of the various age groups in a population determines the current reproductive status of the population and indicates what may be expected in the future. Usually a rapidly expanding population will contain a large proportion of young individuals, a stationary population will show a more even distribution of age classes, and a declined population will have a large proportion of old individuals. A population may pass through changes in age structure without changing in size. We rarely find a natural population that has a stable age structure because populations do not increase for long in an unlimited fashion. From an ecological point of view, age structure can be expressed in three ecological ages: Pre-reproductive, Reproductive and Post-reproductive

## Sex Ratio

The sex ratio is the ratio of males to females in a population. In most sexually reproducing species, the ratio tends to be 1:1. In anthropology and demography, the human sex ratio is the ratio of males to females in a population. More data are available for humans than any other species. The sex ratio for entire world population is 102 males to 100 females (2017). The current sex ratio in India (2019) is 947 females to every 1000 males, and in Maharashtra 922 females to 925 males. In most species, the sex ratio varies according to the age profile of the population.

It is divided into four subdivisions:

a) Primary sex ratio: ratio at fertilization

b) Secondary sex ratio: ratio at birth

c) Tertiary sex ratio: ratio in sexually mature organisms also called as adult sex ratio

d) Quaternary sex ratio: ratio in post-reproductive organisms

Population Dispersal

The movement of individuals and the products of their reproduction into and out of the population is called as population dispersal.

There are three types of population dispersal:

a) Emigration: This is the one-way outward movement from one place to another.

b) Immigration: This is the one-way inward movement from one place to another.

c) Migration: This is the two way movement of individuals involving periodic departure and return. Migratory movements are very conspicuous among fishes, birds and mammals.

## Population Dispersion

The distribution pattern of the population is called as dispersion. There are three types of population distributions as follows:

a) Random Distribution: This distribution is rather random and the individuals rarely show a tendency to aggregate, without any specific pattern. In this type of distribution, the probability of an individual occurring at any one spot is the same as the probability of its occurring at any other spot in a given area.

b) Uniform Distribution: This is a type of distribution in which the individuals are distributed according to a uniform patter i.e. it is more regular and uniform and may be found in places where there is severe competition between individuals.

c) Clumped Distribution: In this, the individuals are clumped or grouped in a limited area. This is the most common pattern of distribution. This pattern is controlled by the biotic, edaphic and climatic conditions of the area.

GROWTH CURVES

Population is changing entity. Its size and composition are ever changing. The changes in size and composition are dependent on birth rate, deaths and movements of organisms into and away from the population. In the beginning, the number of animals in first age category would increase (by birth) while those of the older age groups would remain stationary. But as time goes on the age categories increase as the survivors of the initial age groups grow sides. As more animals enter into the reproductive stage; greater number of young is produced. Eventually after several generations the population will grow at fairly steady rate.

There are mainly two types of growth curves:

1) Exponential Growth Curve or ‘J’ Shaped Growth Curve

1) Exponential Growth Curve or ‘J’ Shaped Growth Curve

This type of growth curve involves geometric ratio of increase upto a certain point after which there is an abrupt decline in growth rate. The decline is due to factors of environmental resistance. The growth curve is more or less ‘J’ shaped. In the beginning, the density of population increases rapidly in compound interest fashion and then stops abruptly on the environmental resistance or other limiting factors become effective. These factors may be food, space or seasonal or termination of reproductive seasons. In this pattern of growth, the density reaches the upper limits remains at that level for time and then decline suddenly indicating catastrophic condition. This type of growth pattern can be seen in early in algal blooms, some insects, annual plants and the lemmings of Tundra, as well mammals as in deer. This type of growth curve is not very common.

2) Logistic Growth Curve or ‘S’ Shaped Growth Curve

In the logistic or ‘S’ shaped growth curve, the initial growth rate is rather slow and this is called as positive acceleration phase. This is followed by a rapid growth rate and this stage is known as logarithmic phase. This rapid rate of growth continues upto a certain point known as inflection point after which there is a steady decrease in the rate of increase due to environmental resistance.

Subsequently the population reaches a maximum limit known as asymptote (or equilibrium). This asymptote represents the limiting size of the population. Thereafter a sort of equilibrium is established between potential natality and environmental resistance, thus maintaining this maximum limit of population density form long periods. The sigmoid or logistic curve of growth rate is common in populations.

## POPULATION REGULATION

1)Density Dependent Regulation: They vary in the intensity of their action with the size or density of the population. They increase in intensity as the population level rises and decrease as the population level declines. They are biotic; they depend on intraspecific or interspecific coactions . Populations are self-governing systems.

- a)Competition: The role of competition in regulating population is directly effective by causing mortalities, nest destruction and loss of food supplies.
- b)Predation: The predator-prey relationship provides a typical example of density dependent regulation
- C)Reproductivity: The birth and death rates have their important roles in regulation of population size.
- d)Emigration: Emigrations occur when there is overcrowding in the migratory locust, grouse, snowy owl, snowshoe rabbit etc.

2) Density Independent Regulation:

- It is determined by factors like space or cover, prevailing weather, food supply and toxic pollution abiotic conditions of the environment.
- Maximum population size in plants determined by the physical environment.
- Small insects grows during the short wet season, until the drought kills the plants upon which they feed
- The food supply also determines the size of population size. Territorial behavior have enough to survive and breed, whereas the rest are excluded from breeding.
- Thus, the production of offspring is adjusted to the food supply.

POPULATION INTERACTIONS

There are two basic types of interactions among the biota and these are called as intraspecific and interspecific. Intraspecific interactions take place between members of the same populations. And interspecific interactions take place between members which belong to two or more populations. Interspecific population interactions take place in different ways.

GAUSE’S PRINCIPLE

Competition exclusion principle (Gause’s Principle) is experimentally confirmed by Russian Biologist, C.F.Gause in two species of Paramecium. Thus, Gause’s principle lays stress on the fact that closely related organisms (or species) remain ecologically separated. In other words, it is the principle of the ecological separation of closely related species, due to interspecific competitions.

Gause cultured two species of Paramecium: Paramecium caudatum and Paramecium aurelia separately and together (mixed). When cultured separately under the same set of controlled environmental conditions and fed with the same species of bacterium, both species flourished and shows sigmoid growth in laboratory. However, when cultured together under the same environmental control and forced to compete for the same food, Paramecium aurelia is survived but Paramecium caudatum did not. The survival of P.aurelia was simple due to the greater growth than the P.caudatum, thus been more successful in competing for the limited food supply. This clearly shows that the two species of Paramecium cannot live together and grow normally in the same culture.

QUADRATE

A quadrate is a frame, traditionally square, used in ecology and geography to isolate a standard unit of area for study of the distribution of an item over a large area. The quadrate is suitable for sampling plants, slow moving animals and some aquatic organisms.

QUADRATE METHOD

When an ecologist wants to know how many organisms in a particular habitat? It would not be feasible to count them all. Instead, they would be forced to count a smaller representative part of the population, called a sample. A sampling of plants or slowly moving animals (i.e. snails) can be done by using a sampling square called a Quadrate. A suitable size of a quadrant depends on the size of the organisms being sampled. For example, to count plants growing on a school field, one could use a quadrate with sides 0.5 or 1 m2
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quadrate size depends to a large extent on the type of survey being conducted. Random sampling is usually carried out when the area under study is fairly uniform, very large and/or there is limited time available. When using random sampling techniques; large numbers of samples are taken from different positions within the habitat. A quadrate frame is most often used for this type of sampling. The frame is placed on the ground, and the animals or plants inside it counted or collected, depending on what the survey is for. This is done many times at different points within the habitat to give a large number of different samples.

TRANSECT METHOD

When the vegetation or animals is to be studied along an environmental gradient or eco-tone, a line is laid down across a stand or several stands at right angle. This method of linear sampling of the vegetation is called transect. Depending upon the object of study, two types of transect can be drawn. They are as follows:

a) Line Transect

In this type of transect the vegetation is sampled only over a line (without any width). A line is laid over the vegetation with a metric steel tape or steel chain or long rope and kept fixed with the help of pegs or hooks. This line will touch some plants on its way from one point to the other. The observer will start recording these plants from this type of transect following information could be collected. From the observations in a number of such parallel lines transect, comments can be made on the habitat and other environmental conditions on different portions of transect. Every species has its own ecological amplitude and tentatively expresses the status of available water and other edaphic conditions, atmospheric humidity, availability of light, grazing and other biological pressures

b) Belt Transect

The belt is a long strip of vegetation of uniform width. The width of the belt is determined according to the type of vegetation or the stratum of vegetation under study. In close herbaceous vegetation it is usually 10 cm, but it varies from 1 to 10 meters in woodland. The length of the vegetation is determined according to the purpose of the study.

A belt is generally studied by dividing it into some equal sized segments. The length of each segment is generally equal to the width of transect. The segments are sometimes called quadrats. Belt transects are used in determining and understanding the gradual change in abundance dominance, frequency and distribution of different species in the transitional region between two different types of vegetation.

# Factors that Influence Population Size

- Density-dependent factors- the size of the population will influence an individual's probability of survival.
  - Ex. Disease, competition, food
- Density-independent factors- the size of the population has no effect on the individual's probability of survival.
  - Ex. Natural disasters, Floods, droughts, volcanoes

Density dependent factor

Only affects the population once it has grown to a certain density (size)

Density independent

Affects the growth of a population **regardless** of the population density

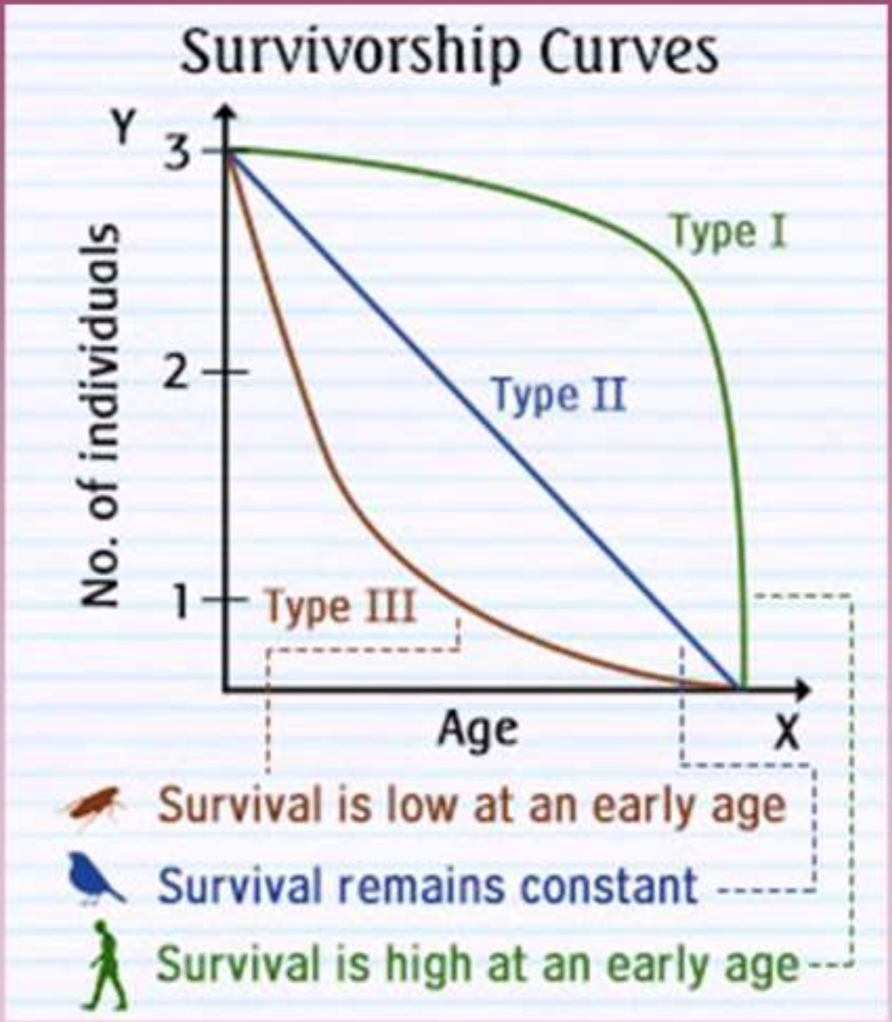
Give two examples of a density-independent factors

Flood,drought (forest fire)

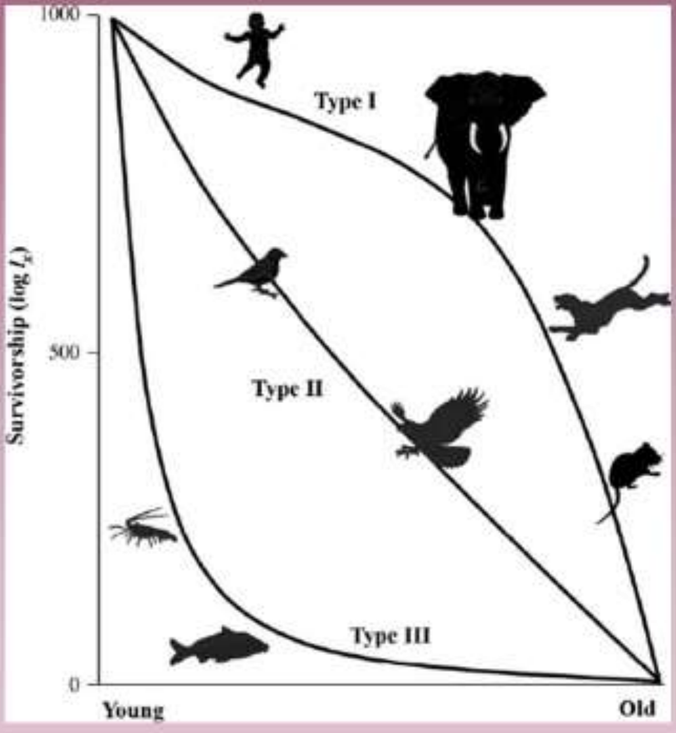
Give 4 examples of an density-dependent factors

Availability of food, disease, predators, build up of toxic wastes

# Survivorship Curves




Draw these for notes.



F Y B Sc Zoology

Paper II Sem I

# (3.2) Population

By
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Shri Anand College Pathardi
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**Chapter 3 Population (08 Lectures)**

**3.1Characteristic of population: Density, Natality, Mortality, Fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion.**

**3.2Exponential and logistic growth,**

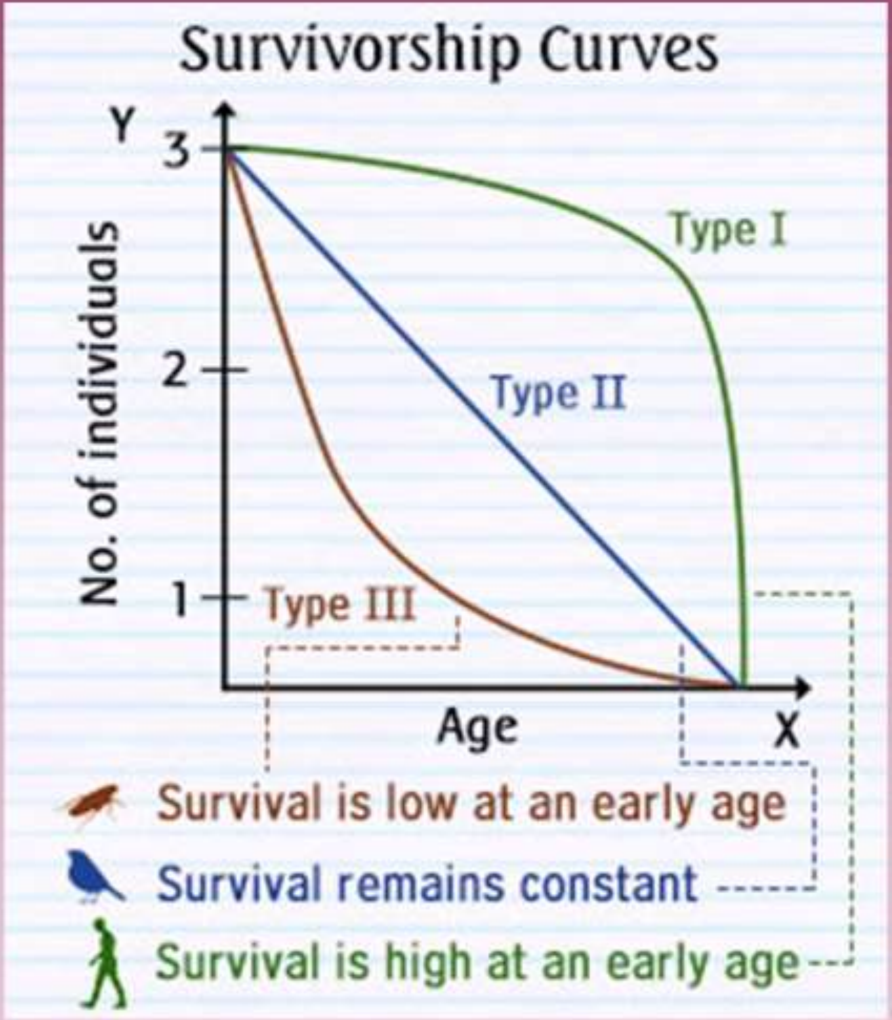
**3.3 Population regulation – density-dependent and independent factors. Population interactions, Gause's Principle with laboratory and field interactions,**

**3.4 Quadrate, line and belt transect methods.**

## Survivorship Curves

- A graph obtained when number of survivors in a population is plotted against time is called as survivorship curve.
- A vital thing for a population is how many members survive but not which members die. Consequently, specific mortality rate of a population is expressed by survivorship curve. There are three types of survivorship curves:
- a) Diagonal Curve: When mortality rate remain constant at all ages i.e. in embryonic, young, adult, the curve appears in a straight diagonal line Example: Hydra, Birds etc.
- b) Convex Curve: When most of the individuals live at their potential life span and die in old age and curve appears convex in nature. Example: Man, Deer, Rabbit etc.
- c) Concave Curve: In this extremely heavy mortality appears in early life and curve appears concave in nature. Exmple: Oyster, Snails etc.

# Survivorship Curves

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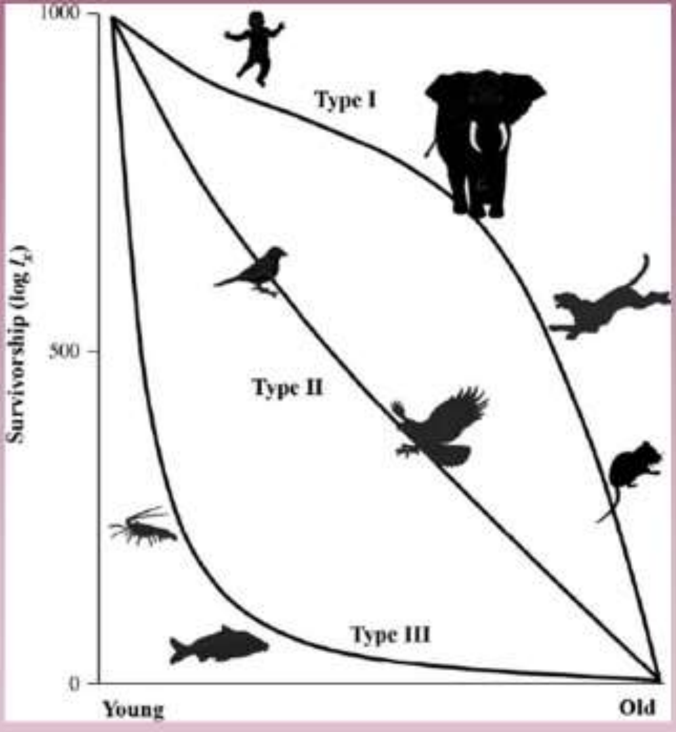
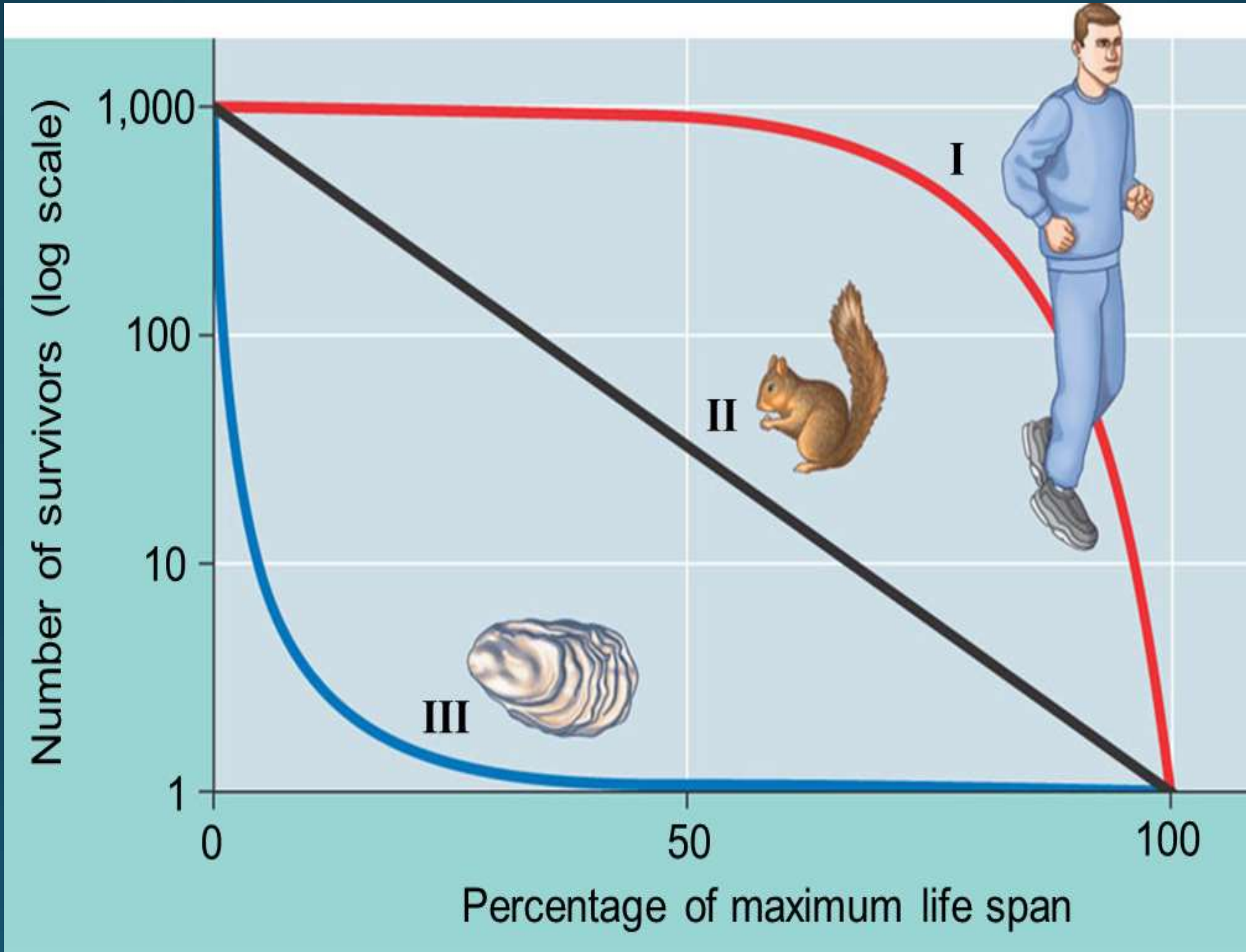
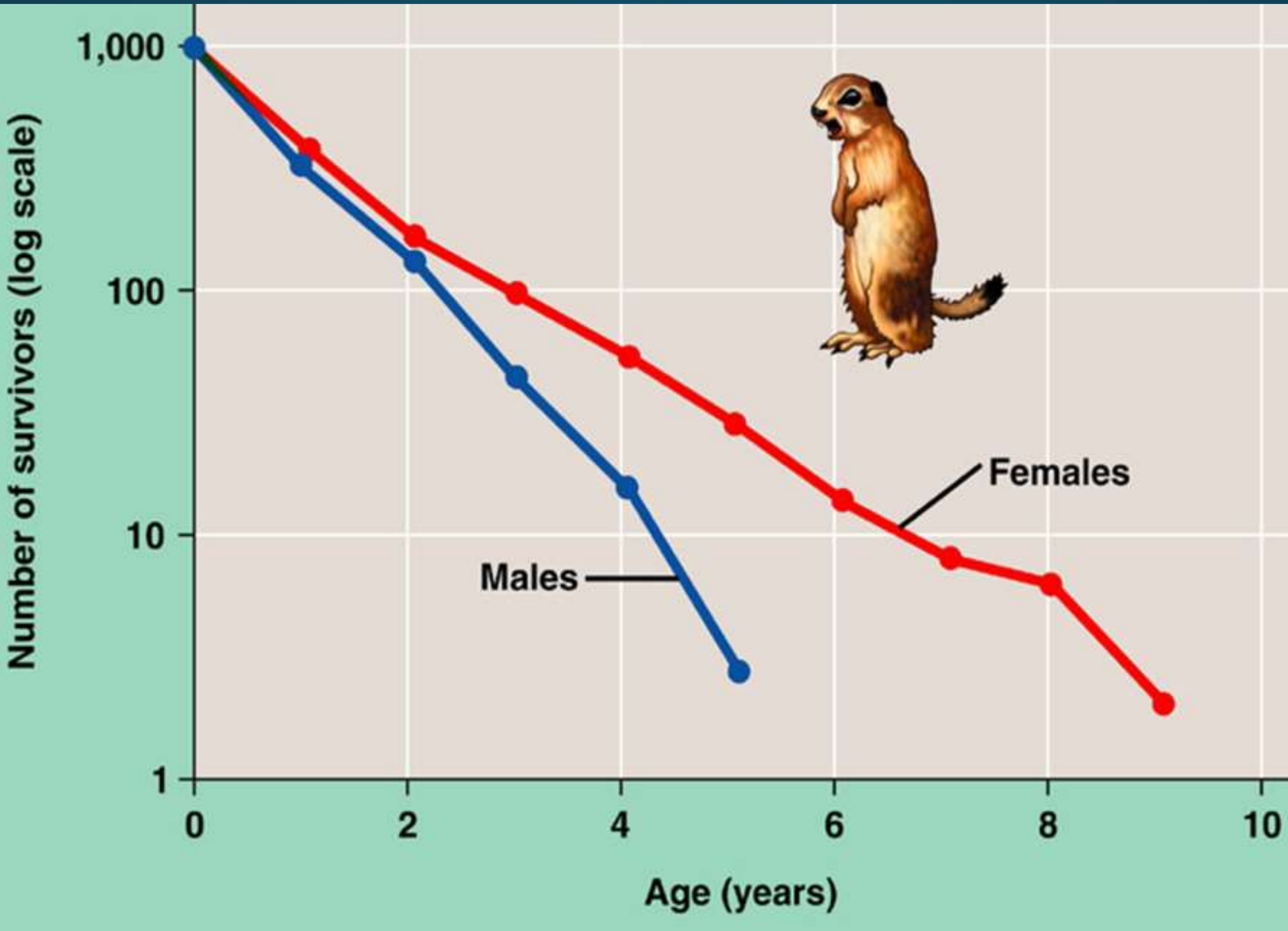




Number of survivors (log scale)
1,000
100
10
1
0
50
100
Percentage of maximum life span
I
II
III


Number of survivors (log scale)
1,000
100
10
1
0
2
4
6
8
10
Age (years)
Females
Males

## Age Ratio

- **Age distribution affects both natality and mortality.**
- **The ratio of the various age groups in a population determines the current reproductive status of the population**
- **Usually a rapidly expanding population will contain a large proportion of young individuals.**
- **A declined population will have a large proportion of old individuals.**
- **A population may pass through changes in age structure without changing in size.**
- **We rarely find a natural population that has a stable age structure because populations do not increase for long in an unlimited fashion.**
- **From an ecological point of view, age structure can be expressed in three ecological ages:**
- **Pre-reproductive, Reproductive and Post-reproductive**

## Sex Ratio

- The sex ratio is the ratio of males to females in a population. The sex ratio tends to be 1:1.
- In anthropology and demography, the human sex ratio is the ratio of males to females in a population.
- More data for entire world population is 102 males to 100 females (2017).
- The current sex ratio in India (2019) is 947 females to every 1000 males, and in Maharashtra 922 females to 1000 males.
- It is divided into four subdivisions:
- a) Primary sex ratio: ratio at fertilization
- b) Secondary sex ratio: ratio at birth
- c) Tertiary sex ratio: ratio in sexually mature organisms also called as adult sex ratio
- d) Quaternary sex ratio: ratio in post-reproductive organisms

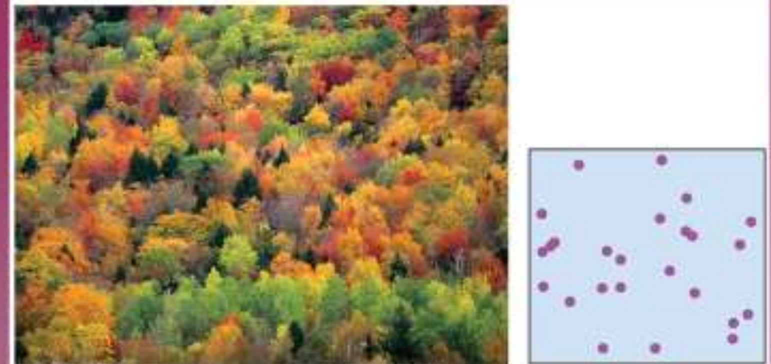
# Population Dispersal

- The movement of individuals and the products of their reproduction into and out of the population is called as population dispersal.
- There are three types of population dispersal:
- a) Emigration: This is the one-way outward movement from one place to another.
- b) Immigration: This is the one-way inward movement from one place to another.
- c) Migration: This is the two way movement of individuals involving periodic departure and return. Migratory movements are very conspicuous among fishes, birds and mammals.

## Population Dispersion

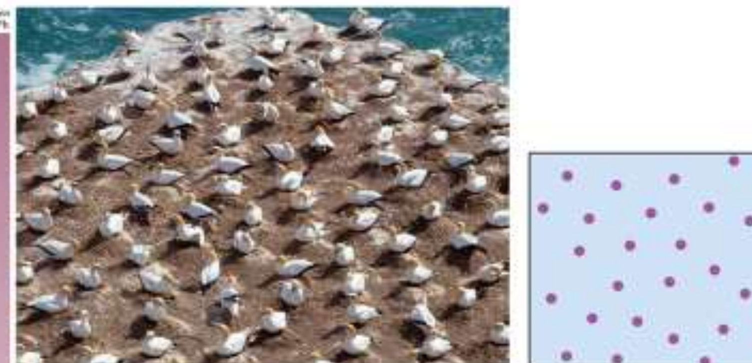
- The distribution pattern of the population is called as dispersion.
- **a) Random Distribution:** **In this individuals rarely show a tendency to aggregate, without any specific pattern. In this type of distribution, the probability of an individual occurring at any one spot is the same as the probability of its occurring at any other spot in a given area.**
- **b) Uniform Distribution:** This is a type of distribution in which the individuals are distributed according to a uniform patter i.e. it is more regular and uniform and may be found in places where there is severe competition between individuals.
- **c) Clumped Distribution**: In this, the individuals are clumped or grouped in a limited area. This is the most common pattern of distribution. This pattern is controlled by the biotic, edaphic and climatic conditions of the area.

5. Population distribution- how individuals are distributed with respect to one another.



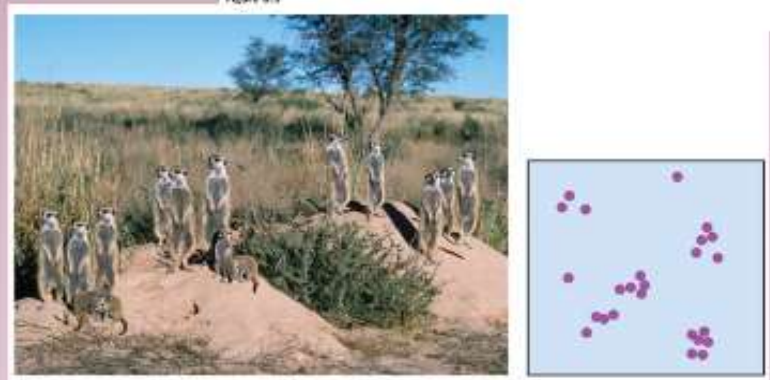
(a) Random distribution

Figure 6.3



(b) Uniform distribution

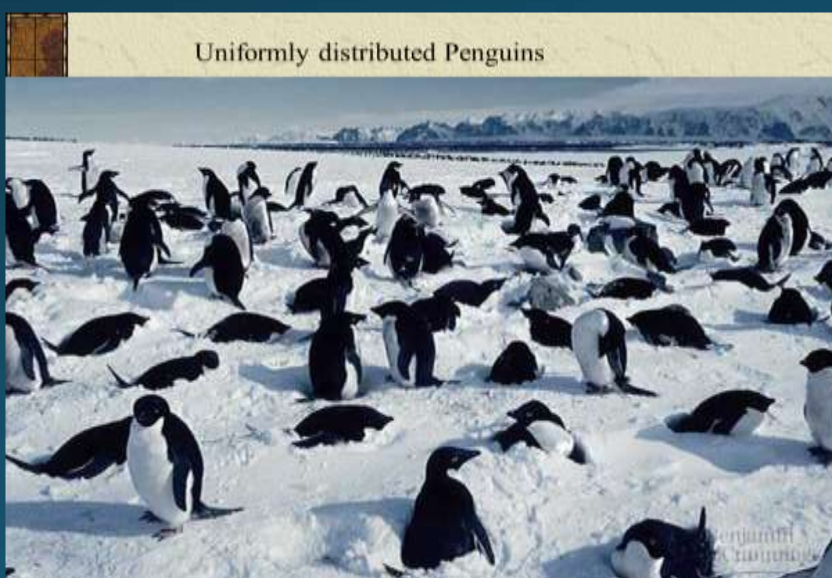
Figure 6.3



(c) Clumped distribution

Figure 6.3


Randomly distributed ferns


Uniformly distributed Penguins


Clumped organisms

## GROWTH CURVES

- Population is changing entity.
- Its size and composition are ever changing.
- The changes in size and composition are dependent on birth rate, deaths and movements of organisms into and away from the population.
- In the beginning, the number of animals in first age category would increase (by birth) while those of the older age groups would remain stationary.
- But as time goes on the age categories increase as the survivors of the initial age groups grow sides.
- As more animals enter into the reproductive stage; greater number of young is produced.
- Eventually after several generations the population will grow at fairly steady rate.
- There are mainly two types of growth curves:

## 1) Exponential Growth Curve or ‘J’ Shaped Growth Curve

- This type of growth curve involves geometric ratio of increase upto a certain point after which there is an abrupt decline in growth rate is due to factors of environmental resistance.
- The growth curve is more or less ‘J’ shaped.
- In the beginning, the density of population increases rapidly in compound interest fashion and then stops abruptly on the environmental resistance These factors may be food, space or seasonal or termination of reproductive seasons.
- In this pattern of growth, the density reaches the upper limits remains at that level for time and then decline suddenly indicating catastrophic condition.
- Ex. early in algal blooms, some insects, annual plants and the lemmings of Tundra, as well mammals as in deer.
- This type of growth curve is not very common.

- The J-shaped curve of exponential growth
  - Is characteristic of some populations that are rebounding

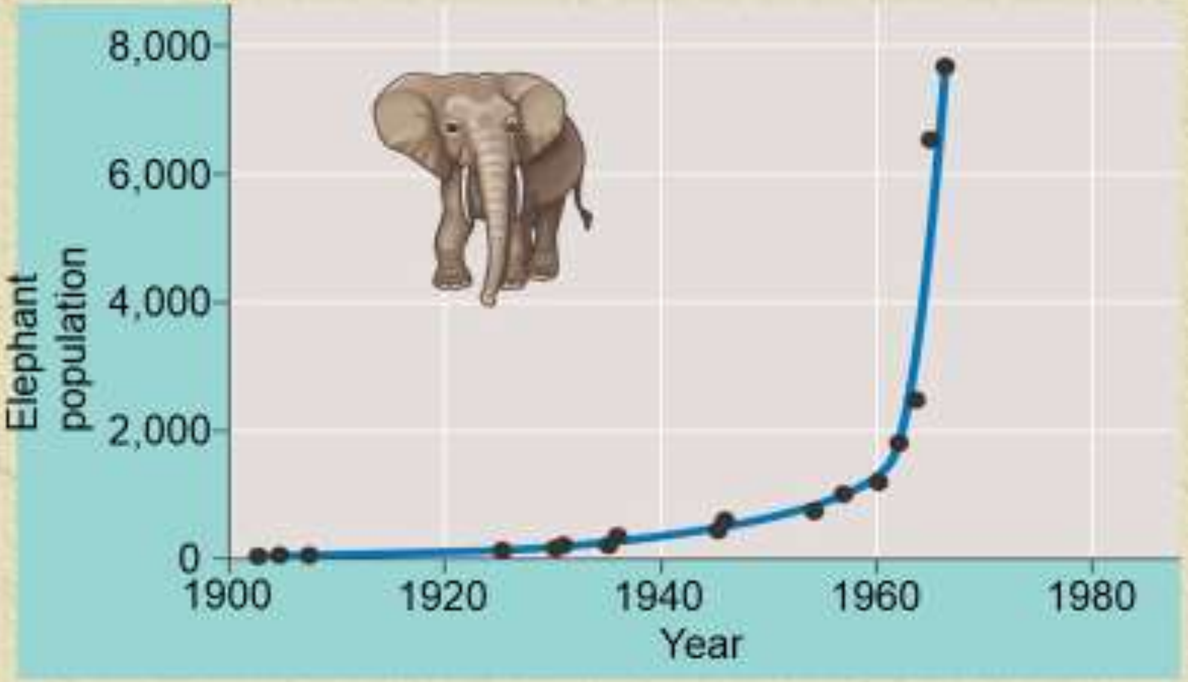



Figure 52.10

## 2) Logistic Growth Curve or 'S' Shaped Growth Curve

- **In the logistic or 'S' shaped growth curve, the initial growth rate is rather slow and this is called as positive acceleration phase.**
- **This is followed by a rapid growth rate and this stage is known as logarithmic phase.**
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- **Subsequently the population reaches a maximum limit known as asymptote (or equilibrium).**
- **This asymptote represents the limiting size of the population.**
- **Thereafter a sort of equilibrium is established between potential natality and environmental resistance, thus maintaining this maximum limit of population density form long periods.**
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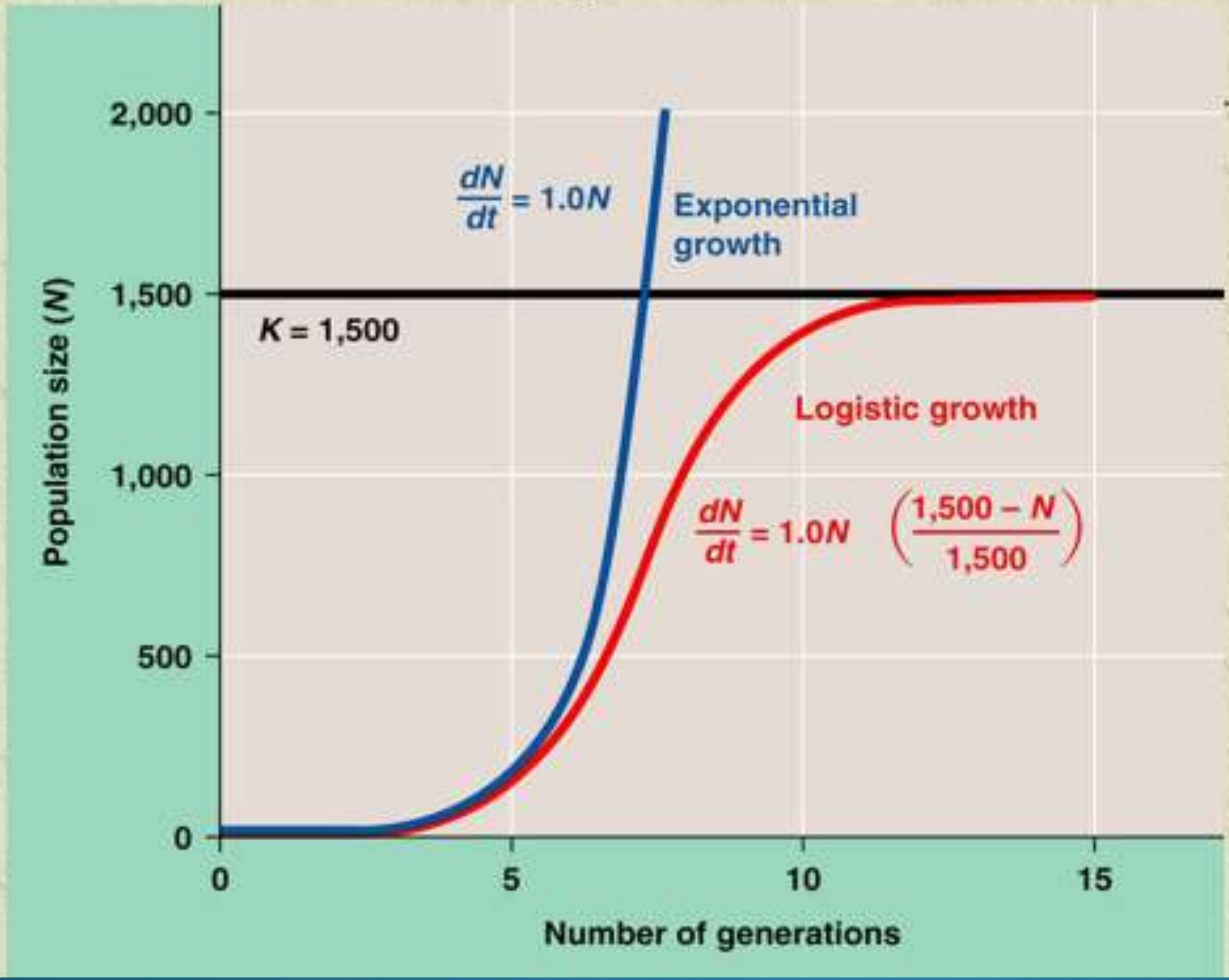
Logistic model produces a sigmoid (S-shaped) population growth curve.



## POPULATION REGULATION

**1)Density Dependent Regulation: They increase in intensity as the population level rises and decrease as the population level declines.**

**They are biotic; they depend on intraspecific or interspecific coactions .**

**Populations are self-governing systems.**

- **a)Competition: The role of competition in regulating population is directly effective by causing mortalities, nest destruction and loss of food supplies.**
- **b)Predation: The predator-prey relationship provides a typical example of density dependent regulation**
- **C)Reproductivity: The birth and death rates have their important roles in regulation of population size.**
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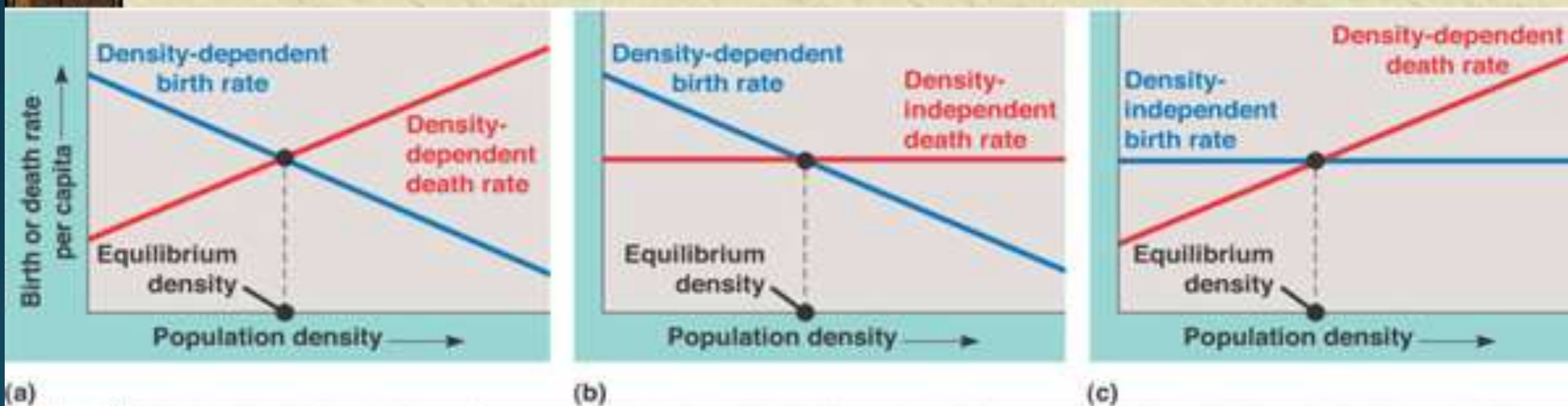
In density-dependent population either birth rate or death rate or both may be density dependent.



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## GAUSE'S PRINCIPLE

- **Competition exclusion principle experimentally confirmed by Russian Biologist, C.F.Gause in two sps of Paramecium.**
- **It suggest that closely related organisms (or sps) remain ecologically separated.**
- **Gause cultured two sps of Paramecium: P caudatum and P aurelia separately and together (mixed).**
- **When cultured separately under the same set of controlled env conditions and fed with the same sps of bacterium, both sps flourished and shows sigmoid growth in laboratory.**
- **However, when cultured together under the same environmental control and forced to compete for the same food, P aurelia is survived but P caudatum did not.**
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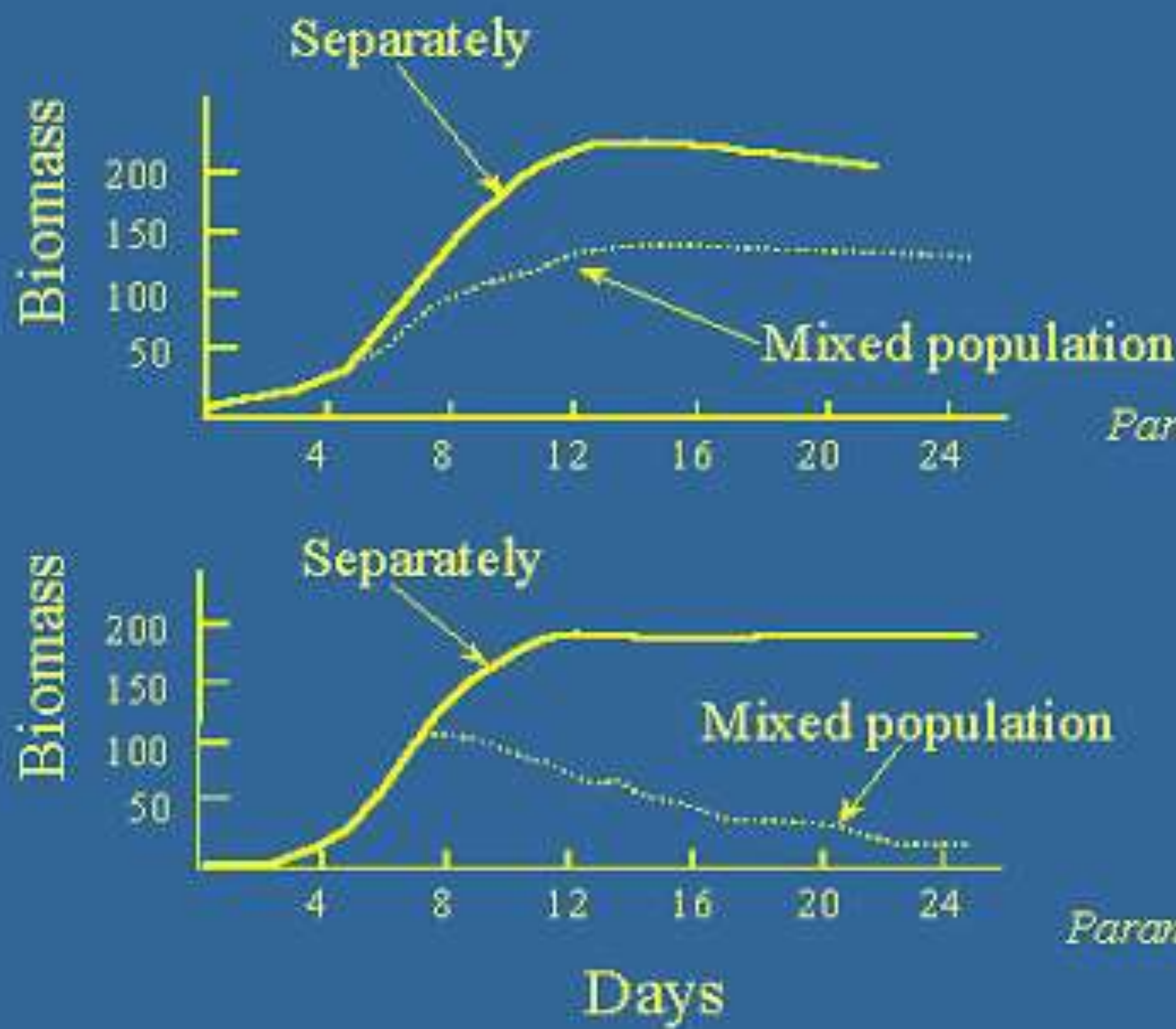
# Gause's Experiment




*Paramecium aurelia*

*Paramecium caudatum*

## QUADRATE

A quadrate is a frame, traditionally square, used in ecology and geography to isolate a standard unit of area for study of the distribution of an item over a large area.

## QUADRATE METHOD

Instead, ecologist would be forced to count a smaller representative part of the population, called a sample. A sampling of plants or slowly moving animals (i.e. snails) can be done by using a sampling square called a Quadrate. A suitable size of a quadrant depends on the size of the organisms being sampled. For example, to count plants growing on a school field, one could use a quadrate with sides 0.5 or 1 m2 in length. Choice of quadrate size depends to a large extent on the type of survey being conducted. Random sampling is usually carried out when the area under study is fairly uniform, very large and/or there is limited time available. When using random sampling techniques; large numbers of samples are taken from different positions within the habitat. A quadrate frame is most often used for this type of sampling. The frame is placed on the ground, and the animals or plants inside it counted or collected, depending on what the survey is for. This is done many times at different points within the habitat to give a large number of different samples.

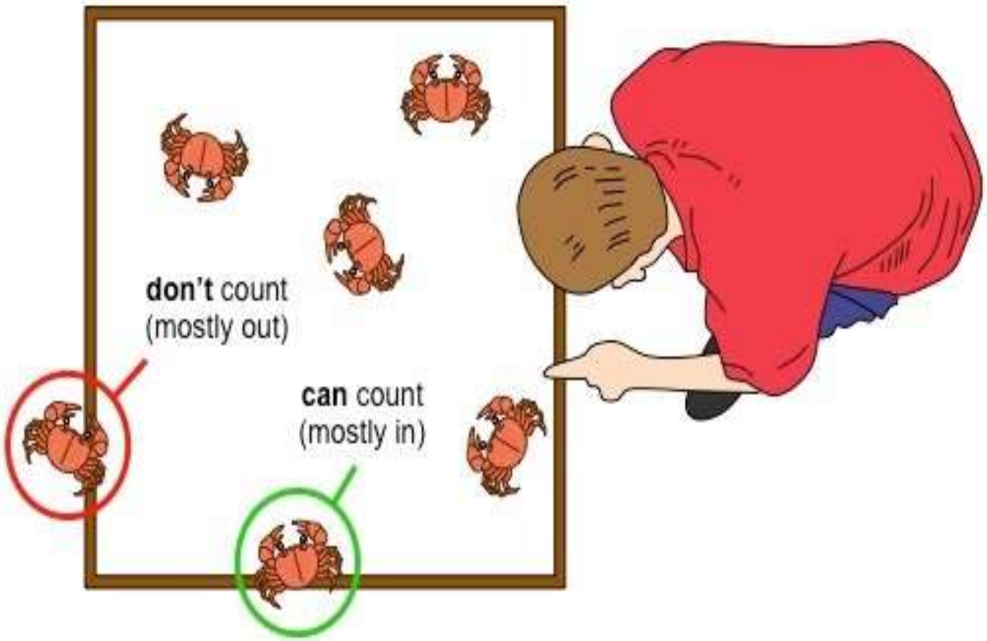
## TRANSECT METHOD

When the vegetation or animals is to be studied along an environmental gradient or eco-tone, a line is laid down across a stand or several stands at right angle.

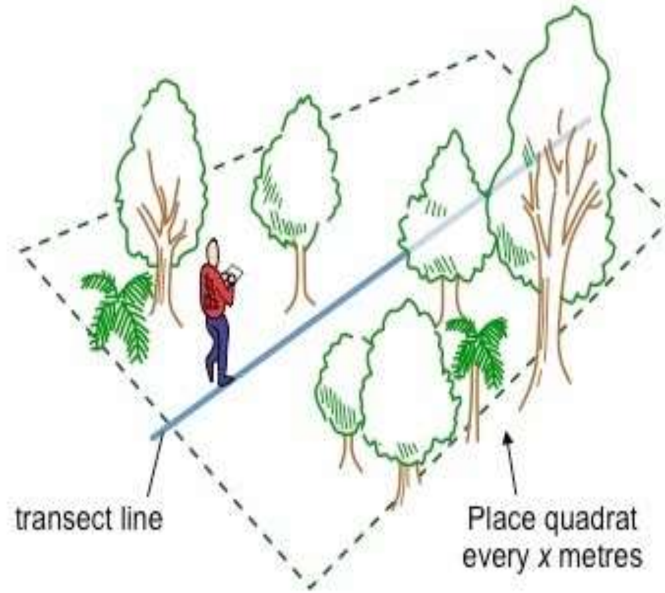
This method of linear sampling of the vegetation is called transect. Depending upon the object of study, two types of transect can be drawn. They are as follows:

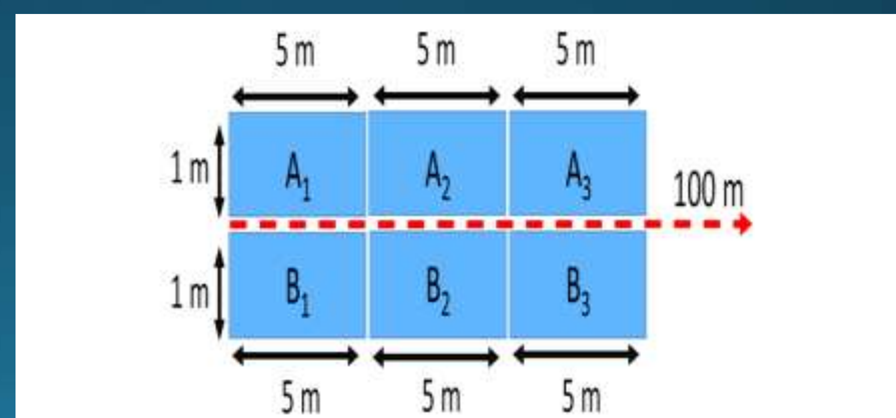
**a) Line Transect:** In this type of transect the vegetation is sampled only over a line (without any width). A line is laid over the vegetation with a metric steel tape or steel chain or long rope and kept fixed with the help of pegs or hooks. This line will touch some plants on its way from one point to the other. The observer will start recording these plants from this type of transect following information could be collected. From the observations in a number of such parallel lines transect, comments can be made on the habitat and other environmental conditions on different portions of transect. Every species has its own ecological amplitude and tentatively expresses the status of available water and other edaphic conditions, atmospheric humidity, availability of light, grazing and other biological pressures

## Quadrat Counting Method




## Line Transects



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Belt transects are used in determining and understanding the gradual change in abundance dominance, frequency and distribution of different species in the transitional region between two different types of vegetation.

# F Y B Sc Zoology

## Paper II Sem I

# (3.3) Population


By

**Dr Bhausaheb R Ghorpade**

**Dept Of Zoology**

**Shri Anand College Pathardi**

**Dist Ahmednagar (MS)**

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3.2Exponential and logistic growth,

3.3 Population regulation – density-dependent and independent factors. Population interactions, Gause's Principle with laboratory and field interactions,

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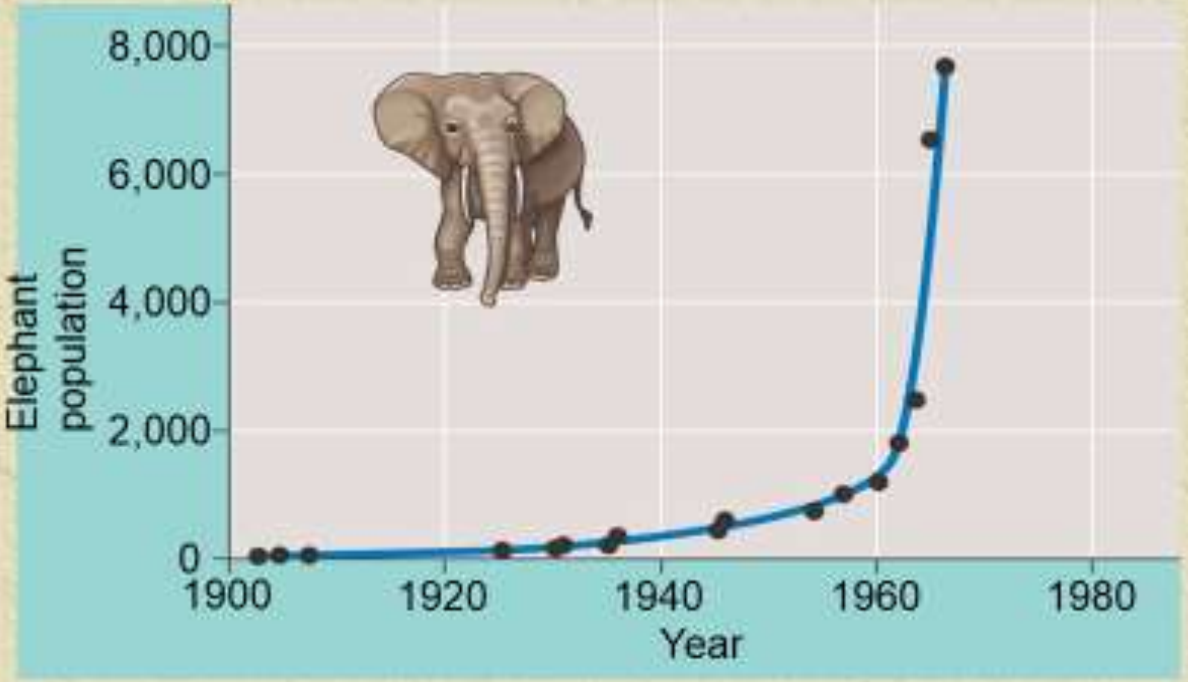


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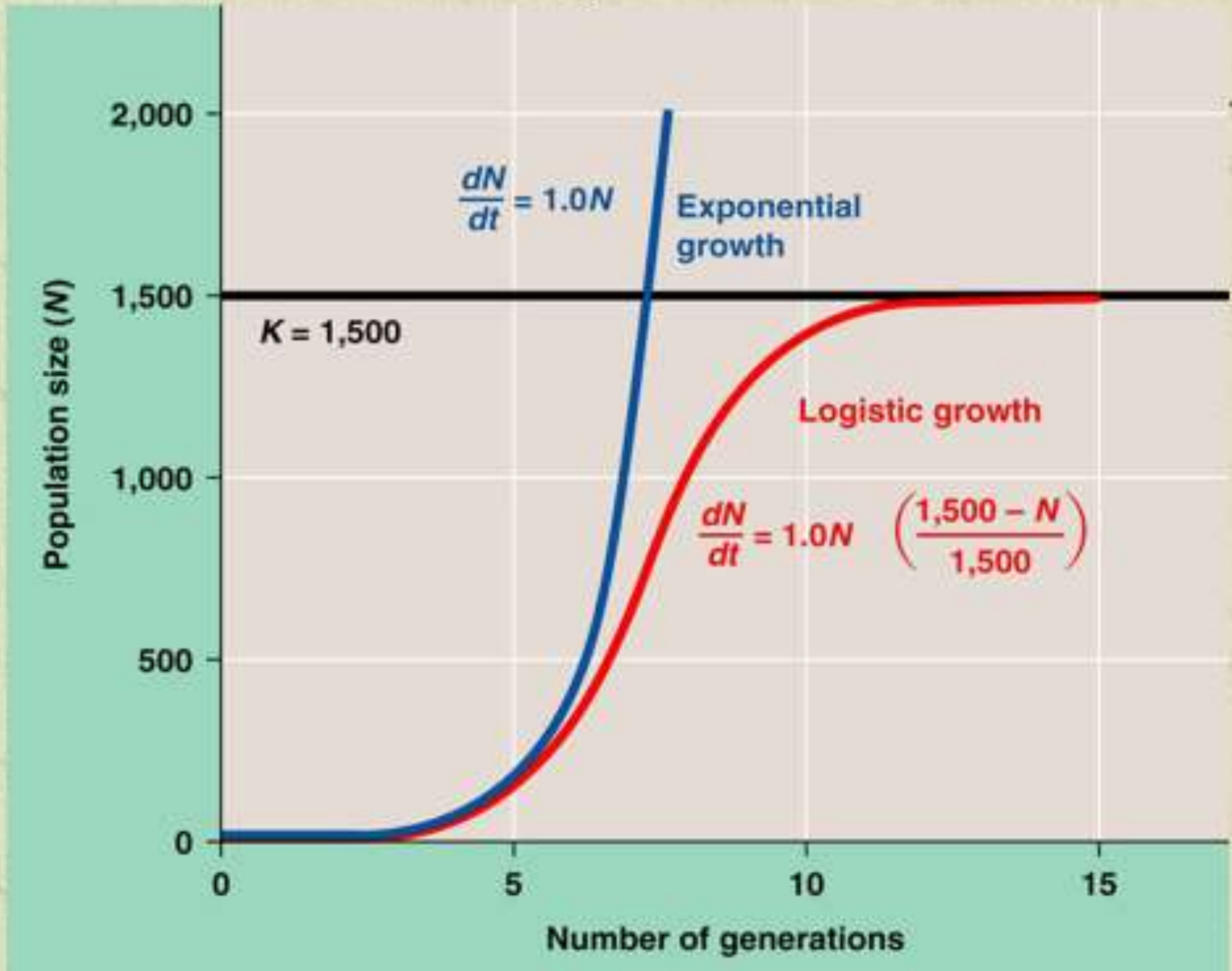

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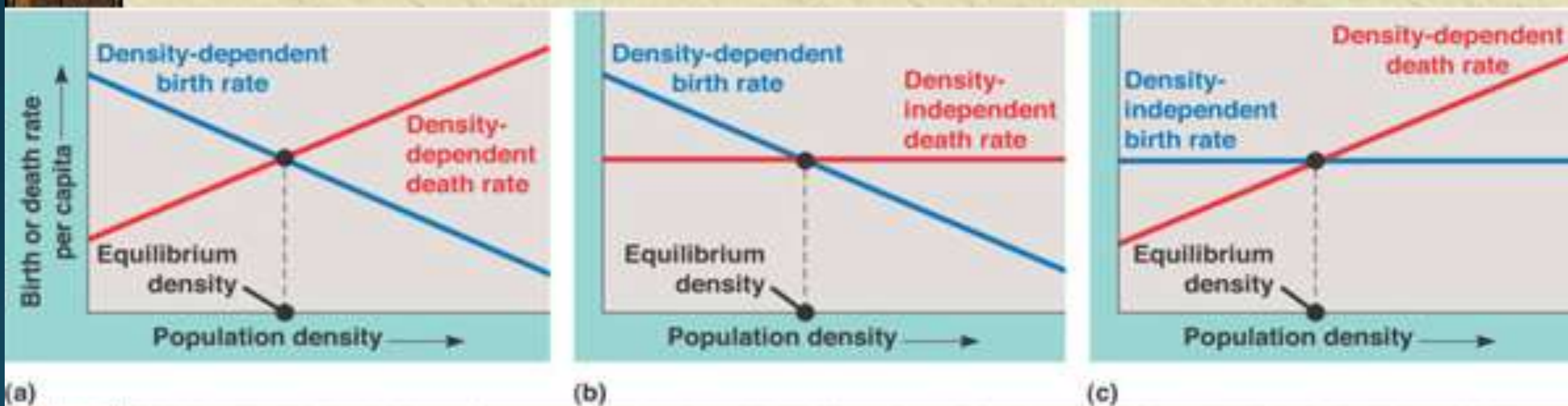

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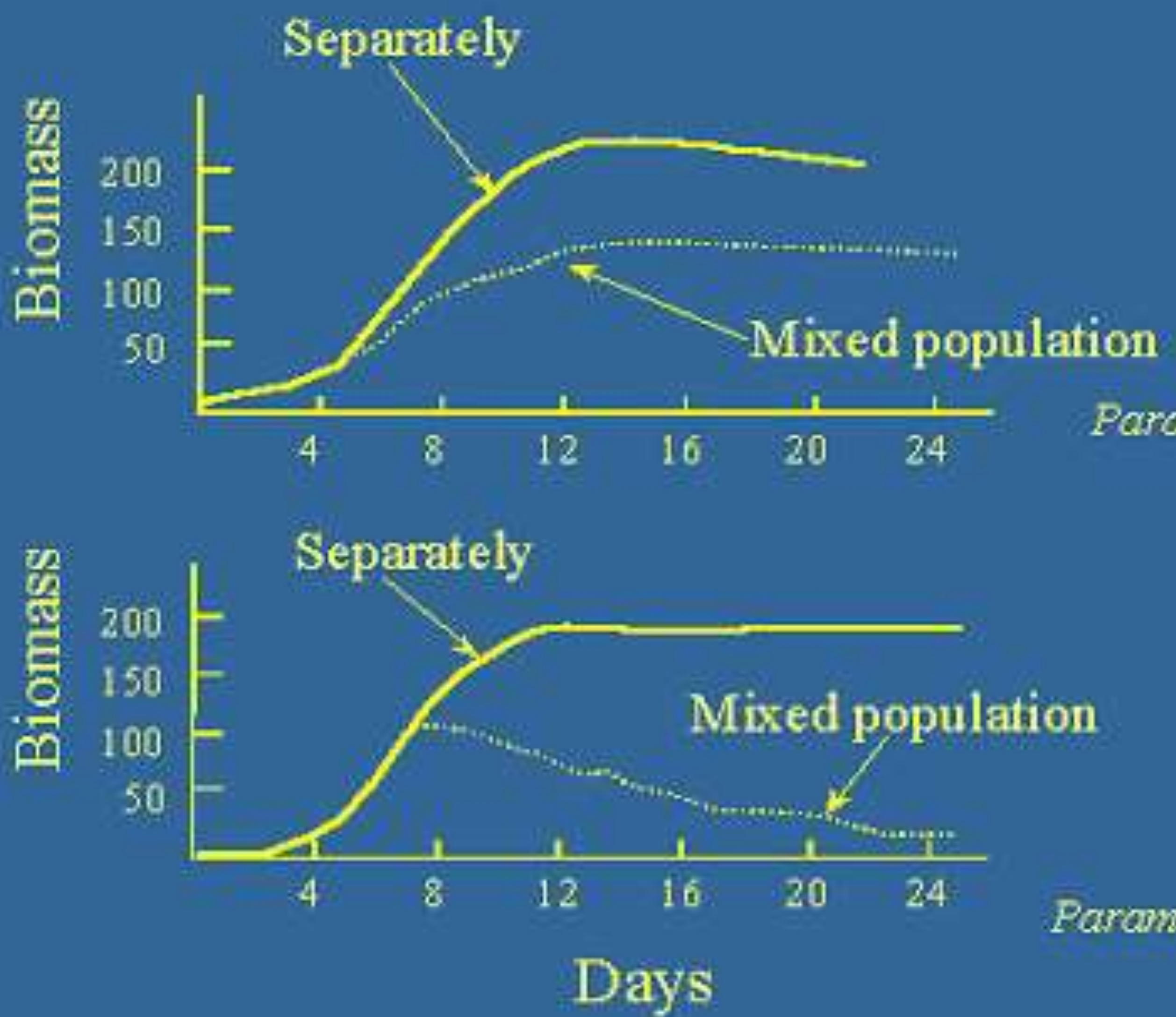
- However, when cultured together under the same environmental control and forced to compete for the same food, P aurelia is survived but P caudatum did not.
- The survival of P.aurelia was simple due to the greater growth than the P.caudatum, thus been more successful in competing for the limited food supply.
- This clearly shows that the two sps of Paramecium cannot live together and grow normally in the same culture.

# Gause's Experiment




*Paramecium aurelia*

*Paramecium caudatum*

## QUADRATE

A quadrate is a frame, traditionally square, used in ecology and geography to isolate a standard unit of area for study of the distribution of an item over a large area.

## QUADRATE METHOD

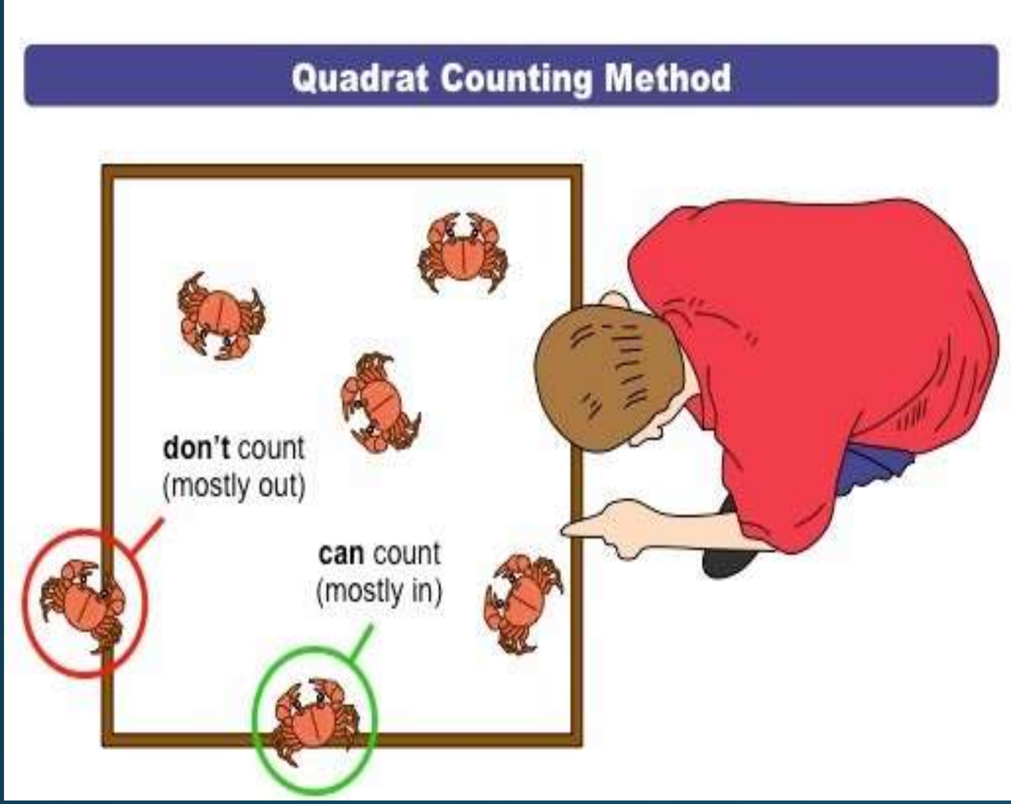
Instead, ecologist would be forced to count a smaller representative part of the population, called a sample. A sampling of plants or slowly moving animals (i.e. snails) can be done by using a sampling square called a Quadrate. A suitable size of a quadrant depends on the size of the organisms being sampled. For example, to count plants growing on a school field, one could use a quadrate with sides 0.5 or 1 m2 in length. Choice of quadrate size depends to a large extent on the type of survey being conducted. Random sampling is usually carried out when the area under study is fairly uniform, very large and/or there is limited time available. When using random sampling techniques; large numbers of samples are taken from different positions within the habitat. A quadrate frame is most often used for this type of sampling. The frame is placed on the ground, and the animals or plants inside it counted or collected, depending on what the survey is for. This is done many times at different points within the habitat to give a large number of different samples.

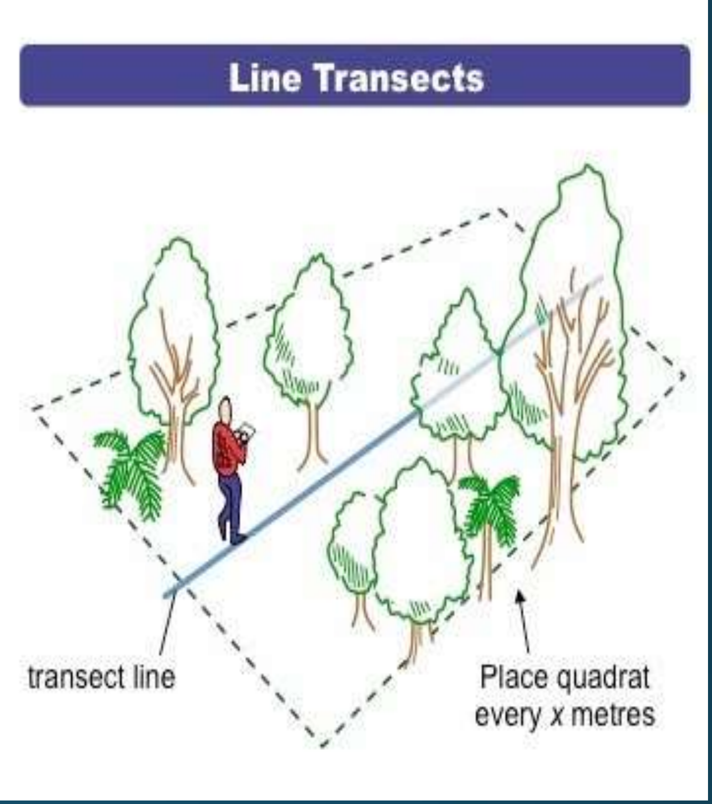
## TRANSECT METHOD

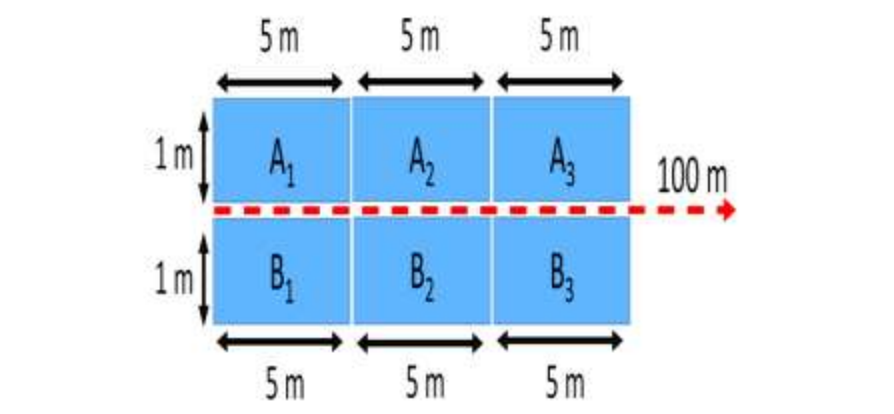
When the vegetation or animals is to be studied along an environmental gradient or eco-tone, a line is laid down across a stand or several stands at right angle.

This method of linear sampling of the vegetation is called transect. Depending upon the object of study, two types of transect can be drawn. They are as follows:

**a) Line Transect:** In this type of transect the vegetation is sampled only over a line (without any width). A line is laid over the vegetation with a metric steel tape or steel chain or long rope and kept fixed with the help of pegs or hooks. This line will touch some plants on its way from one point to the other. The observer will start recording these plants from this type of transect following information could be collected. From the observations in a number of such parallel lines transect, comments can be made on the habitat and other environmental conditions on different portions of transect. Every species has its own ecological amplitude and tentatively expresses the status of available water and other edaphic conditions, atmospheric humidity, availability of light, grazing and other biological pressures


Quadrat Counting Method
don't count
(mostly out)
can count
(mostly in)


Line Transects
transect line
Place quadrat
every x metres


5 m
5 m
5 m
1 m
A1
A2
A3
100 m
1 m
B1
B2
B3
5 m
5 m
5 m

## b) Belt Transect

- The belt is a long strip of vegetation of uniform width. The width of the belt is determined according to the type of vegetation or the stratum of vegetation under study.
- In close herbaceous vegetation it is usually 10 cm, but it varies from 1 to 10 meters in woodland.
- The length of the vegetation is determined according to the purpose of the study.
- A belt is generally studied by dividing it into some equal sized segments.
- The length of each segment is generally equal to the width of transect. The segments are sometimes called quadrats.
- Belt transects are used in determining and understanding the gradual change in abundance dominance, frequency and distribution of different species in the transitional region between two different types of vegetation.

***Thanks***

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**Paper No.** : 12 Principles of Ecology
**Module** : 19 Community: Community characteristics, types of biodiversity, diversity index, abundance, species richness, vertical and horizontal stratification: Part III

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| Description of Module | |
|---|---|
| **Subject Name** | **ZOOLOGY** |
| **Paper Name** | **Zool 12, Principles of Ecology** |
| **Module Name/Title** | **Community** |
| **Module Id** | **M19, Community characteristics, types of biodiversity, diversity index, abundance, species richness, vertical and horizontal stratification : Part- III** |
| **Keywords** | **Community characteristics, Vertical stratification, Zonation, species diversity, dominance, abundance, Keystone species, ecotone, edge effect** |

## Contents

## 1. Learning Outcomes

After studying this module, you shall be able to

- Understand the structure of community
- Briefly study the physical and biological structure of community
- Study the vertical and horizontal (Zonation) stratification of the community
- Understand the role of species richness, dominance and diversity in characterizing a community.
- Learn about the characteristics of community such as ecotone and edge effect etc.

## 2. Introduction

Community is an organized ecological unit in which organism interact through various associations such a predation, competition, mutualism and parasitism, linked to each other *via* feeding relationships and are adapted to prevailing physical environmental surroundings. These interactions, associations and adaptations by the organisms provide community its distinct structure and influence other characteristics such as growth and developments of the community, dominance and species diversity.

## 3. Structure of the community

The basic structure of the community is divided into physical and biological structure. The physical structure of community is defined by the growth forms and life forms.

**Physical Structure: Growth forms and Life forms**

The structure and form of vegetation defines the differences between different terrestrial communities. On the basis of the **growth forms** the vegetation of the community can be classified. Plant community may exhibit different growth forms such as short or tall plants, woody or herbaceous plants or deciduous or evergreen plants. The herbs, shrubs and trees are further sub-divided these categories into evergreen sclerophylls, needle-leafed evergreens, thorn trees, broad-leafed evergreen or broad-leafed deciduous trees, dwarf shrubs, shrubs, grasses, ferns, mosses, lichens and forbs.

The plants are also classified on the basis of **life forms** by Christen Raunkiaer (1903). He is a Danish botanist, who defined life forms on the basis of perennating tissue above ground or simply height of the plant. He suggested that in a given area, all the species are grouped into six principal classes of life forms, namely epiphytes, phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes. A community consisting mostly of phanerophytes are characterised by warm climate whereas when mostly comprised of hemicryptophytes and chamaephytes are characterised by cold climate.

**Stratification**

The ecological communities are arranged in different layer or strata forms, a phenomenon called **stratification**. For example in a natural forest community, as per the height of the plants the community is arranged into number of strata or layers such as herbaceous layer consisting of herbaceous plants followed by shrubs, smaller trees and tall trees. This fractionation in the community is caused by the gradations in the external environmental factors like water levels, temperature and light. Different strata or layer of forest community receives different degree of light intensity providing vertical stratification to the community structure. In a forest community generally three or more vertical layers or strata of plants are found including a herb layer, shrub, small tree layer followed by canopy tree layer. The canopy tree or other taller trees produces more foliage and interrupt the light to reach smaller plants on the ground. The gradients in the physical environment of the community cause horizontal layering or patterns among species. Differences in the amount of factors such as nutrients and water can significantly alter the distribution of plant and animal species over a region.

A community consists of different growth form determining the community structure such as herbs, shrubs, trees. A growth form also has variations such as a tree can be long leaved or broad leaved etc. Various growth form have different mode of arrangement classifying community into (a) **Horizontal Zonation and (b) Vertical stratification,** i.e. Populations assembled to form communities and these populations are dispersed into definite vertical or horizontal strata.

**a. Horizontal Zonation**

The spatial arrangement of community species exhibit patterns and based on these patterns the community is divided into sub-communities which are ecologically related. If the distribution pattern is horizontal it’s called zonation layering in community. For example in lakes or deep ponds majorly three zones are recognised i.e. littoral, limnetic (Photic or open-water) and profondal zone (Aphotic or Deep-water). The organism varies in each zone of zonation pattern. Another example include mountain associated vegetation, altitudinal and latitudinal variations of vegetation in relation to climate of the existing region.

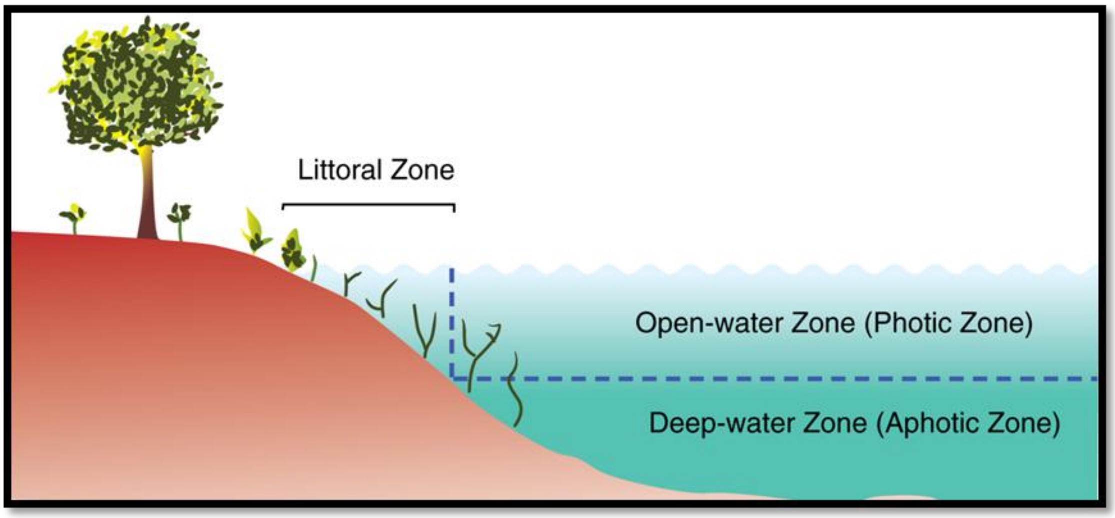



**Figure 1: A deep lake depicting a Horizontal Zonation**

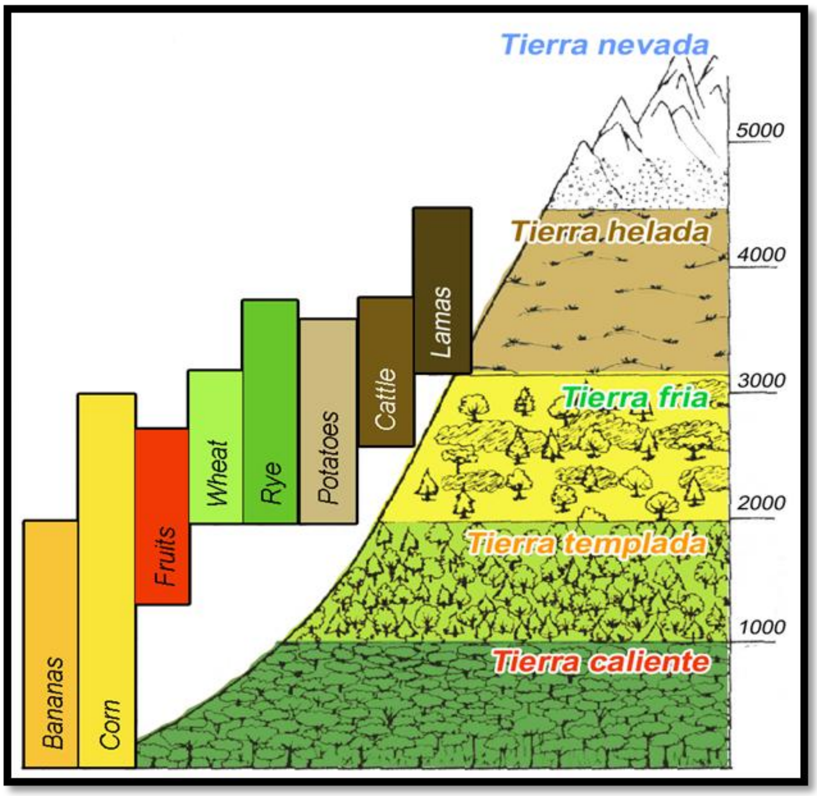



**Figure 2: A mountain depicting a Horizontal Zonation**

**b. Vertical Stratification**

Vertical change in the pattern of community structure is called stratification. Vertical Stratification is as simple as the horizontal zonation community of pond, where each zone has different vertical storey, or complex stratification. For example in grassland communities distinct floor with different yet characteristics growth forms are exhibited. The lowest vertical sub-division is called (1) **Subterranean**-beneath the soil. Subterranean, which includes roots of plants, debris and living organisms like soil bacterium, protozoas or fungi etc.

(2) Herbaceous substratum: Above the soil with roots of growth forms, the herbaceous sub-stratum includes upper parts of growth forms. The forest community stratification is much more complex with five vertical layering including: The vertical stratification in the forest community mostly comprised of following strata's: Subterranean, **Forest floor**-with the upper parts of growth form along with the litters, fungi, bacteria etc., **Herbaceous vegetation, Shrubs and Forest Strata (canopy).** An additional stratum called emergent trees which are present in the tropical rain forest and these plants rises above the canopy of the forest.

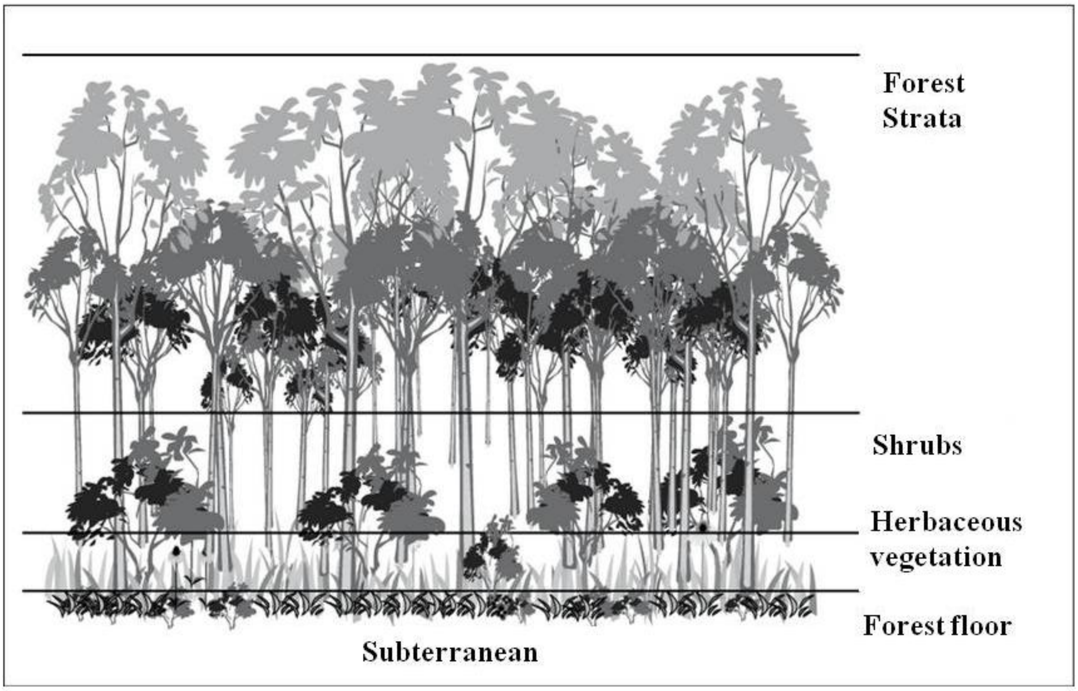



**Figure 3: Vertical Stratification in a forest community**

Forest animal's lives in different substrata and many of them may shift between substratums. The properties (requirement and adjustments) of one stratum can be similar to the same stratum of different community somewhere else in the world. For example forest floor of one community in country 1 share common requirements and adjustments to the community in country 2 although these countries are geographically separated. The animals living in such geographically separated but similar substratum are called **Ecological Equivalent**.

## 4. Biological Structure and Characteristics of a Community

A community has the following characteristics:

**(a) Structure:** By virtue of understanding the structure of the community, the frequency, density and abundance of different type of species are measured.

**(b) Dominance:** The community type is determined by the dominant species. These species of one or more type either occupy large space or occur in large number and called as dominant species.

**(c) Diversity:** The community show diversity which is composed of different species of plants and animals in different groups that may belong to different growth forms or life forms and are essentially prevailing in uniform environmental surroundings. Diverse communities are healthy and stable communities.

**(d) Periodicity:** The dominant species of the community are studied in various seasons of the year to determine various life processes such as reproduction, growth and respiration. Periodicity is defined as the expression and reoccurrence of various life processes annually at regular intervals in nature.

**(e) Stratification:** Within ecological communities, the habitat arrangement in form of layering (either vertical or horizontal) is called Stratification. The stratification of two different types of communities may differ such as the lake community represent horizontal stratification whereas mountain plant communities obey vertical stratification.

**(f) Eco-tone and Edge-effect:** Ecotones are easily recognisable marginal zones of vegetations separating two distinct types of communities. The species diversity is greater in the ecotone in comparison to the adjacent communities. This phenomenon of greater intensity and diversity at the common junction is defined as edge-effect.

**(g) Ecological Niche:** Ecological niche is defined as the role or function of species it plays in its ecosystem. In the ecological complex, different plants and animals of different species differ in their function and their combined interactions with other species in its environment are called its ecological niche. In other words, it can also be defined as the small habitat of single species within a large habitat in which it survives. E.P Odum defines and differentiate ecological niche and habitat by saying that ecological niche is the profession of the species within the ecosystem whereas the habitat is its address.

**(h) Community Productivity:** Community productivity is defined as the net storage of energy and production of biomass per unit time by the community.

**(i) Biotic Stability:** Biotic stability is the ability of a community to regain its equilibrium followed by disturbances causing population fluctuations. The stability of the community is directly dependent on the diversity of the community.

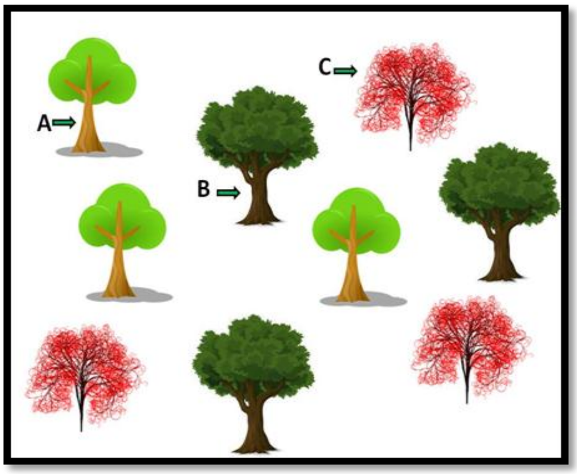
**In 1994, Krebs characterized communities into five characteristics that can be studied, namely Growth forms and life forms** (described earlier in section), species richness, dominance, relative abundance and trophic structure. Other major types of factors that constitute the structure of the community are as following:

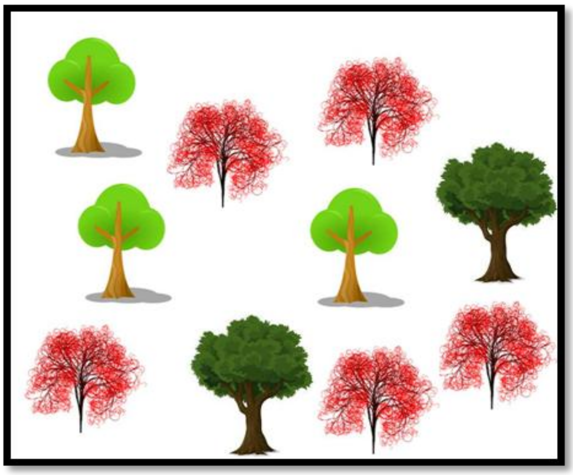
***a. Species Richness***

Species Richness is given as number of species in a community. In an ecological habitat, landscape or community the count of different species represents the species richness. It does not indicate about the species abundance or relative abundance of species. For example beetles counted from a pitfall trap etc. Sample heterogeneity and the number of species influence the species richness. If the samples are collected from different environment and habitats then the collected data is higher for species richness. Thus sampling should be performed on large areas as the more heterogeneous environment prevails and large size of population. Species richness helps in assessing the conservation values of landscapes or habitat by relative comparisons. Although it does not consider the type of species but areas with rare species have higher conservation values than same number of species which are commonly found.

***b. Species Diversity***

The major biodiversity measurements are species richness, Shannon Weiner Index and Simpson’s Index. Species diversity comprised of two factors species evenness and species richness (number of species). Species evenness indicates the relative abundance of each species.



**Community “1”** **Community “2”**

Both communities have three types of plant species depicting same species richness but relative abundance vary.

In community “1” species A, B and C are equal in proportion (three each) indicating higher species evenness thus revealed higher species diversity.

In community “2” species C is more in proportion indicating low species evenness and species diversity.

**Diversity Indices:**

In a given community, the species diversity can be measured mathematically by the Diversity Index. The measurement of diversity index is dependent on the species abundance and species richness. The species abundance is given as the number of organisms per species and the species richness is given as the number of species in the community. Information statistic indices and dominance indices are the two types of diversity indices given as Shannon Index and Simpson Index respectively.

The equations for the two indices are given as:
**Shannon-Weiner Index**

It’s a common Index of species diversity represented as

$$\boxed{H^{o} = -\sum_{i=1}^{s} p_i \log_e p_i}$$

Where, N= total number of individuals found; n= individuals of one particular species found p= n/N; proportion; Σ= sum of the calculations; $H^{o}$ is the diversity index, the proportion of $i^{th}$ species is represented as $p_i$ while “s” is species richness i.e. number of species in community.

**Simpson Index ($D_s$)**
$D_S = \sum_{i=1}^{s} (n_i (n_i-1))/ (N(N-1))$
Where, N= total number of individuals in $i^{th}$ species
n= individuals of one particular $i^{th}$ species
p= n/N; proportion
Σ= sum of the calculations

The Shannon index is based on the assumptions that samples are randomly collected and all species are represented in that randomly collected sample. It's an information statistic index.

The Simpson index is majorly dependent on the dominant or common species and thus, it's a dominance index. In this type of index, rare species in less number with only few representatives do not produce any significant differences in the measurement of diversity. In 1949, Edward H. Simpson introduced Simpson index which measures the extent of concentration when organisms are classified. In 1950, Orris C. Herfindahl rediscovered the same index. In 1945, Albert O. Hirschman already introduced the square root of the index. Therefore, the Simpson index in ecology is also called as **Herfindahl-Hirschman index (HHI) or Herfindahl index in economics**.

**Gini–Simpson index**

In contrast to the probabilities of same type of entities taken at random in the original Simpson index (λ) the Gini-Simpson index (1- λ) represent its transformation that equals the probability of two entities corresponding to different types. In ecology it is also called as PIE or probability of interspecific encounter. It can be expressed in the following equation:

$$1 - \lambda = \sum_{i=1}^{R} pi^2 = 1 - 1/^2\mathbf{D}$$

***c. Dominance***

In a community different species interacts among themselves and in some communities the interaction results into dominance by one species or by a prominent species in group. The organisms dominating others are referred to as **dominants**.

In ecology the proportion of biomass or abundance of one species or taxon than other interacting species or taxon in a community. It's the dominant species that defines the ecological community. For example *Alnus glutinosa* (Alder) is the tree dominating in the Western Europe woodland areas. They are used to classify or identify the type of ecology.

In a community we can consider a community as dominant on the basis of following:
Either they are occupying maximum space of community habitat or have highest biomass or play critical role in nutrient cycling, contribute maximum to energy flow or regulate other community organisms.

Sometimes numerically abundant (means more in number) makes organisms superior and dominant but not necessarily always. Microclimate within the community also effect and complicate this system by contributing more dominant species per microclimate.

Microclimates have local environment differences like nutrients levels, moisture, topographic location etc.

Its only how impactful and important functions a species play in shaping the structure and function of community which decides its dominance. Sometimes even the low density group of species or a single species can be dominant.

**Keystone species:** Dominant species (plants/animals) playing crucial and unique role and highly effect community structure and function in relative to its abundance are called Keystone species. These keystone species have very intense inter species associations thus, controls the number and types of other species in community. Therefore, if we remove keystone species the community will shift to new form dramatically and vary from its original structure and function.

A classic example of keystone species is *Pisaster ochraceus*, a starfish. This starfish is a keystone predator and the only natural predator for mussels, sea urchins and many other shellfishes. So, if we remove starfish, the mussels or urchin population will proliferate in an uncontrolled manner shifting the community.

Another example includes a prey predator system where small predators like weevil *E. lecontei* which forage on herbaceous species called *E. watermifoil*. *E. watermifoil* can eliminate dominant plant species of the inhabited community but it's the predator *E. lecontei* which control *E. watermifoil* from doing so by feeding on it. *E. watermifoil* (prey) number is less and thus requires low density of predator (*E. watermifoil*). But if predator is eliminated out of the community, the prey will outgrow in number dramatically thereby, vanishing the dominant species of community and thus, by eliminating the small number predator, the community character will now be altered without its actual dominant species.

This example indicates that dominant species directly control the community character but keystone species indirectly alter the community character.

Several approaches are used to determine the ecological dominance.
If a sample is collected from a large area than the individuals of a species found in large number represents the abundance of species and its distribution within ecosystem is called as **relative species abundances**.

a. **Relative abundance:** When the total abundance of all organisms is compared to numerically abundant one species it is called as species relative abundance. If a sample is collected from a large area than the individuals of a species found in large number represents the abundance of species and its distribution within ecosystem is called as relative species abundances.

b. **Relative dominance:** Dominance among same sized species can be measured by occupying by a species to the entire area of community.
c. **Relative frequency:** Among different sized species, the dominance is measured by the relative frequency.

All these three measurements summed up to provide an important value to each species. These values of species ranked them in a list and index species are the species with high level of important value.

**Sporadically/Locally abundant**

The frequency of species occurrence in all samples is termed as incidence which relates to abundance. If the incidence or frequency is low but the abundance of species in sample is high it is called sporadically abundant. How to measure and calculate Relative species abundance? There are several kind of sampling methods such as Track count, Spotlight count, Monitoring point pressure, Roadkill counts and Plant cover for plant species etc. and the relative abundance of the community is calculated as:

**Relative abundance of species = No. of species from one sampling/ Total no. of species of all sampling**

***d. Ecotone***

The two integrating community meets at a transitional area called **Ecotone**. The transition area between ecosystems like grassland and forest forms regional ecotone and between forest and field forms a local ecotone which can be wide or narrow. This ecotone may appear as clear boundaries with homogenous surfaces or in gradual blending forms between two communities.

**Formation of ecotone**

When physical environment changes, example from forest to clean land, a clear and sharp interface is created between two communities. Moreover, gradual blended interface forms when unique local species and species common to both interacting community found together for example in Mountain ranges. Most Wetlands are ecotones (eg. woodlands of Western Europe).

**Type of ecotone**

a. Halocline (gradient salinity)
b. Thermocline (gradient in temperature)
c. Pycnocline (water density gradient)
d. Chemocline (chemical gradient)

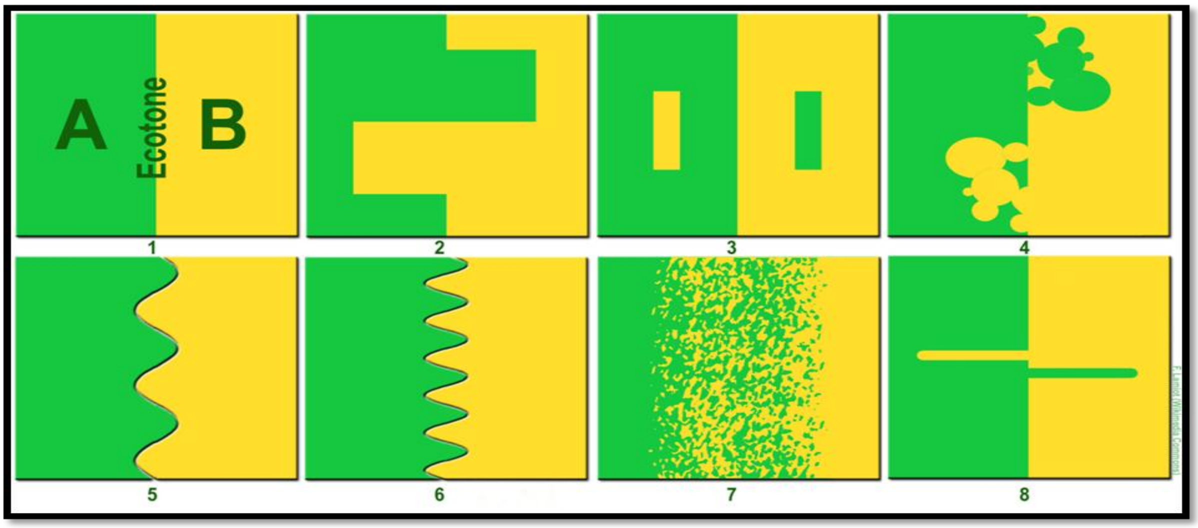



**Figure 4: Different forms of ecotones**

**Features**

1. A sharp vegetation transition for example change in grass colours indicates an ecotone.
2. Physiognomy: a key indicator of ecotone where the plant species differ in physical appearance.
3. Change in species is indicators of ecotone where we observe some specific organisms at one side of the ecotone boundary while some other specific organism on the other side.
4. **Spatial mass effect**: New plant establishment or migration obscures an ecotone as they cannot form self sustaining population in different ecotone. But if survives between two communities, then species richness is exhibited by the ecotone.
5. An ecotone can reveal the space sharing efficiency of two communities and the types of biomes by observing the exotic species abundance in ecotone.
6. Best model to study diverse ecosystem.
7. Shift in dominance represented by ecotone.
8. Ecotone act as an ecological niche for the species colonizing at the junction called **edge effect**.
9. **Ecoclines:** A physical transition zone between biological systems termed as ecoline relates to ecotone. It depicts the physiochemical environmental changes microclimatically or chemically signalling an ecotone *via* signals such as gradient of hydrothermal, salinity or pH respectively.

*e. Edge Effects*

In ecology, ecotone exhibit changes in population constituting community structure allowing for greater biodiversity at the boundaries of the merged habitats and this is called as **edge effects**. When two habitats are separated by wise edge effects called ecotone than they develop their own type of vegetation and environmental conditions.

**Types of Edge effects**

1. **Narrow Edge effect**: Abrupt ending of one habitat from where another habitat begins is a narrow edge effect.
2. **Wide Edge effect:** Significant distance between two habitats is exhibited as Wide edge effect or ecotone.
3. **Induced Edge effect:** The structural changes are induced over time either by the human interference or natural disturbances (eg. fire) and leads to induced edge effect.
4. **Inherent Edge effect:** The border between two habitats are separated and stabilized by natural features are called as Inherent edge effect.
5. **Perforated Edge effect:** The distance between two habitats has gaps in them which help in assisting other habitats.
6. **Convoluted Edge effect:** A nonlinear division of two habitats leads to convoluted edge effect.

**Edge effects on Succession**

When vegetation spreads the succession is affected by edge effects. Different species colonizes to central portions or to the edge leading to differential species distribution. With the change in orientation the edge also changes, thus, participating in different vegetation patterns.

Other structural factors may include **Seasonal and Diurnal Fluctuations:** With space and time the population fluctuates in the communities, **Pattern Diversity:** Community is organized on the basis of pattern diversity. The patterns can be horizontal segregation or vertical stratification etc.

## 5. Summary

The interactions, associations and adaptations by the organisms provide community its distinct structure and influence other characteristics such as growth and developments of the community, dominance and species diversity. The basic structure of the community is divided into physical and biological structure. The physical structure of community is defined by the growth forms and life forms. On the basis of the **growth forms** the vegetation of the community can be classified. Plant community may exhibit different growth forms such as short or tall plants, woody or herbaceous plants or deciduous or evergreen plants. The plants are also classified on the basis of **life forms**, classified on the basis of perennating tissue above ground or simply height of the plant. All the species are grouped into six principal classes of life forms, namely epiphytes, phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes. The ecological communities are arranged in different layer or strata forms, a phenomenon called **stratification**. This fractionation in the community is caused by the gradations in the external environmental factors like water levels, temperature and light. Different strata or layer of forest community receives different degree of light intensity providing vertical stratification to the community structure. The gradients in the physical environment of the community cause horizontal layering or patterns among species. Differences in the amount of factors such as nutrients and water can significantly alter the distribution of plant and animal species over a region. Various growth form have different mode of arrangement classifying community into (a) **Vertical stratification and (b) Horizontal Zonation,** i.e. Populations assembled to form communities and these populations are dispersed into definite vertical or horizontal strata. If the distribution pattern is horizontal it's called zonation layering in community. For example in lakes or deep ponds majorly three zones are recognised i.e. littoral, limnetic (Photic or open-water) and profondal zone (Aphotic or Deep-water). Vertical Stratification is as simple as horizontal zonation, where each zone has different vertical storey, or complex stratification. The forest community stratification is much more complex with five vertical layering including: The vertical stratification in the forest community mostly comprised of following strata's: Subterranean, **Forest floor**-with the upper parts of growth form along with the litters, fungi, bacteria etc., **Herbaceous vegetation, Shrubs and Forest Strata (canopy).** The biological structure of the community is characterised by the factors such as species richness, dominance, relative abundance, eco-tone and edge effects. Species Richness is given as number of species in a community. Sample heterogeneity and the number of species influence the species richness. Species diversity comprised of two factors species evenness and species richness (number of species). Species evenness indicates the relative abundance of each species. In a community different species interacts among themselves and in some communities the interaction results into dominance by one species or by a prominent species in group. The organisms dominating others are referred to as **dominants**. Dominant species (plants/animals) playing crucial and unique role and highly effect community structure and function in relative to its abundance are called Keystone species. If a sample is collected from a large area than the individuals of a species found in large number represents the abundance of species and its distribution within ecosystem is called as **relative species abundances**. The two integrating community meets at a transitional area called **Ecotone**. This ecotone may appear as clear boundaries with homogenous surfaces or in gradual blending forms between two communities. In ecology, ecotone exhibit changes in population constituting community structure allowing for greater biodiversity at the boundaries of the merged habitats and this is called as **edge effects**.

# F Y B Sc Zoology

## Paper II Sem I

# (4.1) Community

By
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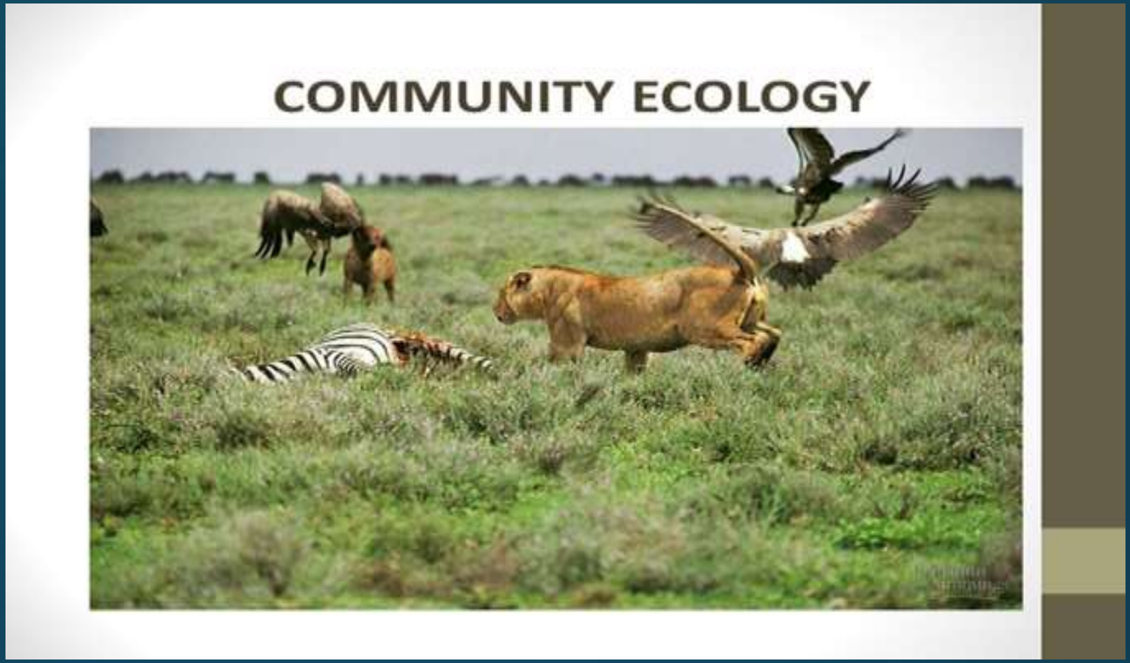
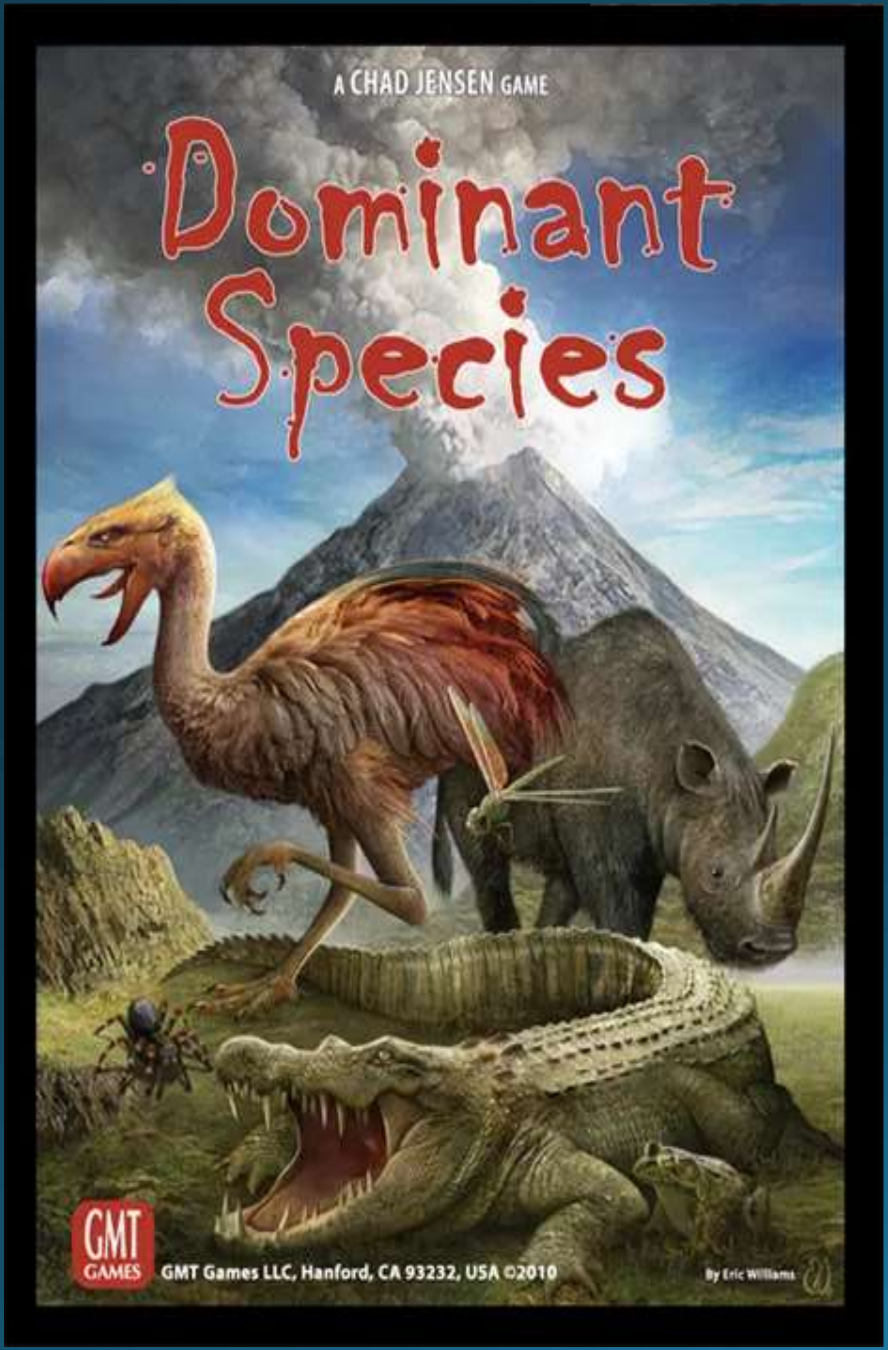
Chapter 4. Community (07 Lectures)

4.1Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Eco tone and edge effect; Ecological succession with one example.

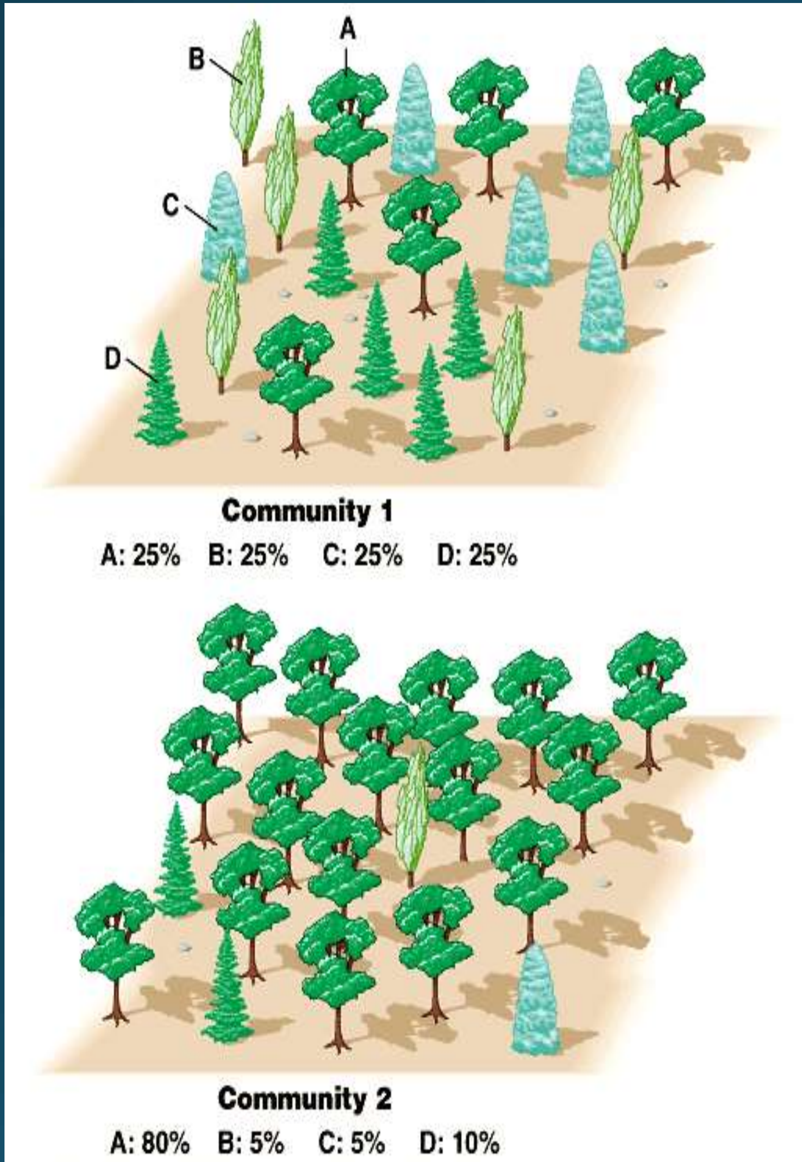



- **INTRODUCTION**
- **Community is a local association of several populations of different species. According to Krebs (1972) a community is an assemblage of the populations of living organisms in a prescribed are or habitat.**
- **According to Clarke (1954) a group of mutually adjusted plants and animals inhabiting a natural area is known as a community.**
- **Major or autotrophic communities which together with their habitats, form more or less complete and self-sustaining units for the indispensable input of solar energy.**
- **b) Minor or heterotrophic communities which are secondary aggregations within the major communities and are not, therefore completely independent units as far as circulation of energy is concerned i.e. they are depend on major communities for their energy source.**
- **COMMUNITY CHARACTERISTICS**
- **Communities do not have exact limits but tend to overlap each other.**
- **Animals frequently shift from one community to another because of seasonal or other variations.**
- **Some characteristics of the community are as follows:**

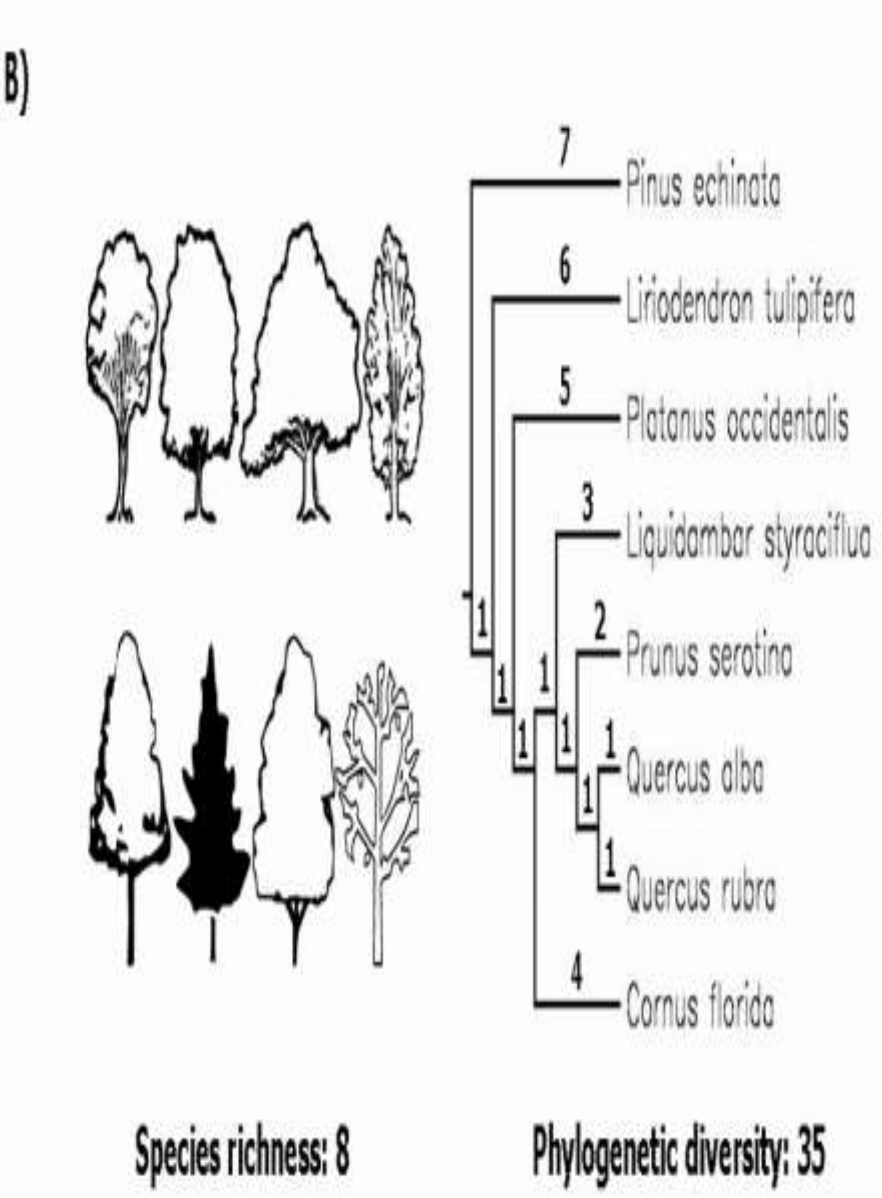

A CHAD JENSEN GAME
Dominant Species
GMT GAMES
GMT Games LLC, Hanford, CA 93232, USA ©2010
By Eric Williams

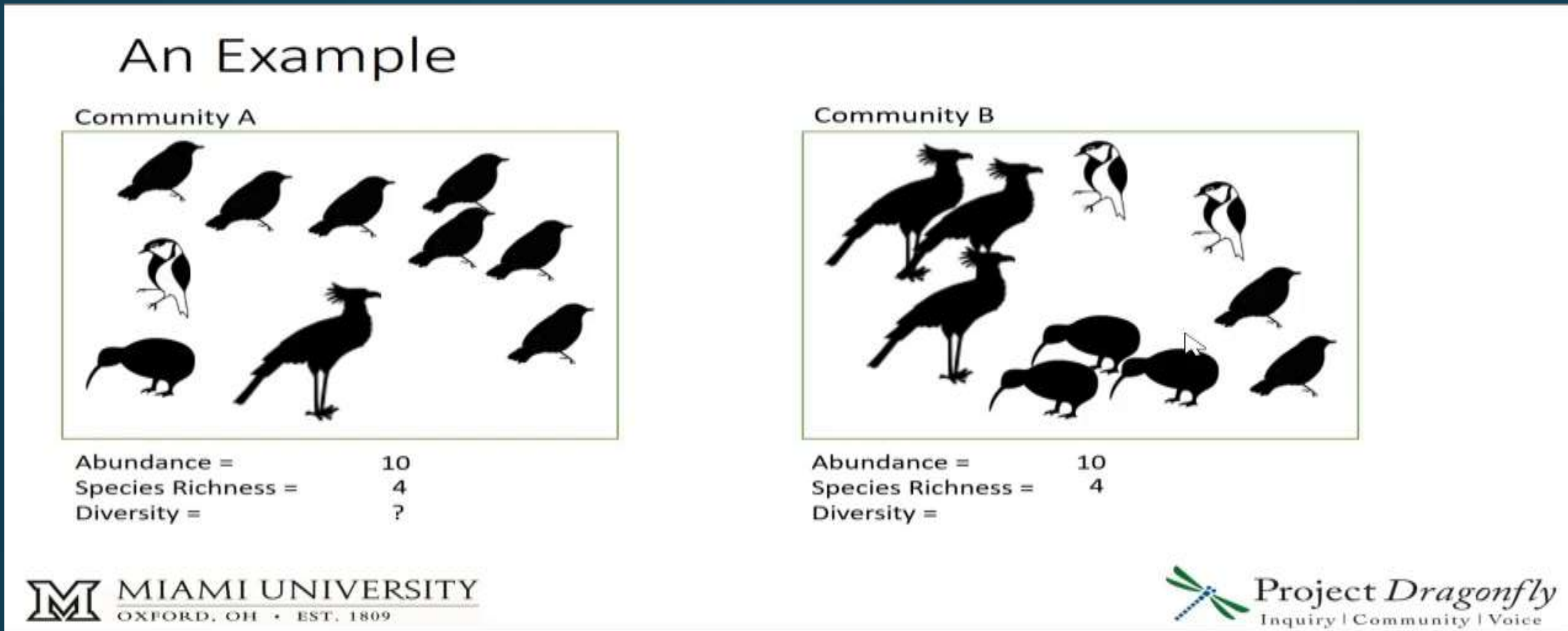
## SPECIES RICHNESS

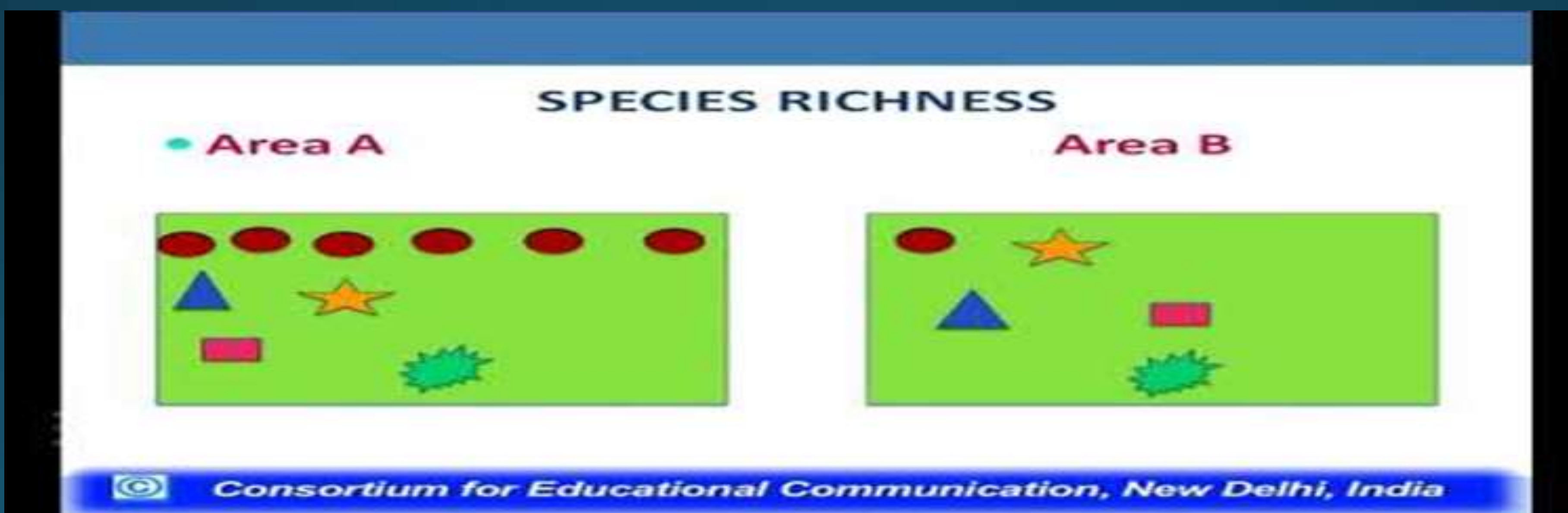
- Species richness is the number of different species represented in a ecological community, landscape or region.
- The species richness is affected not only by the number of individuals but also by the heterogeneity of the sample.
- Species richness is the number of species within a community or area.
- eg Plot A has 24 species of plants and plot B has 84 species of plants. Plot B has higher species richness amongst the two plots.
- DOMINANCE The phenomenon wherein various species within the community are dominated by one species or more than one species is termed as community dominance, and the dominating species are recognized as community dominants.
- According to Clements and Shelford (1939), dominance is most commonly expressed in the reactions of an organism on its habitat.
- In a forest community, trees are dominant.
- They decrease light intensity, increase the relative humanity, intercept precipitation, monopolize most of the moisture and nutrients in the soil, decrease wind velocity and furnish shelter and food for animals.


A
B
C
D
Community 1
A: 25% B: 25% C: 25% D: 25%
Community 2
A: 80% B: 5% C: 5% D: 10%




B)
7
Pinus echinata
6
Liriodendron tulipifera
5
Platanus occidentalis
3
Liquidambar styraciflua
2
Prunus serotina
Quercus alba
Quercus rubra
4
Cornus florida
Species richness: 8
Phylogenetic diversity: 35


An Example
Community A
Community B
Abundance = 10
Species Richness = 4
Diversity = ?
Abundance = 10
Species Richness = 4
Diversity =
MIAMI UNIVERSITY
OXFORD, OH • EST. 1809
Project Dragonfly
Inquiry | Community | Voice

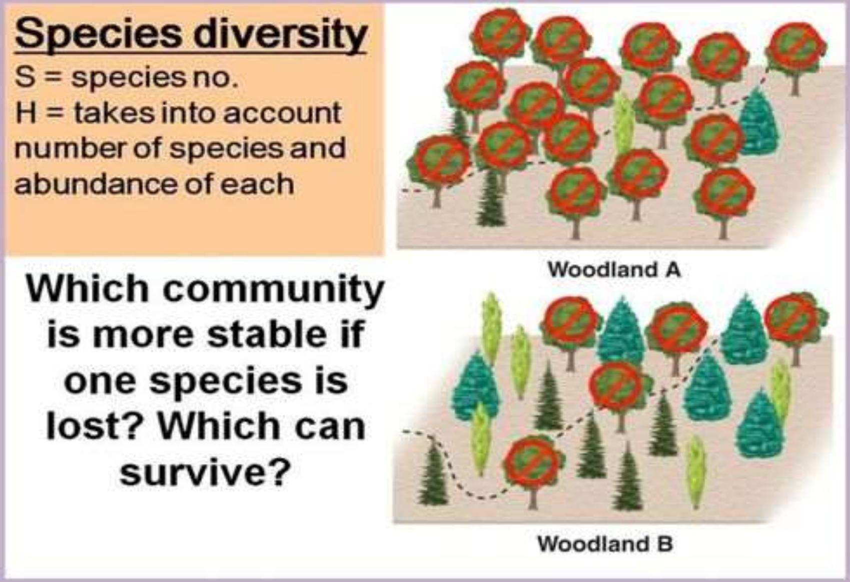

SPECIES RICHNESS
Area A
Area B
Consortium for Educational Communication, New Delhi, India

## SPECIES DIVERSITY

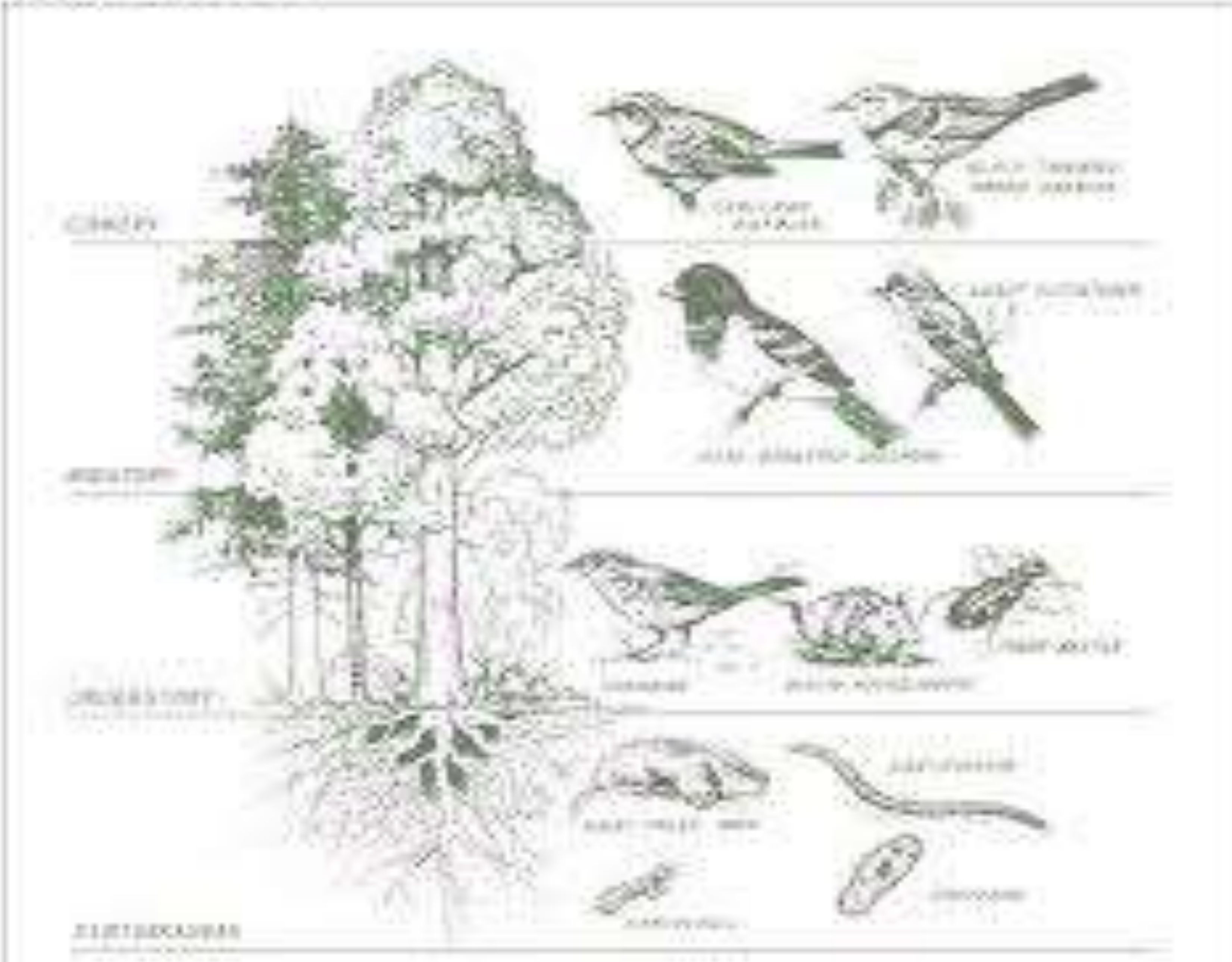
- Each community consists of very diverse organisms i.e. plants and animals.
- The older and more stable the community, is the more will be species diversity.
- Nature favours high species diversity while man prefers monoculture and brings about uniformity.
- Natural communities with high species diversity are less vulnerable than manmade communities;
- e.g, crop fields, orchards, nurseries etc. may be completely destroyed by env hazards or epidemics.
- Species diversity is very useful parameter for comparison of two communities especially to study the influence of biotic disturbance or to know the state of succession and stability in the community.

# Species Diversity

- Species Richness - # of total individuals present
- Species Evenness – number of different types of species
- Species Dominance – Most abundant species present

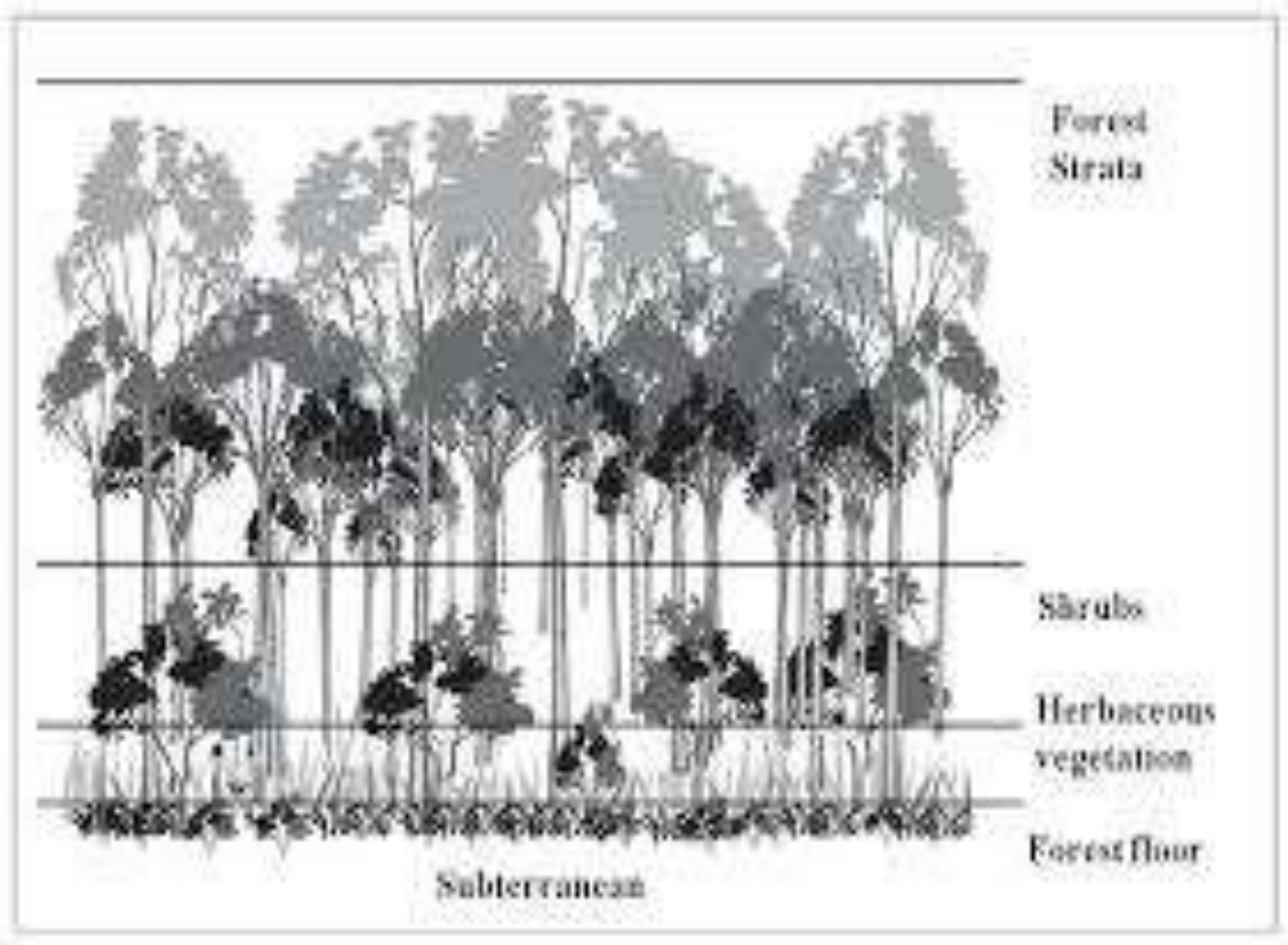


- **ABUNDANCE**
- **Abundance is the relative representation of a species in a particular ecosystem. measured as the number of individuals found per sample.**
- **Species abundance is the number of individuals per species and relative abundance refers to the evenness of distribution of individuals among species in a community.**
- **Two communities may be equally rich in species but differ in relative abundance.**
- **Abundance is in simplest terms usually measured by identifying and counting every individual of every species in a given sector.**
- **And relative species abundance is calculated by dividing the number of species from one group by the total number of species from all groups.**



## VERTICAL STRATIFICATION

- **Most communities show vertical differentiation or stratification; that is different species occur at different heights above the ground or depths below the water surface.**
- **Vertical Stratification in Plants:**
- **The forest trees with their upper foliage in full sunlight, forms the Canopy or uppermost level.**
- **The leaves and branch surfaces of the canopy trees may absorb more than half of the sunlight energy; but beneath the canopy there is a lower layer of smaller trees utilizing some of the remaining light.**
- **This lower trees stratum usually contains both younger individuals of the canopy tree species and mature trees.**
- **Less than 10% light reaching the upper canopy may penetrate through the tree foliage of both levels, species of a third level of vegetation, shrubs are adapted in utilizing this weaker light within the forest; further reducing light reaches herbs beneath the shrub layer.**
- **The remaining light (1-5%) supports the growth of the herb layer. Below the herbs, mosses on the ground may form still another vegetation layer.**


Forest
Strata
Shrubs
Herbaceous
vegetation
Forest floor
Subterranean

# Rain Forest

- Recall Stratification

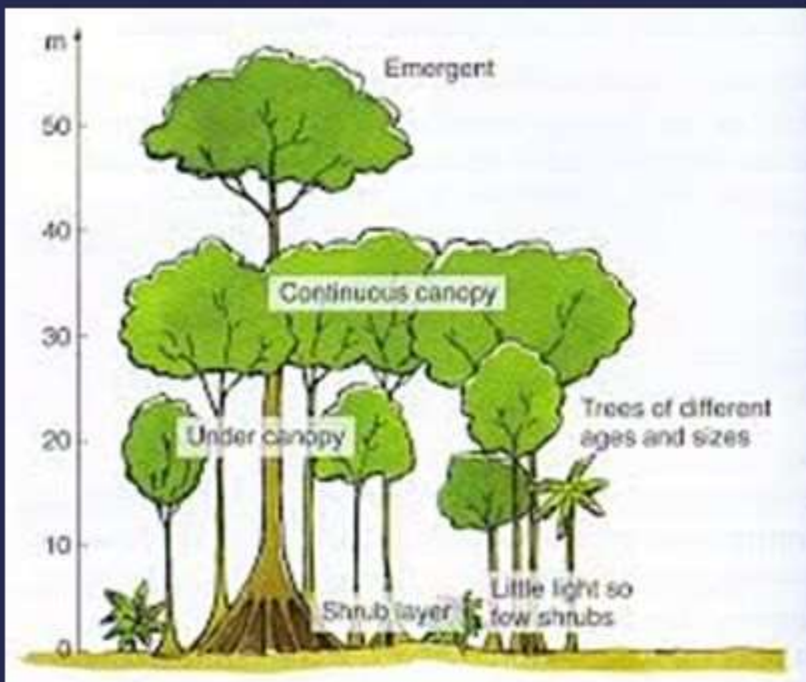
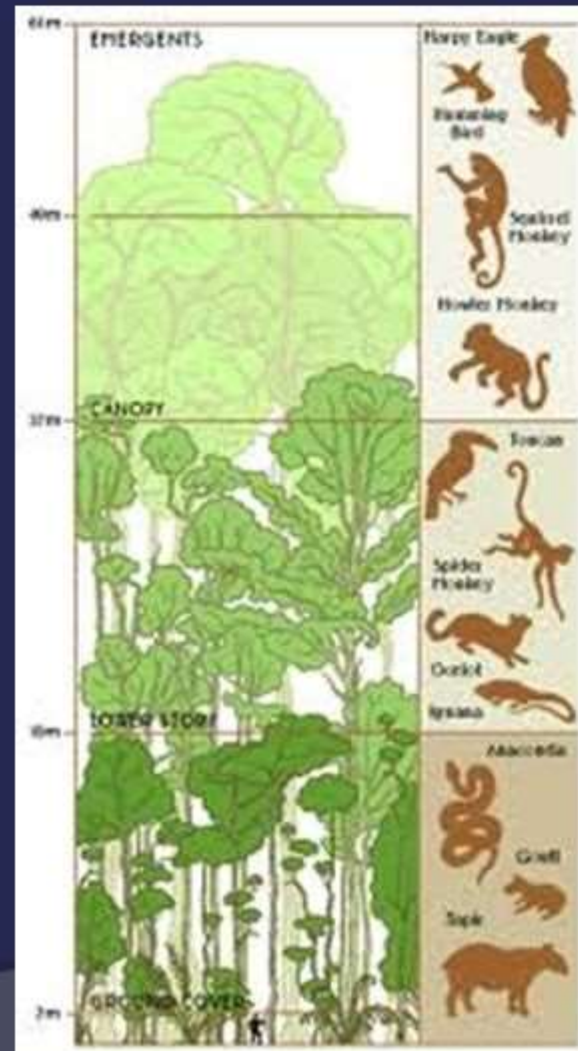


Figure 18 Typical structure of the tropical rainforest

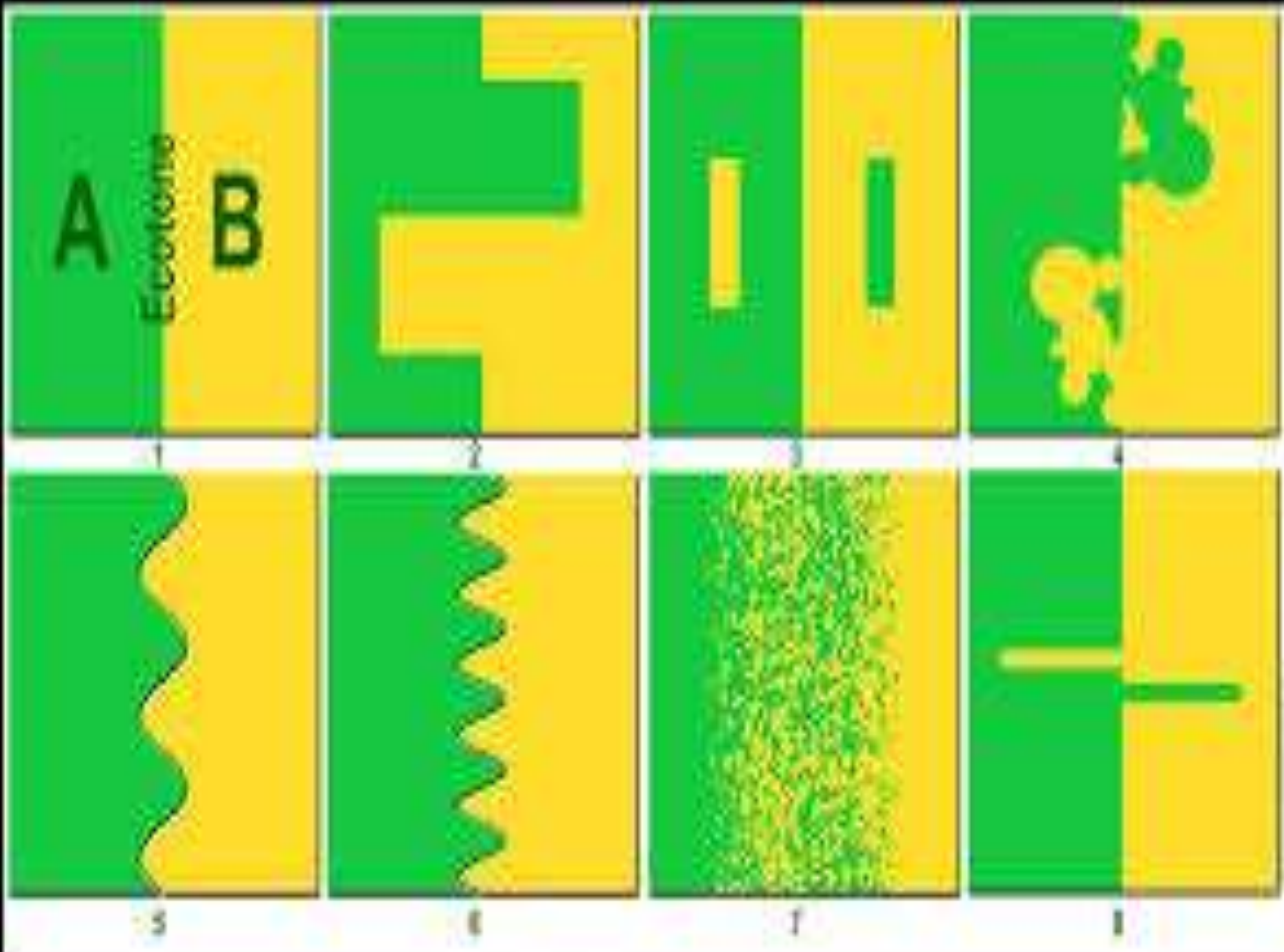


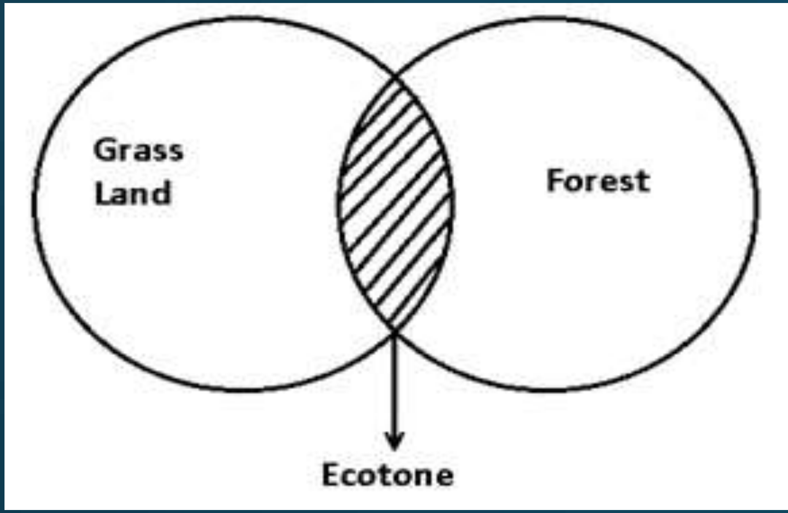
## Vertical Stratification in Animals:

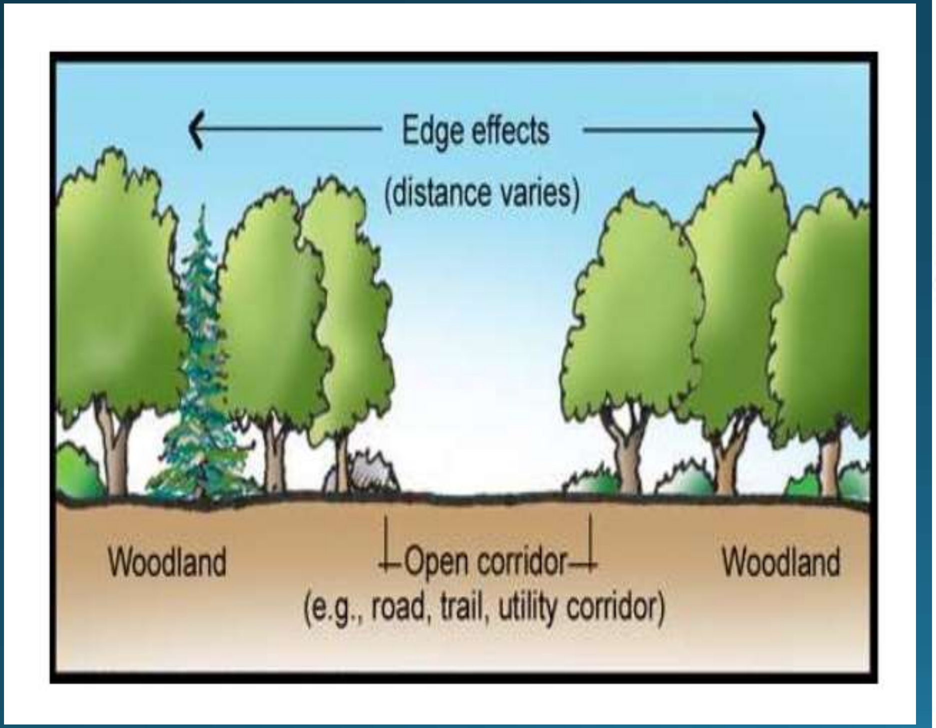
- As different plant species are adapted to different positions in vertical gradient, the different animal species also occupy different level in the forest.
- For example, different group of bird species found feeding and nesting near the ground, in the shrub and small tree foliage beneath the canopy and in the canopy itself.
- Different arthropod species occur at different levels from the canopy downward to the herb stratum and below the ground surface.
- A group of animals – mites, spring tails, centipedes, ground beetles etc. occur in the leaf litter on the soil surface.

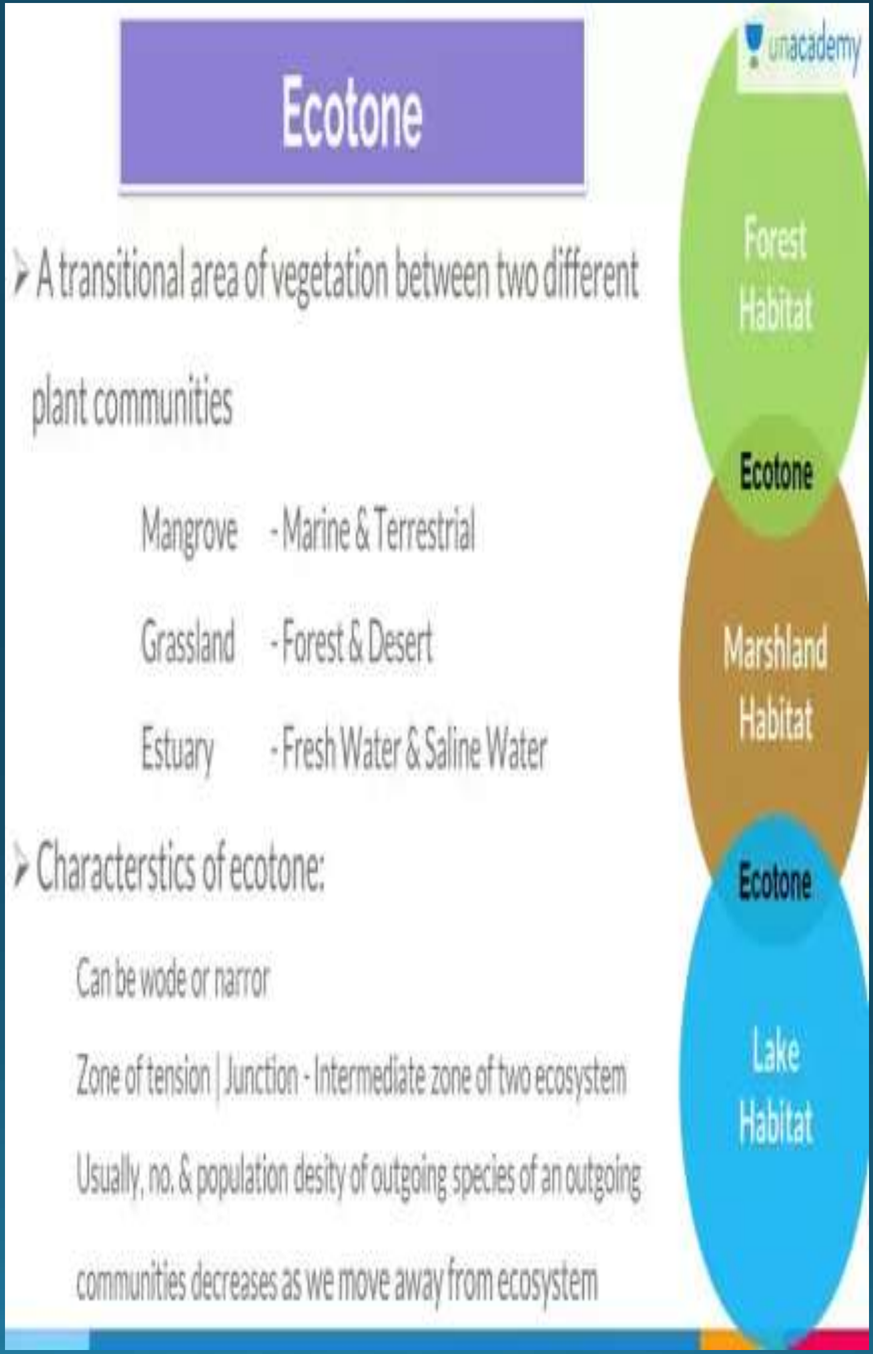
## ➢ECO TONE AND EDGE EFFECT

- **An ecotone can be defined as a zone of transition between adjacent ecological systems(communities).**
- **For example: the boundary between a forest community and a grassland community where the two meet and compete.**
- **An estuary is another example, where the river water and the sea water meet.**
- **The environment conditions of the boundary community are more or less intermediate between the two main communities; in this ecotone contains species of both the communities and also its own endemic (native) species.**
- **Therefore the ecotone is richer in life than either of the two communities.**
- **This phenomenon in which the ecotone has greater number of species and population density than in either of the two main communities is called as edge effect.**
- **The endemic species present ecotones are called edge species.**


A
Ecotone
B
1
2
3
4
5
6
7
8



# Ecotone

- A transitional area of vegetation between two different plant communities

  Mangrove - Marine & Terrestrial

  Grassland - Forest & Desert

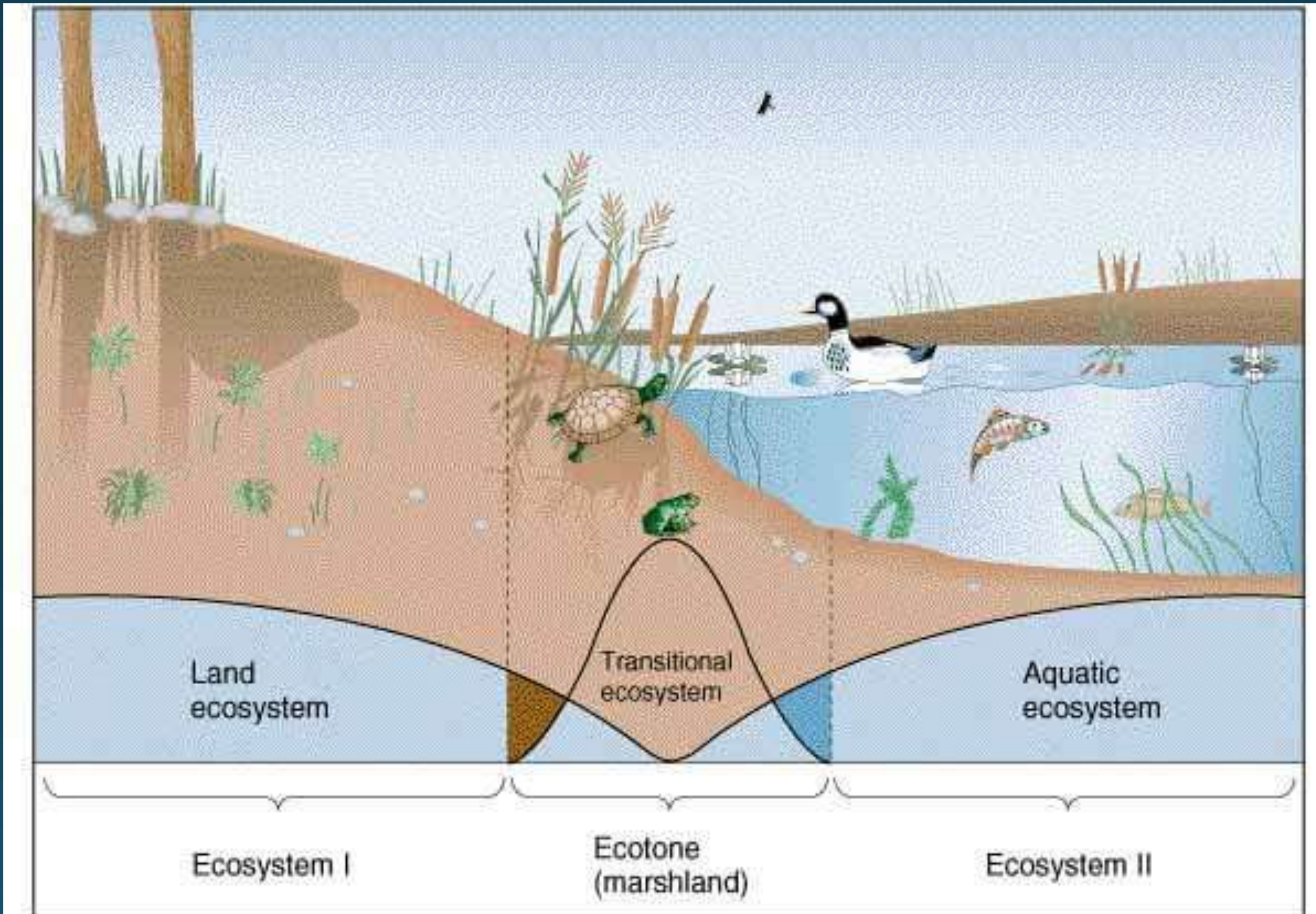
  Estuary - Fresh Water & Saline Water

- Characterstics of ecotone:

  Can be wode or narror

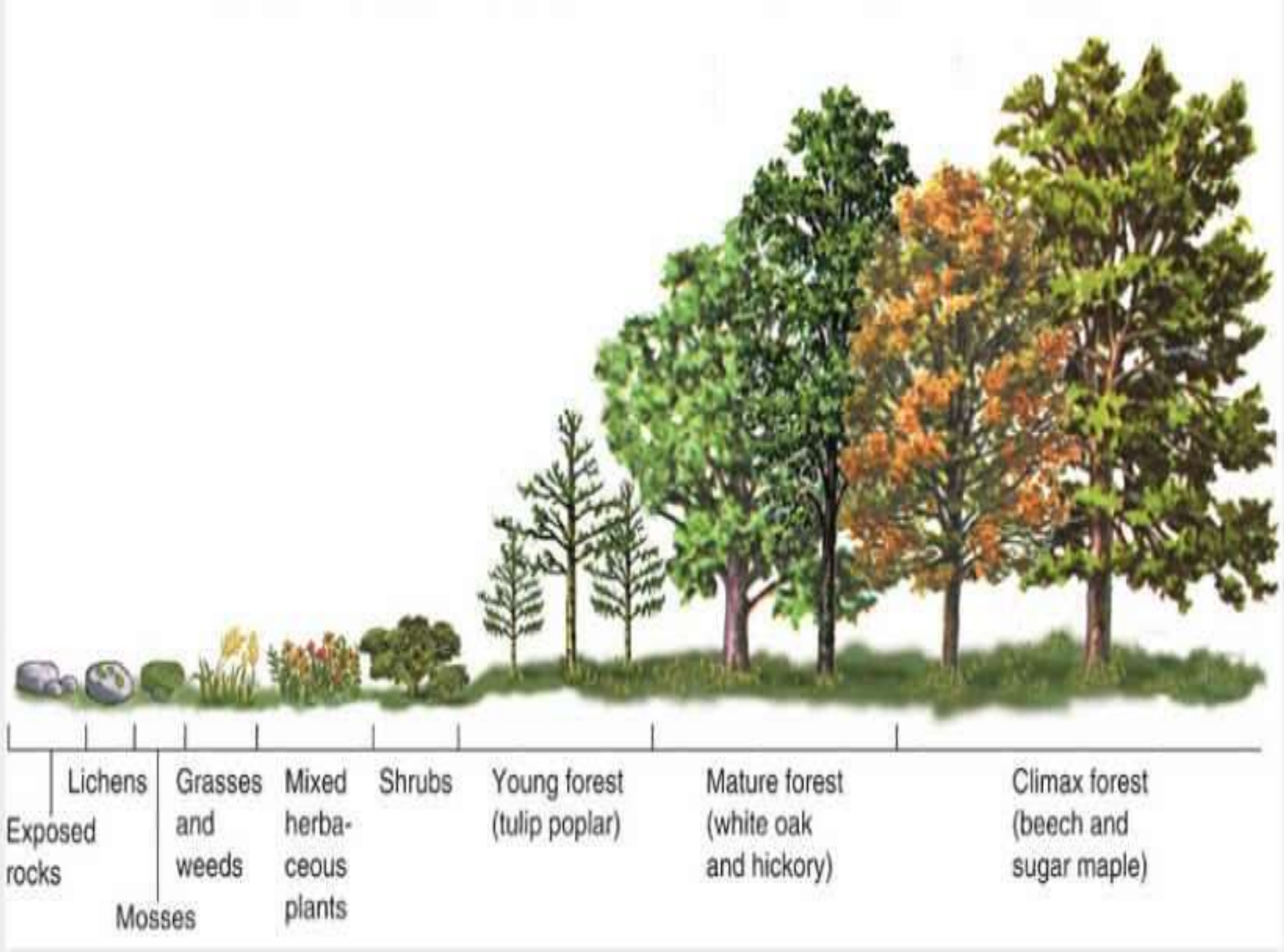
  Zone of tension | Junction - Intermediate zone of two ecosystem

  Usually, no. & population desity of outgoing species of an outgoing communities decreases as we move away from ecosystem


Land
ecosystem
Transitional
ecosystem
Aquatic
ecosystem
Ecosystem I
Ecotone
(marshland)
Ecosystem II

## ECOLOGICAL SUCCESSION

- The process of formn of new communities is called ecological succession.
- It is defined as an orderly and progressive replacement of one community by another till the development of a stable community in that area.
- The stable community is called climax community.
- Thus, succession is the birth of ecosystem and subsequent aging process of its biotic and abiotic factors.
- The biotic communities are not stable.
- They are changing into diff communities or forms in a longer time span. Thus, in a particular geographical area, one community may be replaced by another community or by a series of communities.
- Ex: A pond or lake community which fills with silt and changes gradually from deep to a shallow pond or lake, then transformed into a marshy land community if it is filled with sand and mud.
- In the course of time, the marshy land may be converted into grassland or a dry land forest community. If forest is completely burned over, it remains as a plot of bare ground, on which after some period series of plant communities grow up



Exposed rocks
Lichens
Mosses
Grasses and weeds
Mixed herba-ceous plants
Shrubs
Young forest (tulip poplar)
Mature forest (white oak and hickory)
Climax forest (beech and sugar maple)

# Primary Succession

Unstable PIONEER Community [lichens, mosses]

Time

Stable CLIMAX Community [Trees]

**Primary Succession:**

- Occurs on barren habitats *e.g. rock, sand, clay, ice* this means that there is **NO SOIL** present
- Pioneering organisms colonise and modify the environment until new niches occur
- Slow process - may take thousands of years


Oak
Larger trees (birch, ash, pine)
Large shrubs, small trees (rowen, alder)
ferns, bracken, shrubs, brambles
Herbs, grasses, small plants
Mosses
Blue- green bacteria
High- water

Animal Ecology

# Chapter 5 Animal Interactions

**By**

**Dr Bhausaheb R Ghorpade**

**Dept Of Zoology**

**Shri Anand College Pathardi**

**Dist Ahmednagar (MS)**

## TYPES OF ANIMAL INTERACTIONS

Animal interactions can be classified into four basic types based on how the participating species are affected by the interaction. They are:

1) Competitive Interactions:

For example: Interaction between lions and hyenas.

2) Consumer-Resource Interactions:

examples of this type of interaction include predator-prey interactions and herbivore-plant interactions.

These consumer-resource interactions affect the species involved in different ways.

### 3) Detritivore-Detritus Interactions:

Detritivore-detritus interactions involve a species that consumes the detritus (dead or decomposing organic matter) of another species. This interaction is a positive interaction for the consumer species. By cleaning up decomposing plant and animal matter, they play an important role in maintaining the health of ecosystems.

For example: Detritivores include small creatures such as millipede, slugs, wood lice and sea cucumbers.

### 4) Mutualistic Interactions:

Mutualistic interactions are interactions in which both species-resource and consumer are benefitted from the interactions. The interaction is beneficial to the species, plants and animals.

For example: Interaction between plants and pollinators. Large number of flowering plants depends on animals to help them to pollinate. In exchange for this service, animals such as bees and butterflies are rewarded with food in the form of pollen or nectar.

INTERSPECIFIC COMPETITION Members belonging to different species or population compete for many factors in the environment. space, better feeding grounds, and better breeding place and so on is called as interspecific competition.

INTRASPECIFIC COMPETITION

Intraspecific interaction is simply the mass assemblage of the individuals of the same species. In this most associations are beneficial to the species and to the individuals, but under extreme conditions may prove to be harmful. This type of association may be either temporarily or permanently affecting the biological environmental factors due to competition for food, competition for space, moisture, light, protection or competition between sexes.

# Ecological Interactions between organisms

**A.) Competition—**

**when two organisms of the same or different species attempt to use an ecological resource in the same place at the same time. Ex: food, water, shelter**

Monkeys compete with each other and other animals for food.


Rams compete with each other for mates.

**Until Americans introduced gray squirrels into parts of England in the early 20th century, red squirrels had been the only species of squirrel in the country. The gray squirrels were larger and bred faster and successfully competed for resources. Within a couple years of overlap in an area, the red squirrels disappeared.**

COMMENSALISM

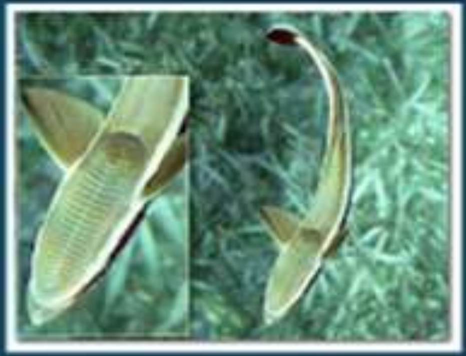
It is a latin term which means eating on the same table..

The basis for a commensalism relationship between two organisms may be space, substrate, defense, shelter, transportation or food.

Example: An association between sucker fish Remora and large, powerful hostShark. Remora is a carnivorous fish growing to about 50 cm in length. It canswim independently but is more often carried about by the large host Shark.

Example: Another popular example of commensalism is the relationship between cattle Egrets and livestock like Cow, Buffalo, and Horse. The cattle Egret is a common species of Heron that is mostly seen moving along with herds of cattle. The movement of foraging livestock also dislodges various insects like flies, mites and bugs from the field, which cattle Egrets feed on.

**The Remora fish attaches to the shark and gets a free ride.**



**Birds build nests in trees.**

**Commensalism**—one member of the association benefits and the other is neither helped nor harmed. (WIN-0) Example: barnacles on a whale

## MUTUALISM

It is a latin term which means exchange. In this association, both the partners are beneficial to each other by exchanging the metabolites. Example: Association between Termite and protozoan flagellate Trichonympha Trichonympha gets shelter and it hydrolyses cellulose into glucose, If the Trichonympha is removed from the intestine of the host termite, it suffers from starvation or even death occurs.

Example: bees and the flowers. The bees fly from flower to flower in search of nectar, which they can transform into food. On the other hand, whenever the bees are placed on a flower, particles of pollen adhere to their body. pollination. This is the relationship of mutualism in which the bees obtains food and the plant reproduces itself.

Example: Mutualism is also found by the cleaning symbiosis in fish by prawns.

Animal Ecology

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Symbiosis—any relationship in which two species live closely together

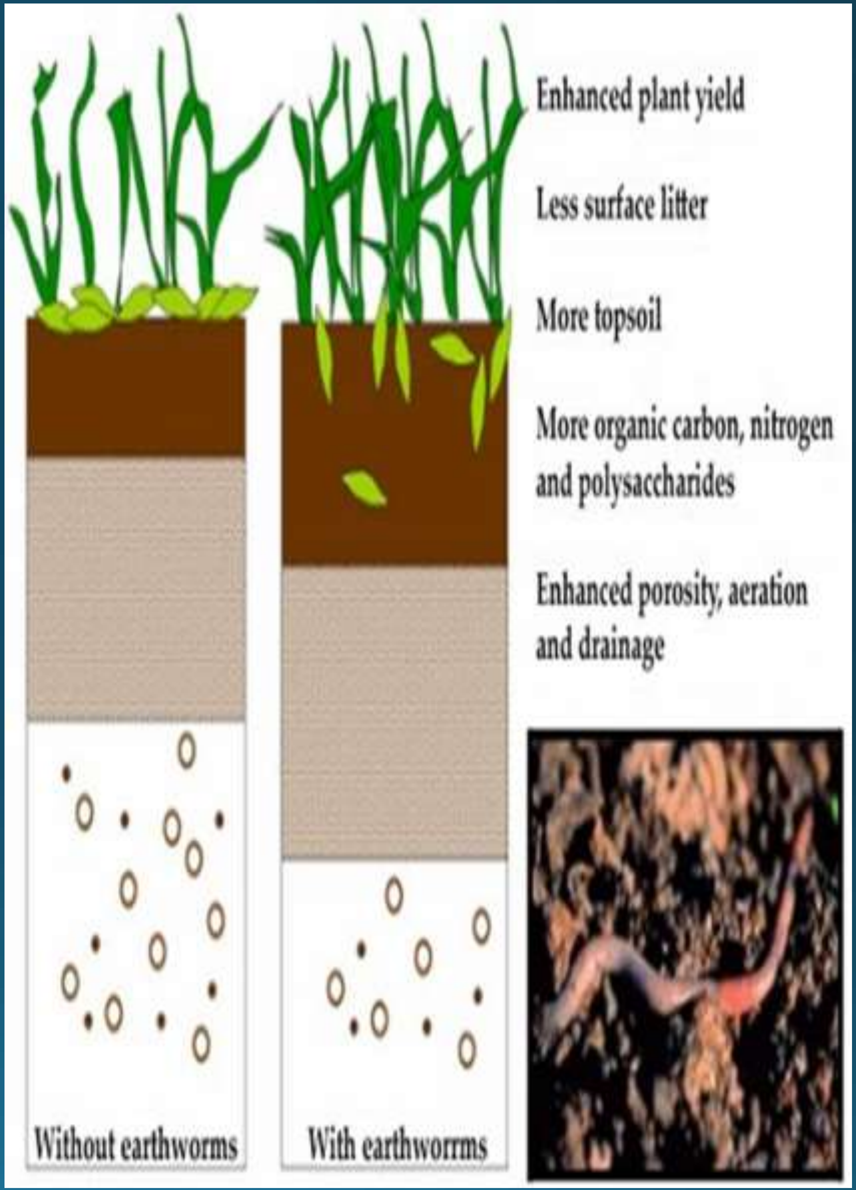
Mutualism—both species benefit (WIN-WIN) a.

Ex: insects and flowers

Niche—the ecological niche involves both the place where an organism lives and the roles that an organism has in its habitat. Example: The ecological niche of a sunflower growing in the backyard includes absorbing light, water and nutrients (for photosynthesis), providing shelter and food for other organisms (e.g. bees, ants, etc.), and giving off oxygen into the atmosphere.

**The ecological niche of an organism depends not only on where it lives but also on what it does.** By analogy, it may be said that the habitat is the organism's"address", and the niche is its "profession", biologically speaking.

**"Address"—Soil, Ground, etc.**
**Worm's Niche**
**"Profession"– Mix-up soil**



**Predation**—one organism captures and feeds on another organism
**Predator**—one that does the killing
**Prey**—one that is the food



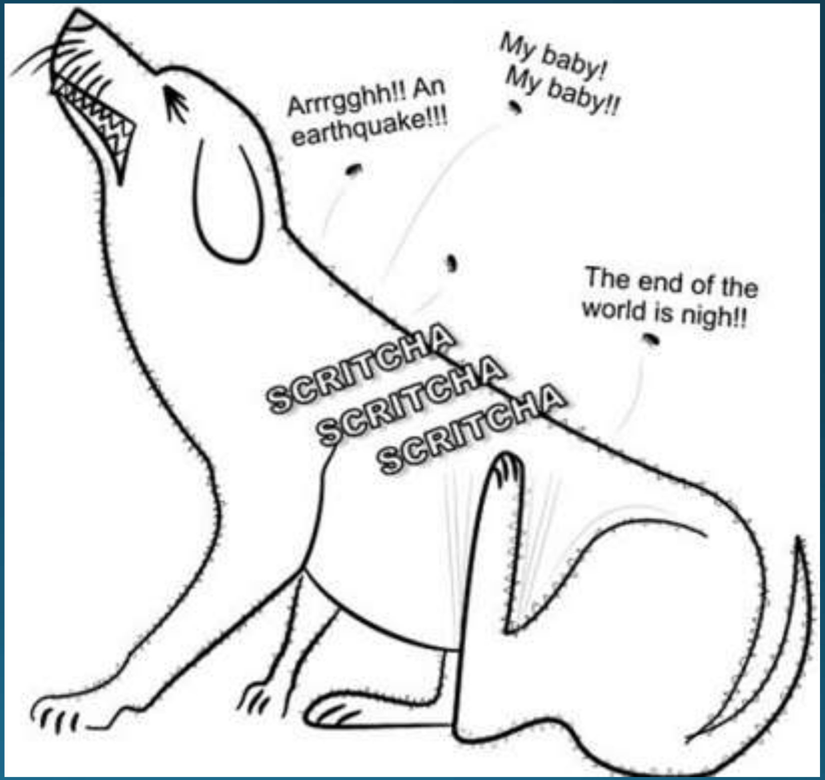
## PARASITISM

Parasitism is a unique kind of symbiotic association in which the parasite remains very close to its food or host. Parasite is defined as an animal or plant which lives partially or wholly at the cost of another living organism called as host. The parasite is always benefitted in this association and the host is injured or harmed. This relationship between parasite and host is called as parasitism.

When the parasite lives on the surface of the body of the host, it is called as ectoparasite. Examples of ectoparasites are head louse, tick, mite, bedbug, leech etc. When the parasite lives inside the body of the host, it is called as endoparasite. Examples of endoparasites are Plasmodium, Entamoeba and Ascaris.

Parasitism—one organisms lives on or inside another organism (host) and harms it. The parasite obtains all or part of its nutritional needs from the host. (WIN-LOSE)

**Example: fleas on a dog**



Wasp eggs on back of caterpillar.

Parasitism

Sea lampreys feed on fluids of other fish.

Mosquito biting a human.

## PREY PREDATION

- Predation is a biological interaction where one organism (predator) kills and eats another organism (prey).
- Predators choose prey selectively based on age or condition.
- The predator typically hunts live prey, which it kills and feed on its flesh or drinks the blood.
- The predation is commonly associated with the idea of strong attacking the weak.
- Predation is helpful in the regulation of population size.
- Example: The mountain Lions selectively prey upon mule Deer. Young deer are most vulnerable to mountain lion predation. A lion (predator) is an animal that attacks, kills and feed on another organism deer (prey).
- Similar examples are found as the hawk eats the sparrow, the frog eats insects etc.

Thanks…

**1) The following is an example of lentic biome**

a) Rivers

b) <u>Lakes</u>

c) Oceans

d) Sea

---

**2) The following is an example of lotic biome**

---

a) <u>Rivers</u>

b) Lakes

c) Oceans

d) Pond

---

**3) Ecosystem is smallest unit of**

---

a) Ionosphere

b) Lithosphere

c) <u>Biosphere</u>

d) Mesosphere

---

**4) The region of earth, where life exists is known as**

---

a) Hydrosphere

b) Lithosphere

c) Atmosphere

d) <u>Biosphere</u>

---

**5) Deciduous plants are those in which leaves fall**

---

a) <u>Once in a year</u>

b) Twice in a year

c) Many times a year

---

d) None of the above

---

**6) Which forests have maximum diversity?**

---

a) Sub-tropical rainforests

b) Coniferous forest

c) <u>Tropical forests</u>

d) Deciduous forest

---

**7) Which one is not a factor of the abiotic environment?**

---

a) Sunlight

b) <u>Decomposers</u>

c) Water

d) Temperature

---

**8) Maximum productivity is found in which one of the following**

---

a) <u>Oceans</u>

b) Forests

c) grassland

d) agro ecosystem

---

**9) Pond is which one of the following**

---

a) biome

b) <u>natural</u> ecosystem

c) artificial ecosystem

d) community of plants and animals only

---

**10) Which one is main source of energy in ecosystem?**

---

a) fermentation of sugar

b) photosynthesis by plants

c) decomposition of plants and animal by bacteria

d) <u>sunlight</u>

---

**11) The term Ecosystem was coined by…………**

a) Odum
b) E. Munch
c) Tansley
d) E. Haeckel

**12) Converters or transducers organisms in the food chain are called**

a) Herbivorous
b) Carnivorous
c) Decomposers
d) Producers

**13) Biological equilibrium is an equilibrium among the**

a) Producers
b) Producers and consumers
c) Decomposers
d) Producers consumers and decomposers

**14) The flow of energy in an ecosystem is which one of following**

a) Unidirectional
b) Bidirectional
c) multidirectional
d) no direction

**15) The term ecology is coined by which one of the following**

a) Odum
b) E. Munch
c) Tansley
d) E. Haeckel

**16) Geometric representation of age structure is characteristics of which one following**

a) Population
b) _landscape
c) ecosystem
d) biotic community

---

**17) The sum total of the population of same kinds of organism constituted which one of following**

---

a) Community
b) genus
c) Colony
d) species

---

**18) Producers in any grazing food chain**

---

a) Feed the herbivorous
b) Feed the carnivorous
c) Clean the atmosphere
d) Capture solar energy

---

**19) Trophic level in a food chain which cycles the various materials between environment and living organisms is constituted by**

---

a) Producers
b) Consumers
c) Decomposers
d) All the above

---

**20) Food web is constituted by**

---

a) Various interlinked food chains in a community
b) Relationship between animals and plants
c) Relationship between organisms and their environment
d) Relationship between animals, plants and microbes

---

**21) Vegetation of a Geographic region with low rainfall, high temperature, loose and sandy soil is of the type called**

---

a) Grassland

b) Scrub forest

c) Xerophytic

d) Evergreen tropical forest

**22) In pond ecosystem the shape of pyramid of number is**

a) Linear

b) Irregular

c) Upright

d) Inverted

**23) In parasitic food chain, the pyramid of number is**

a) Linear

b) Upright

c) Inverted

d) Inverted upright

**24) In grassland ecosystem, the pyramid of biomass is**

a) Linear

b) Upright

c) Inverted

d) Inverted upright

**25) Energy _____ in an Ecosystem.**

a) is absorbed

b) is released

c) flows

d) None of the above

**26) Ecosystems rely on the following major sources of energy**

a) Sun

b) Chemical or Nuclear fuels

c) Both (A) and (B)

d) None of the above

---

**27) The following is a Secondary consumer**

---

a) Goat

b) Lizard

c) Wolf

d) Lion

---

28) **The simple inorganic substances released into environment by the decomposers and then reused by the ______**

---

a) Producers

b) Consumers

c) Both (a) and (b)

d) None of the above

---

29) **In a pond, insects and small fishes are**

---

a) Primary Micro-consumers

b) Secondary consumers

c) Tertiary consumers

d) None of the above

---

**30) In the process of Photosynthesis, plants use chlorophyll to transform sunlight into _____ energy.**

---

a) Heat

b) Chemical

c) Light

d) None of the above

---

**31) Of the solar radiation that does reach the earth's surface (incident energy), about ____ % is ultraviolet.**

---

a) 10

---

b) 20

c) 30

d) 40

32) **The following is the correct grazing food chain**

a) <u>Grass – Grasshopper – Frog – Snake – Hawk</u>

b) Grass – Frog – Grasshopper– Snake – Hawk

c) Grass – Grasshopper – Frog – Hawk – Snake

d) Grass – Grasshopper – Snake – Frog – Hawk

**33) The Pyramid of Biomass is based on**

a) The total dry weight

b) Calorific value

c) Total amount of living material

d) <u>All of the above</u>

34) **The following is (are) the cause(s) for Ecological succession.**

a) Biotic causes

b) Climatic causes

c) Continuing causes

d) <u>All of the above</u>

35) **The following succession are visible on sea-coasts**

a) <u>Sand dune succession</u>

b) Bog succession

c) Succession in Oceans

d) All of the above

36) **In Desert Ecosystem, Shrubs or Bushes are**

a) <u>Producer organisms</u>

b) Consumers

c) Decomposers

d) None of the above

37) **An estuary….**

a) is rich in nutrients
b) usually support an abundance of fish
c) is area where river join the sea/ocean
d) <u>all of the above</u>

38) **The following is not a type of Ecosystem.**

a) Grassland Ecosystem
b) Aquatic Ecosystem
c) Desert Ecosystem
d) <u>Mountain Ecosystem</u>

**39) Which one is best example of Symbiosis?**

a) Lichen
b) Anabaena and azolla
c) mycorrhiza
d) <u>all of these</u>

**40) The population of all species that occupy Habitat constitute which one of the following**

a) population
b) <u>community</u>
c) biosphere
d) ecosystem

**41) About 70% of total Global carbon is found from**

a) <u>Oceans</u>
b) forests
c) grassland
d) agro ecosystem

**42) The following type of ecosystems have high energy input**

a) Unsubsidized Natural Solar powered ecosystems
b) Naturally Subsidized Solar powered ecosystems
c) Man Subsidized Solar powered ecosystems
d) Fuel powered ecosystems

43) **Industrial parks are examples of**

a) Unsubsidized Natural Solar powered ecosystems
b) Naturally Subsidized Solar powered ecosystems
c) Man Subsidized Solar powered ecosystems
d) Fuel powered ecosystems

**44) A coastal estuary is an example of**

a) Unsubsidized Natural Solar powered ecosystems
b) Naturally Subsidized Solar powered ecosystems
c) Man Subsidized Solar powered ecosystems
d) Fuel powered ecosystems

45) **Agriculture and Aquaculture are examples of**

a) Unsubsidized Natural Solar powered ecosystems
b) Naturally Subsidized Solar powered ecosystems
c) Man Subsidized Solar powered ecosystems
d) Fuel powered ecosystems

**46) The following type of ecosystem is of utmost importance from human point of view**

a) Unsubsidized Natural Solar powered ecosystems
b) Naturally Subsidized Solar powered ecosystems
c) Man Subsidized Solar powered ecosystems
d) Fuel powered ecosystems

**47) In which of the following ecosystems large volumes of air are purified?**

a) Unsubsidized Natural Solar powered ecosystems
b) Naturally Subsidized Solar powered ecosystems
c) Man Subsidized Solar powered ecosystems
d) Fuel powered ecosystems

**48) Grassland biome for its maintenance requires**

a) Periodic fire
b) Intensive grazing
c) Mowing
d) All the above

**49) Primary consumers in the detritus food chain are**

a) Herbivorous
b) Bacteria and fungi
c) Insect Larva, nematodes
d) All the above

**50) Total organic matter present in an ecosystem is called**

a) Biomass
b) Biome
c) Litter
d) Food

**51) Primary consumers are**

a) Green plants
b) Herbivorous
c) Carnivorous
d) All the above

**52) Secondary consumers are**

a) Green plants
b) Herbivorous
c) <u>Carnivorous</u>
d) All the above

**53) Which of the food chain directly depends on solar radiations?**

a) Predator
b) <u>Grazing</u>
c) Detritus
d) None of these

**54) In pyramid of food, the producers occupy**

a) <u>The base</u>
b) Position near the base
c) Apex
d) Position near Apex

**55) Energy flow in an ecosystem is**

a) <u>Uni directional</u>
b) Bidirectional
c) Multidirectional
d) All the above

**56) Ascending trophic level in grazing food chain pyramid represents**

a) Gradual decrease in biomass from Apex to base
b) <u>Gradual decrease in biomass from producers to the tertiary consumers</u>
c) Gradual increase of the biomass from producers to the tertiary consumers
d) No change in Biomass

57) **Carnivores are at**

a) First trophic level
b) Second trophic level

c) Third trophic level

d) Fourth trophic level

---

**58) Which of the following is not a type of Ecological pyramid?**

a) The Pyramid of Numbers

b) The Pyramid of Biomass

c) The Pyramid of Energy

d) The Pyramid of Food

---

**59) Plankton, nekton and benthos are not the components of one of the ecosystems which is**

a) Oceans

b) Fresh water rivers

c) Grassland

d) Pond or lake

---

**60) The food chain in which microorganisms break down the energy rich compounds synthesized by producers**

a) Predator food chain

b) Parasitic food chain

c) Detritus food chain

d) None of these

---

**61) Ecosystem may be defined as**

a) A species along with environment

b) Plants found in water

c) Plants found on land

d) Call plants and animals species along with environment

---

**62) A pond / lake is**

a) A biome

b) Unnatural ecosystem

---

c) An artificial ecosystem
d) Community of plants and animals only

**63) Biome is……**

a) The fauna of an ocean
b) The Flora of land
c) Communities of organisms interacting with one another
d) The part of the earth and its atmosphere which is inhabited by living organisms

**64) When a big fish eats a small fish which eats water fleas supported by phytoplankton water fleas are**

a) Producers
b) Primary consumers
c) Secondary consumers
d) Top consumers

**65) Detritus food chain in comparison to grazing food chain is**

a) Generally longer
b) Generally equal
c) Generally shorter
d) None of these

**66) Putrefying organisms are**

a) Producer organisms
b) Reducer organisms
c) Consumer organisms
d) Parasitic organisms

**67) The most important organisms for an ecosystem are**

a) Herbivorous
b) Carnivorous
c) Green plants

d) Protozoa

---

**68) A peacock eats snakes which eat frog these eat hoppers which in turn thrive on leaves of the plants, the peacock is**

---

a) Primary consumer
b) Secondary consumer
c) Decomposer
d) <u>Apex of the food pyramid</u>

---

**69) A food chain is**

---

a) Group of organisms which eat the same type of food
b) Animals eating animals eating
c) <u>Series of plants / animals which are interrelated in the form of organisms being eaten as food by the other</u>
d) None of these

---

**70) A food chain consists of**

---

a) Producers
b) Consumers
c) Decomposers
d) <u>Producers and Consumers</u>

---

**71) Trophic leaves in a food chain are formed by**

---

a) Producers
b) Consumers
c) Decomposers
d) <u>All the above</u>

---

**72) Food chain always starts with**

---

a) <u>Photosynthesis</u>
b) Respiration
c) Nitrogen fixation

---

d) Decay

---

**73) The pyramid of energy is which one of following**

a) always inverted

b) always upright

c) sometime inverted and sometime upright

d) spindle shape

---

**74) The largest reservoir of sulphur is which one of the following**

a) Atmosphere

b) Rocks

c) Ocean

d) Lake

---

**75) What represent Niche of species?**

a) Place of Living

b) specific functions

c) Habitat and specific functions

d) none

---

**76) Which of the following is a free living nitrogen fixing bacteria present in soil**

a) Azotobactor

b) Nitrosomonas

c) Rhizobium

d) Pseudomonas

---

**77) The amount of energy transferred from one trophic Level to next trophic level is**

a) 1.5%

b) 10%

c) 20%

---

d) 15 %

**78) Main cause of extinction of species from tropical area is which one of the following**

a) Pollution

b) soil erosion

c) deforestation

d) forest fire

**79) Who one is secondary consumer in a food chain**

a) Herbivorous

b) Carnivorous

c) Omnivores

d) producer

**80) Who one is primary consumer in a food chain**

a) herbivorous

b) carnivorous

c) omnivores

d) producer

**81) Grazing food chain cannot begin in the absence of –**

a) primary consumer

b) secondary consumer

c) decomposer

d) producer

**82) Which of the following represent most stable ecosystem**

a) Mountains

b) Forest

c) Ocean

d) forest

**83) 10% law of energy transfer in a food chain is given by which one of following scientist**

---

a) Haeckel
b) Schimper
c) Elton
d) Lindemann

---

**84) Which of the following is not an air pollutant**

---

a) $SO_2$
b) $CO_2$
c) CFC
d) Aerosol

---

**85) Biodiversity of a geographical region represent which one of the following**

---

a) endangered species found in region
b) the diversity in the organisms living in the region
c) Genetic diversity in the dominant species of the region
d) species endemic to the region

---

**86) Which is known as Lungs of the planet**

---

a) silent valley
b) western ghat
c) Amazon rain forest
d) Eastern ghat

---

**87) The following type of ecosystems have a low productivity or capacity to do work**

---

a) Unsubsidized Natural Solar powered ecosystems
b) Naturally Subsidized Solar powered ecosystems
c) Man Subsidized Solar powered ecosystems
d) Fuel powered ecosystems

---

**88) Every Ecosystem has ___ major component(s).**

a) One
b) Two
c) Three
d) Four

89) **……….. is not a Producer**

a) Algae
b) Green plants
c) Photosynthetic bacteria
d) sheep

**90) ______ are Primary consumers.**

a) Herbivores
b) Carnivores
c) Omnivores
d) All of the above

**91) _____ are Secondary consumers.**

a) Herbivores
b) Carnivores
c) Omnivores
d) Scavengers

92) **The following have vegetarian as well as non-vegetarian diet**

a) Herbivores
b) Carnivores
c) Omnivores
d) All of the above

**93) The following is (are) micro-consumers**

a) Bacteria

b) Fungi

c) Flagellates

d) <u>All of the above</u>

---

**94) Heterotrophic components are**

---

a) Producers

b) <u>Consumers</u>

c) Decomposers

d) None of the above

---

**95) Grasshopper is a**

---

a) <u>Herbivore</u>

b) Carnivore

c) Omnivore

d) None of the above

---

**96) The set of ecosystems is called a**

---

a) <u>Biome</u>

b) Climate

c) Subsystem

d) Structure

---

**97) ……… of the following is biotic components of the ecosystem.**

---

a) Soil

b) Carbon

c) Protein

d) <u>Grass</u>

---

**98) The following is an example of Terrestrial Biome**

---

a) <u>Tropical rain forest</u>

b) Rivers

c) Streams

d) All of the above

---

**99) The following is an example of marine biome**

---

a) Rivers

b) Lakes

c) <u>Oceans</u>

d) All of the above

---

**100) Snake is a**

---

a) Primary consumer

b) Secondary consumers

c) <u>Tertiary consumers</u>

d) Quaternary consumers

---

**101) Functional aspect of an ecosystem is**

---

a) <u>Regulation of populations</u>

b) Light, temperature, Oxygen and Carbon dioxide

c) Both 1 and 3

d) Producers consumers and abiotic environment

---

**102) Which is true of a food chain?**

---

a) Passage of food from one trophic Level to the next higher one

b) Passage of energy from one trophic Level to next higher one

c) Dissipation of energy at successive trophic levels

d) <u>All the above</u>

---

**103) Food web**

---

a) Increases variety of food at each trophic level

b) Delicately balances the inter relations amongst organisms

c) Decreases variety of food but increases quantity of food at each trophic level

d) Increases variety as well as quantity of food at each trophic level

---

**104) The animal which feeds on dead animals is known as which of following**

a) Predator

b) Scavenger

c) Cannibal

d) parasite

---

**105) Rate of storage of organic matter not used by heterotrophic is termed as**

a) Net productivity

b) Net primary productivity

c) Gross primary productivity

d) Secondary productivity

---

**106) Graphic representation of biomass relationship between the Producers and Consumers in an ecosystem is called**

a) Trophic level

b) Ecological system

c) Ecological Niche

d) Ecological pyramid

---

**107) If all green plants of earth are destroyed**

a) All plants shall die

b) Only Herbivorous animals shall die

c) All animals shall die ultimately

d) Nothing shall happened to animals

---

**108) The typical bio of an area having 50 to 100 CM of rainfall is**

a) Desert
b) Grassland
c) Deciduous forest
d) Coniferous forest

**109) Grassland of USA is referred to as**

a) Prairie
b) Steppes
c) Pampas
d) Veldts

**110) Which of the following natural resources is in a non-renewable sources**

a) Wildlife
b) water
c) forest
d) coal

# F.Y.B.Sc. ZOOLOGY PAPER – II – SEMESTER – I
# ZOOLOGY: ZO – 112 - ANIMAL ECOLOGY

## TOPIC NO.1 - INTRODUCTION TO ECOLOGY

## CONCEPTS OF ECOLOGY

Ecology is one of the important branches of science which is also called as Environmental Biology. This is one of the young branches which are connected with the organisms and their environment.

The studies of inter-relationships of organisms with their physical and biotic environment are called as Ecology.

**Branches of Ecology**

1) Habitat Ecology – Study of different habitats of biosphere is called as habitat ecology.
   Ex. Marine ecology, Freshwater ecology, Forest ecology, Desert ecology
2) Population Ecology or Demecology – Study of populations of different species of a ecosystem concerning with birth rate, death rate and different factors affecting their growth is called as population ecology.
   Ex. Study of insects in a particular village or district
3) Ecosystem Ecology – Analysis of ecosystem in relation to structure and function is called as ecosystem ecology.
   Ex. Study of insect diversity with reference to biotic and abiotic factors
4) Radiation Ecology – This is the branch which deals with study of effects of radiation and radioactive substances on organisms and environment.
5) Paleoecology- In this branch, we study about the different forms living in different times in the past and the environment prevailing at that time.
6) Gene Ecology – Study of the relationship of genes and their adaptability in nature is called as gene ecology.
7) Human Ecology – The branch which mainly deals with relationship between man and his environment.

**Significance of Ecology**

- Ecology is a complex branch related to chemistry, physics, botany, zoology, anatomy, taxonomy, physiology, biochemistry and many more.
- Ecology is related to use of pesticides, detergents, sewage disposal etc.
- Ecology is connected with urban development, atomic radiations, power generation, dams etc.
- Ecology is related to cyclones, floods, extreme environmental changes.

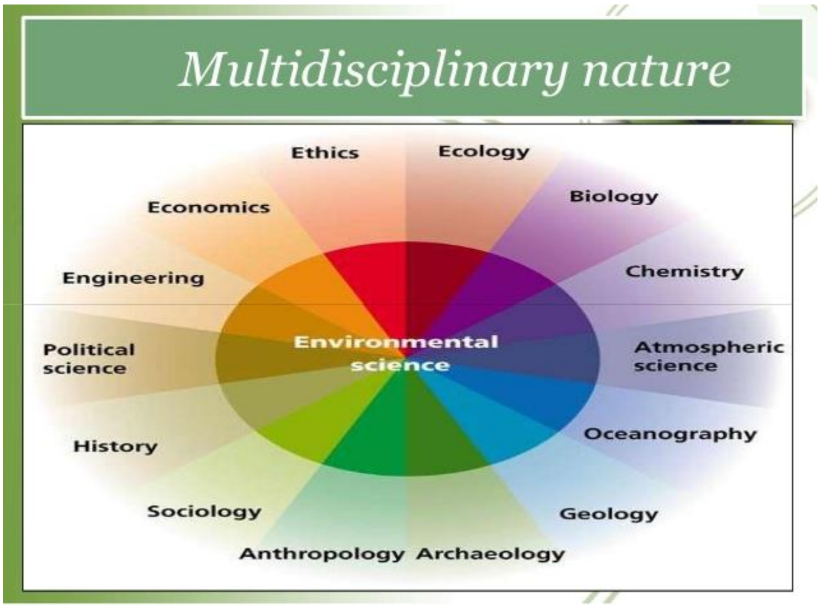
# ENVIRONMENT

Study of inter-relations between living and non-living things is called as Environmental Science.

Environmental Science is a very vast and multidisciplinary subject. In this subject, we basically study interrelation between biotic (living) and abiotic (non-living) components or factors.

Biotic components:- Plants, animals, microorganisms, fungi, bacteria, viruses etc.

Abiotic components:- Soil, air, water, light, energy, chemicals, hazardous factors etc.




## Significance of Environment

- Related with study of biology, physics, chemistry, geography, economics, history, etc.
- We live on the earth where the natural resources are limited.
- Over utilization and misuse of these natural resources is harmful to earth.
- Air pollution, water pollution and soil pollution.
- Huge amount of waste which is produced, is not degraded by natural process and it is accumulated in our environment producing different kinds of pathogens causing several diseases.

## POPULATION

A population is any group of individuals of the same species in a given area or region at a specific time.

A population has many characteristics that are a function of the whole group and not of the individual members, these are:

- Population density
- Natality (Birth rate)
- Mortality (Death rate)
- Age distribution
- Population growth form
- Population fluctuations
- Population dispersal

## COMMUNITY

The community includes all types of organisms in a given area. In other words, the community comprises all the populations in a given area. There is close interrelationship between the community and the non-living environment and also between members of the communities in a given area.

**Community Structure**

The community is mainly composed of three types of organisms and these are as follows:

1) Producers: These are autotrophs, mainly green plants, algae, green flagellates etc. These are capable of synthesizing complex organic molecules, in the presence of radiant energy of the sun, through photosynthesis.
2) Consumers: These are heterotrophs and mainly animals that feed upon other organisms. These are incapable of synthesizing their own food. Those consumers, which feed directly on plants or on the products of plants, are called as herbivores or primary consumers.

   Those consumers, which feed on other animals, are called carnivores or secondary consumers. They feed on primary consumers.

   Those consumers, which feed on secondary consumers are called as tertiary consumers.
3) Decomposers: These are also heterotrophs and include mainly bacteria and fungi, which decompose and break down complex organic substances into simple abiotic substances.

## ECOSYSTEM

Ecosystem is the basic functional unit of organisms and their environment, interacting with each other and within their own components.
An ecological system is a sum total of living organisms, the environment and the processes of interaction between and within all parts of the system.
An ecosystem may be as large as the ocean or a forest or it may be as small as an aquarium jar containing tropical fish, green plants and snails. To qualify as an ecosystem, the unit must be a stable system in which the exchange of materials follows a circular path. All ecosystems are connected with other ecosystems around them.
An ecosystem has two components the biotic components (living things) and abiotic components (non living things).

## BIOSPHERE

Biosphere is defined as a part of the earth and atmosphere in which many smaller ecosystems exists and operates.
In other words, the biosphere is a narrow sphere of earth where the atmosphere (air), hydrosphere (water) and lithosphere (soil) meet, interact and make the existence of life possible.

## Subdivisions of Ecology

### AUTECOLOGY

Autecology is a branch of ecology in which we study an individual species or its population in relation to its biotic (living) and abiotic (non-living) environment. In this branch, one will study a species of organism or its population throughout its life, its interactions with the environment and among themselves.
For Ex.: In a forest, if we study the population of deer species, its increase in number, food taken, its relation to plants and animals living in that locality, its natality, mortality and their interactions within their own population, it is autecology study.

### SYNECOLOGY

Synecology is a branch of ecology which deals with the structure, number, development, distribution and interactions of organic community of a locality with the environment and amongst themselves as a whole.
For Ex.: Study of different plants and animals living in a forest and their interrelationships with the environment and among themselves.

# TOPIC NO.2 - ECOSYSTEM

## INTRODUCTION

Ecosystem is an interacting system where biotic and abiotic factors interact to produce an exchange of materials between the living and non-living factors. Thus, structural and functional system of communities and their environment is called ecosystem. An ecosystem is a region with specific and recognizable area such as forest, grassland, desert, wetland or coastal area. The nature of ecosystem is based on its geographical features such as mountains, hills, plains, rivers, lakes or islands.

Basically there are two types of ecosystems namely terrestrial or land ecosystems and aquatic ecosystems in water.

## TYPES OF ECOSYSTEMS

### 1) AQUATIC ECOSYSTEMS

Aquatic ecosystems are classified into fresh water ecosystems (steam, river, pond, wetland and lake ecosystem), estuarine ecosystems (river deltas) and marine ecosystems (sea and oceans). These ecosystems provide human beings with a wealth of natural resources. They provide fishes, prawns, crabs, lobsters as a protein rich food. Rivers and seas also help in breakdown of organic and inorganic wastes created by man.

#### A) Freshwater ecosystem

Freshwater ecosystem is composed of biotic and abiotic factors present in running water (streams and rivers) and stagnant water (ponds and lakes). There is very little about 3% freshwater on the earth and it is the only source for people all over the world. Plants, animals and microorganisms live in water. The animals are adapted to live in different types of habitat. Abiotic factors are clarity, salinity, oxygen content, pH, mud, light etc.

#### B) Estuarine ecosystem

Estuarine ecosystem is also called as Brackish water ecosystem. In estuarine ecosystem water is less saline as it present in river deltas. It is located at the place where river meets sea and ocean. In estuarine ecosystems, mangrove forests are present in river deltas and these are world’s most productive ecosystems in terms of biomass production. The largest mangroves swamps are in the Sunderbans in the delta of the river Ganga in West Bengal.

**C) Marine ecosystem**

Marine ecosystems are nothing but seas and oceans with highly saline water. Marine ecosystems of India are Arabian Sea, Bay of Bengal and Indian Ocean. In coastal area, sea is shallow and while further away, it is deep and both shows different ecosystems. There are mission of zooplankton and large number of invertebrates on which fish live. Fish is the food of crocodiles and marine mammals. Coral reefs are also rich in species.

## 2) TERRESTRIAL ECOSYSTEMS

Terrestrial ecosystems are classified into forest ecosystems, grassland ecosystems and desert ecosystems. Terrestrial ecosystem is composed of biotic and abiotic factors living on and under soil or crust of earth.

**A) Forest ecosystem**

Forests are formed by a community of plants which include trees, shrubs, grasses, climbers and ground cover. Some forests are homogenous in which majority of plants are of same kind and some are heterogenous forests contains plants of different species. Approximately 30% of the land is covered under forest. Due to human encroachment the forest area all over the world is gradually declining.

These are the kinds of forests:

Equatorial forests
Tropical forests
Temperate forests
Polar forests
Evergreen forests

**B) Grassland ecosystem**

Grassland covers areas where rainfall is usually low and soil depth and quality is poor. Due to low rainfall the growth of trees and shrubs is prevented, but it supports the growth of grass cover during monsoon. In the grassland ecosystem grasses, herbs and several species of insects, birds and mammals are adapted to wide open grass covered areas. These animals are able to live where food is ample after rains.

These are the types of grasslands in India:

a) In Himalayan Mountains, there are high cold Himalayan pastures.

b) Thracts of tall elephant grass in low lying Terai belt of south of Himalayan foot hills.
c) Semi-arid grasslands in western India and in the Deccan plateau, parts of Central India.

**C) Desert ecosystem**

In India, deserts and semi-arid areas are situated in Western India and Deccan plateau. Temperatures are high in such areas hence they are extremely dry. There are also cold deserts such as Ladakh located in the high plateaus of Himalayas. The most typical is TharDesert in Rajasthan. In desert areas, rainfall is very scanty. In an area, it may rain only once every few years.

There are three main types of deserts found in world:

a) Tropical Deserts – Sahara (Africa), Rajasthan (India), Arabian desert (Saudi Arabia)
b) Temperate Deserts – American desert of California, Arizona, Mexico etc.
c) Cold Deserts – Gobi desert (Mangolia), Tibetian desert

## STRUCTURE AND COMPOSITION OF ECOSYSTEM

### ABIOTIC COMPONENTS

Abiotic or non-living factors are essential for the survival of living organisms. These abiotic components include various factors as follows:

1) WATER

Water is essential for life and without water, life is impossible. The water available to plants and animals is due to rainfall. It occupies 71% of the earth surface in the form of fresh water, marine water and estuarine water. The water circulating between atmosphere and earth surface is called hydrologic cycle. The water is in the form of liquid, solid and vapour state. Water of the earth's surface reaches to atmosphere by evaporation and transpiration. Water plays an important role in the ecosystem which affects the distribution, growth and activities of organisms in it.

2) TEMPERATURE

Temperature is a physic-chemical, ecological abiotic factor. Temperature can be defined as the intensity aspect of heat. It is in the form of energy called thermal energy. The biosphere obtains its thermal energy mainly from the sun in the form of solar radiation. Temperature affects all forms of life. It influences the various stages of life activities, such as growth, metabolism, reproduction, movement, distribution, behavior, death etc. Temperature is a variable factor. It varies from place to place and from time to time.

3) LIGHT

Light is the most important and indispensible abiotic factor without which life cannot exist. All plants depend on light for their energy and all animals depend on plants and hence, without light life is impossible. Chlorophyll is the dominant light absorbing pigment found in green plants. By the process of photosynthesis, it converts light or photon energy into chemical energy. Light also plays an important role in transpiration and stomatal functioning.

4) HUMIDITY

The amount of water vapour or moisture in the air is called as humidity. Humidity plays an important role, as it affects the life of plants and animals indirectly. In warm and humid regions, birds and mammals tend to be darker in colour than those inhabiting in the cold and dry regions. As the air warms up, the relative humidity drops because warm air can hold more moisture than cool air. Humidity is greatly influenced by the intensity of solar radiation, temperature, altitude, wind, exposure and status of soil.

5) ATMOSPHERIC GASES

Up to a height of about 300 Km, above the earth's surface, there is present some sort of a thick gaseous mantle. The gaseous mantle consists of different gases in different proportions. Of these gases nitrogen, oxygen and carbon dioxide are major components. Argon, neon, helium, krypton, xenon, hydrogen, methane, ozone are other gases in very minute proportions.

6) SOIL

Soil is another abiotic factor in which structure, formation and characteristics of different soils are studied. It acts as a suitable substratum for plants and animals.

Soil is a complex physical biological system providing support, water, nutrients and oxygen for the plants. It is made up of mineral matter (40%), organic matter, humus (10%), soil water (25%) and soil air (25%).

**BIOTIC COMPONETNTS**

Biotic components of ecosystem are mainly plants, animals including human being and microbes. These are generally called as producers, consumers and decomposers.

1) PRODUCERS

The green plants, certain bacteria and algae can synthesize their own food with the help of chlorophyll in presence of sunlight. Therefore they are called as producers or autotrophs. They do not depend on others for food.

2) CONSUMERS

Animals cannot produce their own food but depend on plants and other organisms to obtain their food. Therefore these are called as consumers or heterotrophs. Animals which feed on green plants are called as primary consumers or herbivores. Organisms which consume an herbivore are called as secondary consumers or carnivores. The organisms which consume secondary consumers are called as tertiary consumers.

3) DECOMPOSERS

Certain fungi and bacteria which are responsible for the decomposition are called decomposers or reducers. They are saprotrophs and they breakdown complex compounds of dead or living protoplasm and release water, $CO^2$, phosphates and a number of organic compounds which are largely the metabolic by-products and release them in the environment, making them available again to autotrophs.

## FOOD CHAIN

DETRITUS FOOD CHAIN

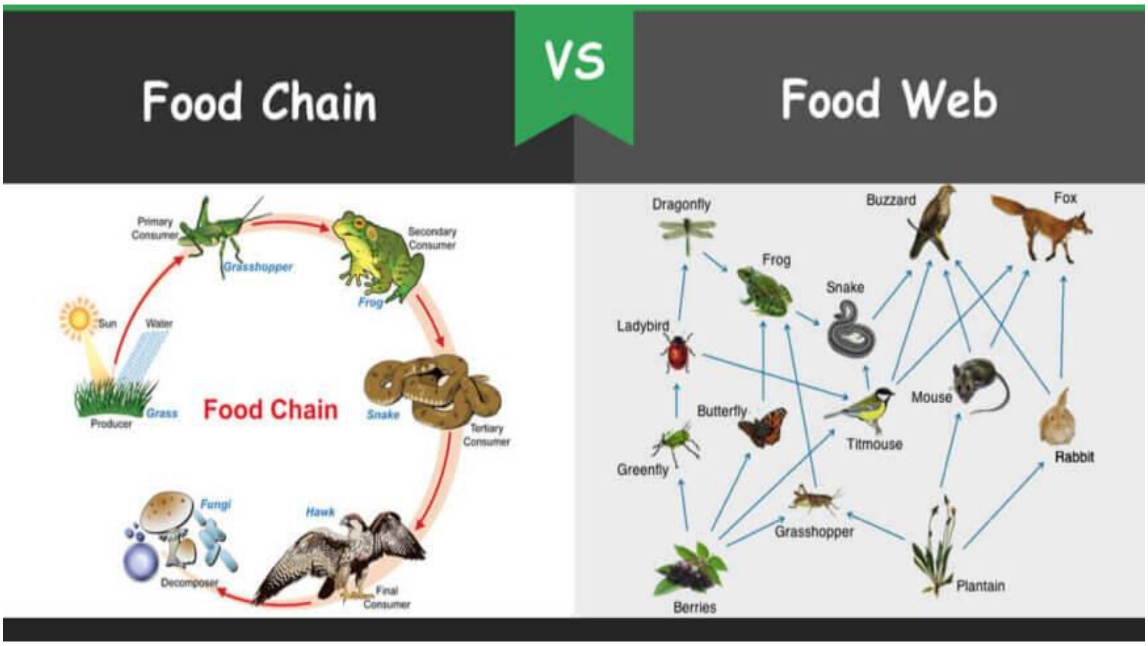
This type of food chain goes from dead organic matter into micro-organisms and then to organisms feeding on detritus (detrivores) and their predators. Such ecosystems are thus less dependent on direct solar energy. These mainly depend on influx of the organic matter produced in another system.
Example: Leaves fallen in shallow water $\longrightarrow$ Protozoa, fungi $\longrightarrow$ Insect larvae, grass shrimps $\longrightarrow$ Fish $\longrightarrow$ Birds

GRAZING FOOD CHAIN

The consumers which start the food chain, utilizing plants or plant parts as their food, constitute the grazing food chain. The food chain begins from green plants at the base and the primary consumer is herbivore.
Example: Grass $\longrightarrow$ Grasshopper $\longrightarrow$ Birds $\longrightarrow$ Hawk

## FOOD WEB

In an ecosystem the various food chains are interconnected with each other forming some sort of interlocking pattern called as food web. Food chains in natural conditions never operate as isolated sequences.
Food webs are very important in maintaining the stability of an ecosystem. For example: decrease in population of rabbit would naturally cause an increase in the population of alternative herbivore, the mouse. This may decrease the population of the consumer (carnivore) that prefers to eat rabbit. When one type of herbivore becomes extinct, the other types of herbivores increase in number and control vegetation. Thus, each species of any ecosystem is indeed kept under some sort of a natural check, so that the system may remain balanced. The complexity of any food web depends upon the diversity of organisms in the system.




**ENERGY FLOW THROUGH THE ECOSYSTEM**

Every ecosystem has several interrelated mechanisms that affect human life. These are the water cycle, carbon cycle, oxygen cycle, nitrogen cycle and energy cycle. Every ecosystem is controlled by these cycles. In each ecosystem, its abiotic and biotic features are distinct from each other. All the functions of the ecosystem are related to the growth and regeneration of its plants and animals.

**WATER CYCLE**: When it rains, water falls on the ground and it flows into rivers or falls directly on the sea. Some water percolates into the ground and it is stored as a underground water for longer period. Plants absorb underground water along with the nutrients. Plants release water from the leaves by transpiration in the form of water vapour which returned to the atmosphere. Due to sunlight, water from sea surface is converted into vapour. The water vapour is lighter than air which forms clouds. When clouds rise higher the vapour condenses and changes into droplets, which fall on the land as rain. This is an endless cycle on which life depends.

**CARBON CYCLE**: Carbon is found in both abiotic and biotic components of the ecosystem. Carbon acts as a building block of both plant and animal tissues. In the atmosphere, carbon occurs in the form of carbon dioxide ($CO^2$). During the process of photosynthesis plant leaves absorb $CO^2$ in presence of sunlight and it combines with water and form carbohydrates. Plants use photosynthesis for their growth and development. In this process, $O^2$ is released in the atmosphere for respiration of animals. Thus, plants help in regulating and monitoring the percentage of $O^2$ and $CO^2$ in the earth's atmosphere. All mankind depends on the $O^2$ produced by this cycle. It also keeps $CO^2$ at acceptable levels.

**OXYGEN CYCLE**: Plants and animals take Oxygen from air during respiration. Plants release Oxygen to the atmosphere during photosynthesis. Thus, Oxygen and Carbon cycles are linked. Because of deforestation oxygen level in the atmosphere is gradually reducing. Thus, plants play vital role in our lives which we generally neglect. Therefore, afforestation programs are very important and everybody should participate in it.

**NITROGEN CYCLE**: Nitrogen forms many essential molecules, like amino acids, the building blocks of proteins and genetic material like DNA and RNA. In the air nitrogen is present 79% but plants and animals cannot use nitrogen in this form. For usable form it must be converted into ammonia ($NH^3$) or nitrate ($NO^3$). The conversion of atmospheric nitrogen into nitrate and ammonia is called as nitrogen fixation and this is done by nitrogen fixing bacteria present in soil and water. Herbivorous animals feed on plants and carnivorous animals feed on herbivorous animals. Thus, animals get nitrogen by feeding on plants.

**ENERGY CYCLE**: The energy cycle is based on the flow of the energy through the ecosystem. In the process of photosynthesis, plants convert solar energy into chemical energy i.e. carbohydrates and this material is used for growth of leaves, flowers, fruits, branches, trunks and roots of the plants. The plants grow themselves by converting solar energy into their tissues. They produce their own food hence plants are called producers. These plants are eaten b the herbivorous animals as a food and they get energy from plants. Major part of this energy is used for day to day functions of these animals like respiration, digestion, growth of tissues, maintaining blood flow and body temperature. Animals also require energy for searching food, finding shelter, breeding and bringing up young ones. Carnivorous animals feed on the herbivorous animals and they get energy from them.

## ECOLOGICAL PYRAMIDS

Ecological pyramid is the graphic representation of the number, biomass and energy of the successive trophic levels of an ecosystem. Charles Elton in 1927, first used and described the term ecological pyramid. In the ecological pyramid,

the producers form the base and the final consumer occupies the apex. The number, biomass and energy of organisms gradually decrease from the producer level to the consumer level. These few steps of trophic level can be expressed in a diagrammatic way and are called as ecological pyramids.
The ecological pyramids are of three types:

**PYRAMID OF NUMBERS**: They show the relationship between producers, herbivores and carnivores at successive trophic levels in terms of their number. The number of individuals at the trophic level decreases from the producer level to the consumer level. The number of producers in an ecosystem is very high. The number of herbivores is lesser than the producers. Similarly, the number of carnivores is lesser than the herbivores. For example: in crop lands the producers or crops are more in number and the grasshoppers feeding on crop plants are lesser in number. The frogs feeding on grasshoppers are still lesser in number. The snakes feeding on frogs are still fewer in number.

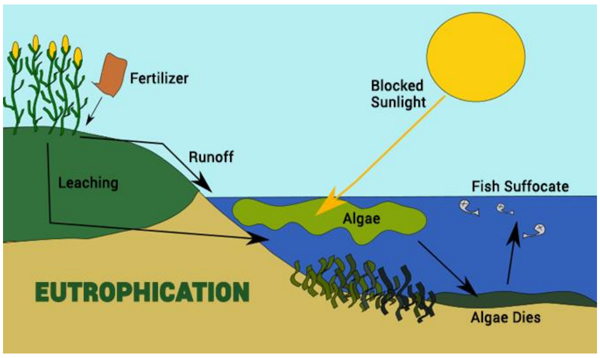
**PYRAMID OF BIOMASS**: Biomass refers to the total weight of living matter per unit area. Therefore, the pyramid of biomass is to weigh individuals in each trophic level instead of counting them. This would give us a pyramid of biomass i.e. the total weight of all organisms at a given level. In an ecosystem, the biomass decreases from the producer level to the consumer level. For most ecosystems on land, the pyramid of biomass has a large base of primary producers with a small trophic level perched on the top. In grassland and forest, there is generally a gradual decrease in biomass of organisms at successive levels from the producers to the top carnivores. Thus, pyramids of biomass are upright.

**PYRAMID OF ENERGY**: The energy in an ecosystem flows from the producer level to the consumer level. At each trophic level 80 to 90% of energy is lost. Hence, the amount of energy decreases from the producer level to the consumer level. This can be represented by the pyramid of energy. The energy inputs and outputs are calculated so that energy flow can be expressed per unit of land or water per unit time. For example: an ecosystem receives 1000 calories of light energy in a given day. Most of the energy is not absorbed; some is reflected back to space. Of the energy absorbed, only a small portion is utilized by green plants, out which the plants uses some part of the energy for respiration, growth and repair. Of the 1000 calories, therefore only 100 calories are stored as energy rich materials. Now suppose an animal, say a dear, eats the plant containing 100 calories of food energy. The deer uses some of it for its own metabolism and stores only 10 calories as food energy. A lion that eats the deer gets an even smaller amount of energy. Thus, usable energy decreases from sunlight to producer to herbivore to carnivore. Therefore energy pyramid will always be upright.

## CONCEPT OF EUTROPHICATION IN LAKES AND RIVERS

The decomposition of organic matter makes the water rich in nutrients. Due to phosphates and nitrates, the water body becomes highly productive or eutrophic and this phenomenon is called as eutrophication. Eutrophication denotes the enrichment of a water body by input of organic waste containing nutrients, chiefly nitrates and phosphates. Sewage and domestic waste water contains these nutrients.

Artificial eutrophication, which results from human activities, is a dramatically fast process. This happens when domestic waste, agricultural residues, land drainage and industrial wastes reach a water body. The problem of eutrophication arises due to nutrients released from organic wastes by the activity of aerobic bacteria in presence of oxygen. The nutrients induce changes in the ecosystem balance and composition of aquatic life. Addition of nutrients stimulates luxuriant growth of algae in water. These are also shift in the algal flora and blue green algae begin to predominate. They start forming algal blooms, floating scums or blankets of algae. The algal blooms are not utilized by zooplanktons. The algal blooms compete with other aquatic plants for light to perform photosynthesis. Larger plants such as duck weeds and water hyacinth also flourish in water. More of these plants grow as a result of additional nutrients. The water becomes turbid and greenish. As more plants grow, more also die and decay. Both these processes consume oxygen resulting in oxygen deficit.




# TOPIC NO.3 - POPULATION

## INTRODUCTION

A population is a group of individuals of a particular species or kind present at a particular area at a specific given time. A population may be monospecific (containing individuals of only one species) or polyspecific (individuals of many species). Members of a population have more or less similar structure and life history and interbreed among themselves producing fertile offspring. They have similar gene pool. For example, we may study the fish population of the river Ganga, the lion population of the Gir forest or the peacock population of India. The study of population dynamics (changes in population sizes) is called *demography*.

## CHARACTERISTICS OF POPULATION

### Population Density

Population density can be defined as total number of individuals inhabiting specific area of the habitat for particular time period or density of a population refers to its size in relation to some unit of space on observed time or density is the number of individuals per unit area, at a given time. The unit area used in measuring density varies. For example, number of micro-organisms per liter of water; for larger animals or plants, the acre or square kilometer may be the unit, for plants per acre of land or number of people per square kilometer.

Density can mathematically be calculated as follows:

$$D = \frac{n/a}{t}$$

Where, D = density
n = number of individuals
a = area
t = time unit

**Natality**

The natality or Birth rate of a population is defined as the number of new individuals produced by birth, hatching, germination, multiplication or fission in per unit time. The natality varies among different organisms. Some species breed once a year, some breed several times a year, and others breed continuously. When the conditions are ideal (without any limiting factors) or optimal conditions prevail, the natality will be maximum. This is called as Potential natality or Absolute natality. Several factors like nutrition, capacity of reproduction etc. reduce the rate of addition of new individuals. So in a specific environment the birth rate (actual) is always less than the potential natality. This actual birth rate is called as Specific natality or Realized natality.

Natality of a population can be calculated by the formula:

$$Natality = B = \frac{n}{t}$$

Where, B = Birth rate per unit of time

n = new individuals in a population

t = time

**Mortality**

Mortality or death rate may be defined as the number of individuals that die in a population in given area in a given period of time. If the mortality is less than natality, naturally there will be an increase in the number of individuals in a given population. This minimum mortality is called the Specific or Potential mortality and its rate is constant for a given population. The actual or ecological mortality is the actual loss of individuals under a given environmental condition. It is not constant and varies with population and environmental conditions.

The mortality rate can be calculated by the following formula:

$$Death\ rate\ (d) = \frac{Number\ of\ deaths\ per\ unit\ time}{Average\ population}$$

**Fecundity**

Fecundity is the ability to produce offspring. It can also describe the reproductive rate of an individual organism. Animals have limited amount of energy they can use for reproduction. Animals with high fecundity spend their energy in the production of many offspring that do not require much care.

Species vary in the characteristic number of generations, broods produced per year and in the size of them. Protozoans often divide as rapidly as they produce a new generation every few hours. Plankton organisms less fecund may produce a new generation every few days. Many vertebrates breed once a year, some large animals only once every two or three years.

The number of eggs or young produced per litter is correlated inversely with the amount of parental care that they require. When parental care is altogether lacking, invertebrates may lay 1000 to 50 million eggs at one maturation and where protection is afforded by brood pouches, they lay about 100 to 1000 eggs. Some mammals may give birth to more than a dozen young in a single litter and large species usually only one.

**Survivorship Curves**

A graph obtained when number of survivors in a population is plotted against time is called as survivorship curve. A vital thing for a population is how many members survive but not which members die. Consequently, specific mortality rate of a population is expressed by survivorship curve.

There are three types of survivorship curves:

a) Diagonal Curve: When mortality rate remain constant at all ages i.e. in embryonic, young, adult, the curve appears in a straight diagonal line
Example: Hydra, Birds etc.
b) Convex Curve: When most of the individuals live at their potential life span and die in old age and curve appears convex in nature.
Example: Man, Deer, Rabbit etc.
c) Concave Curve: In this extremely heavy mortality appears in early life and curve appears concave in nature.
Exmple: Oyster, Snails etc.

## Age Ratio

Age distribution is an important characteristic of population which affects both natality and mortality. The ratio of the various age groups in a population determines the current reproductive status of the population and indicates what may be expected in the future. Usually a rapidly expanding population will contain a large proportion of young individuals, a stationary population will show a more even distribution of age classes, and a declined population will have a large proportion of old individuals. A population may pass through changes in age structure without changing in size. We rarely find a natural population that has a stable age structure because populations do not increase for long in an unlimited fashion.

From an ecological point of view, age structure can be expressed in three ecological ages:

Pre-reproductive
Reproductive and
Post-reproductive

## Sex Ratio

The sex ratio is the ratio of males to females in a population. In most sexually reproducing species, the ratio tends to be 1:1. In anthropology and demography, the human sex ratio is the ratio of males to females in a population. More data are available for humans than any other species. The sex ratio for entire world population is 102 males to 100 females (2017). The current sex ratio in India (2019) is 947 females to every 1000 males, and in Maharashtra 922 females to 925 males. In most species, the sex ratio varies according to the age profile of the population.

It is divided into four subdivisions:

a) Primary sex ratio: ratio at fertilization
b) Secondary sex ratio: ratio at birth
c) Tertiary sex ratio: ratio in sexually mature organisms also called as adult sex ratio
d) Quaternary sex ratio: ratio in post-reproductive organisms.

## Population Dispersal

The movement of individuals and the products of their reproduction into and out of the population is called as population dispersal.
There are three types of population dispersal:

a) Emigration: This is the one-way outward movement from one place to another.
b) Immigration: This is the one-way inward movement from one place to another.
c) Migration: This is the two way movement of individuals involving periodic departure and return. Migratory movements are very conspicuous among fishes, birds and mammals.

## Population Dispersion

The distribution pattern of the population is called as dispersion.
There are three types of population distributions as follows:

a) Random Distribution: This distribution is rather random and the individuals rarely show a tendency to aggregate, without any specific pattern. In this type of distribution, the probability of an individual occurring at any one spot is the same as the probability of its occurring at any other spot in a given area.
b) Uniform Distribution: This is a type of distribution in which the individuals are distributed according to a uniform patter i.e. it is more regular and uniform and may be found in places where there is severe competition between individuals.
c) Clumped Distribution: In this, the individuals are clumped or grouped in a limited area. This is the most common pattern of distribution. This pattern is controlled by the biotic, edaphic and climatic conditions of the area.

## GROWTH CURVES

Population is changing entity. Its size and composition are ever changing. The changes in size and composition are dependent on birth rate, deaths and movements of organisms into and away from the population. In the beginning, the number of animals in first age category would increase (by birth) while those of the older age groups would remain stationary. But as time goes on the age categories increase as the survivors of the initial age groups grow sides. As more animals enter into the reproductive stage; greater number of young is produced. Eventually after several generations the population will grow at fairly steady rate.

There are mainly two types of growth curves:

1) **Exponential Growth Curve or 'J' Shaped Growth Curve**

   This type of growth curve involves geometric ratio of increase upto a certain point after which there is an abrupt decline in growth rate. The decline is due to factors of environmental resistance. The growth curve is more or less 'J' shaped.
   In the beginning, the density of population increases rapidly in compound interest fashion and then stops abruptly on the environmental resistance or other limiting factors become effective. These factors may be food, space or seasonal or termination of reproductive seasons. In this pattern of growth, the density reaches the upper limits remains at that level for time and then decline suddenly indicating catastrophic condition. This type of growth pattern can be seen in early in algal blooms, some insects, annual plants and the lemmings of Tundra, as well mammals as in deer. This type of growth curve is not very common.

2) **Logistic Growth Curve or 'S' Shaped Growth Curve**

   In the logistic or 'S' shaped growth curve, the initial growth rate is rather slow and this is called as positive acceleration phase. This is followed by a rapid growth rate and this stage is known as logarithmic phase. This rapid rate of growth continues upto a certain point known as inflection point after which there is a steady decrease in the rate of increase due to environmental resistance.
   Subsequently the population reaches a maximum limit known as asymptote (or equilibrium). This asymptote represents the limiting size of the population. Thereafter a sort of equilibrium is established between potential natality and environmental resistance, thus maintaining this maximum limit of population density form long periods. The sigmoid or logistic curve of growth rate is common in populations.

## POPULATION REGULATION

Different factors or mechanisms under different circumstances determines (regulate) the size of a population.
These are as follows:

1) **Density Dependent Regulation:**
   Density dependent factors are those that vary in the intensity of their action with the size or density of the population. They increase in intensity as the population level rises and decrease as the population level declines. Thus, density dependent factors are biotic; they depend on intraspecific or interspecific coactions, due to these factors regulated automatically. Populations are self-governing systems. They regulate their densities in relation to their own properties and those of their environments.
   The most important density dependent factors are as follows:
   **Competition:** The role of competition in regulating population is directly effective by causing mortalities, nest destruction and loss of food supplies.
   **Predation:** The predator-prey relationship provides a typical example of density dependent regulation
   **Reproductivity:** The birth and death rates have their important roles in regulation of population size.
   **Emigration:** Emigrations occur when there is overcrowding in the migratory locust, grouse, snowy owl, snowshoe rabbit etc.

2) **Density Independent Regulation:**
   The level at which populations become stabilized is determined by factors viz. space or cover, prevailing weather, food supply and toxic pollution; there magnitude determined by physical or abiotic conditions of the environment. Maximum population size in plants could be determined by the physical environment. Small insects living in arid conditions, their population grows during the short wet season, until the drought kills the plants upon which they feed and the insects disappear, thus their population depends on their intrinsic rate of increase. The food supply also determines the size of population size. Wynne-Edwards (1962) has suggested that most animals somehow keep their population below the level at which they would begin to starve. Territorial behavior and peck

orders serve to parcel out the available food to the stronger member, so that they have enough to survive and breed, whereas the rest are excluded from breeding. Thus, the production of offspring is adjusted to the food supply.

## POPULATION INTERACTIONS

There are two basic types of interactions among the biota and these are called as intraspecific and interspecific. Intraspecific interactions take place between members of the same populations. And interspecific interactions take place between members which belong to two or more populations. Interspecific population interactions take place in different ways.

### GAUSE'S PRINCIPLE

Competition exclusion principle (Gause's Principle) is experimentally confirmed by Russian Biologist, C.F.Gause in two species of *Paramecium*. Thus, Gause's principle lays stress on the fact that closely related organisms (or species) remain ecologically separated. In other words, it is the principle of the ecological separation of closely related species, due to interspecific competitions.

Gause cultured two species of *Paramecium*: *Paramecium caudatum* and *Paramecium aurelia* separately and together (mixed). When cultured separately under the same set of controlled environmental conditions and fed with the same species of bacterium, both species flourished and shows sigmoid growth in laboratory. However, when cultured together under the same environmental control and forced to compete for the same food, *Paramecium aurelia* is survived but *Paramecium caudatum* did not. The survival of P.aurelia was simple due to the greater growth than the P.caudatum, thus been more successful in competing for the limited food supply. This clearly shows that the two species of *Paramecium* cannot live together and grow normally in the same culture.

# QUADRATE

A quadrate is a frame, traditionally square, used in ecology and geography to isolate a standard unit of area for study of the distribution of an item over a large area. The quadrate is suitable for sampling plants, slow moving animals and some aquatic organisms.

## QUADRATE METHOD

When an ecologist wants to know how many organisms in a particular habitat? It would not be feasible to count them all. Instead, they would be forced to count a smaller representative part of the population, called a sample. A sampling of plants or slowly moving animals (i.e. snails) can be done by using a sampling square called a Quadrate. A suitable size of a quadrant depends on the size of the organisms being sampled. For example, to count plants growing on a school field, one could use a quadrate with sides 0.5 or 1 $m^2$ in length. Choice of quadrate size depends to a large extent on the type of survey being conducted.
Random sampling is usually carried out when the area under study is fairly uniform, very large and/or there is limited time available. When using random sampling techniques; large numbers of samples are taken from different positions within the habitat. A quadrate frame is most often used for this type of sampling. The frame is placed on the ground, and the animals or plants inside it counted or collected, depending on what the survey is for. This is done many times at different points within the habitat to give a large number of different samples.

## TRANSECT METHOD

When the vegetation or animals is to be studied along an environmental gradient or eco-tone, a line is laid down across a stand or several stands at right angle. This method of linear sampling of the vegetation is called transect.

Depending upon the object of study, two types of transect can be drawn. They are as follows:

a) **Line Transect**
In this type of transect the vegetation is sampled only over a line (without any width). A line is laid over the vegetation with a metric steel tape or steel chain or long rope and kept fixed with the help of pegs or hooks. This line will touch some plants on its way from one point to the other. The observer will start recording these plants from this type of transect

following information could be collected. From the observations in a number of such parallel lines transect, comments can be made on the habitat and other environmental conditions on different portions of transect. Every species has its own ecological amplitude and tentatively expresses the status of available water and other edaphic conditions, atmospheric humidity, availability of light, grazing and other biological pressures.

**b) Belt Transect**

The belt is a long strip of vegetation of uniform width. The width of the belt is determined according to the type of vegetation or the stratum of vegetation under study. In close herbaceous vegetation it is usually 10 cm, but it varies from 1 to 10 meters in woodland. The length of the vegetation is determined according to the purpose of the study.

A belt is generally studied by dividing it into some equal sized segments. The length of each segment is generally equal to the width of transect. The segments are sometimes called quadrats. Belt transects are used in determining and understanding the gradual change in abundance dominance, frequency and distribution of different species in the transitional region between two different types of vegetation.

# TOPIC NO.4 - COMMUNITY

## INTRODUCTION

Community is a local association of several populations of different species. According to Krebs (1972) a community is an assemblage of the populations of living organisms in a prescribed are or habitat. According to Clarke (1954) a group of mutually adjusted plants and animals inhabiting a natural area is known as a community.

The biotic communities are divided into two types:

a) Major or autotrophic communities which together with their habitats, form more or less complete and self-sustaining units for the indispensable input of solar energy.
b) Minor or heterotrophic communities which are secondary aggregations within the major communities and are not, therefore completely independent units as far as circulation of energy is concerned i.e. they are depend on major communities for their energy source.

## COMMUNITY CHARACTERISTICS

All communities have certain characteristics in common and their maintenance is governed by similar forces. Like other like other entities, a community grows, develops, passes through a relatively stable mature phase,, reproduces and ultimately dies. Such community life cycles, taking hundreds and thousands of years, result from an interaction between organisms and their environment. Communities do not have exact limits but tend to overlap each other. Animals frequently shift from one community to another because of seasonal or other variations. Some characteristics of the community are as follows:

## SPECIES RICHNESS

Species richness is the number of different species represented in a ecological community, landscape or region. Species richness is simply a count of species, and it does not take into account the abundances of the species or their relative abundance distributions. The observed species richness is affected not only by the number of individuals but also by the heterogeneity of the sample. If individuals are drawn from different environmental habitats or conditions, the species richness of the resulting set can be expected to be higher than if all individual are drawn from similar environments.

Species richness is the number of species within a community or area. For example, if we have two plots of a land, A and B. Plot A has 24 species of plants and plot B has 84 species of plants. Plot B has higher species richness amongst the two plots.

## DOMINANCE

The phenomenon wherein various species within the community are dominated by one species or more than one species is termed as community dominance, and the dominating species are recognized as community dominants. According to Clements and Shelford (1939), dominance is most commonly expressed in the reactions of an organism on its habitat. Dominants are most prominent species in the community, make up its greatest mass of living material (biomass) and serve as the major source of food, substrate and shelter for the animals that are present. In a forest community, trees are dominant. They decrease light intensity, increase the relative humanity, intercept precipitation, monopolize most of the moisture and nutrients in the soil, decrease wind velocity and furnish shelter and food for animals.

## SPECIES DIVERSITY

Each community consists of very diverse organisms i.e. plants and animals belonging to different taxonomic groups. The number of species and population abundance in communities also vary greatly. The older and more stable the community, is the more will be species diversity. Nature favours high species diversity while man prefers monoculture and brings about uniformity. Natural communities with high species diversity are less vulnerable to environmental vagaries, while manmade communities; for example, crop fields, orchards, nurseries etc. are open to greater damages by environmental hazards or epidemics and may be completely destroyed. Species diversity is very useful parameter for comparison of two communities especially to study the influence of biotic disturbance or to know the state of succession and stability in the community.

## ABUNDANCE

In ecology, local abundance is the relative representation of a species in a particular ecosystem. It is usually measured as the number of individuals found per sample. The ratio of abundance of one species to one or multiple other species living in an ecosystem is referred to as relative species abundances. Both indicators are relevant for computing biodiversity. Species abundance is the number of individuals per species and relative abundance refers to the evenness of distribution of individuals among species in a community. Two communities may be equally rich in species but differ in relative abundance.

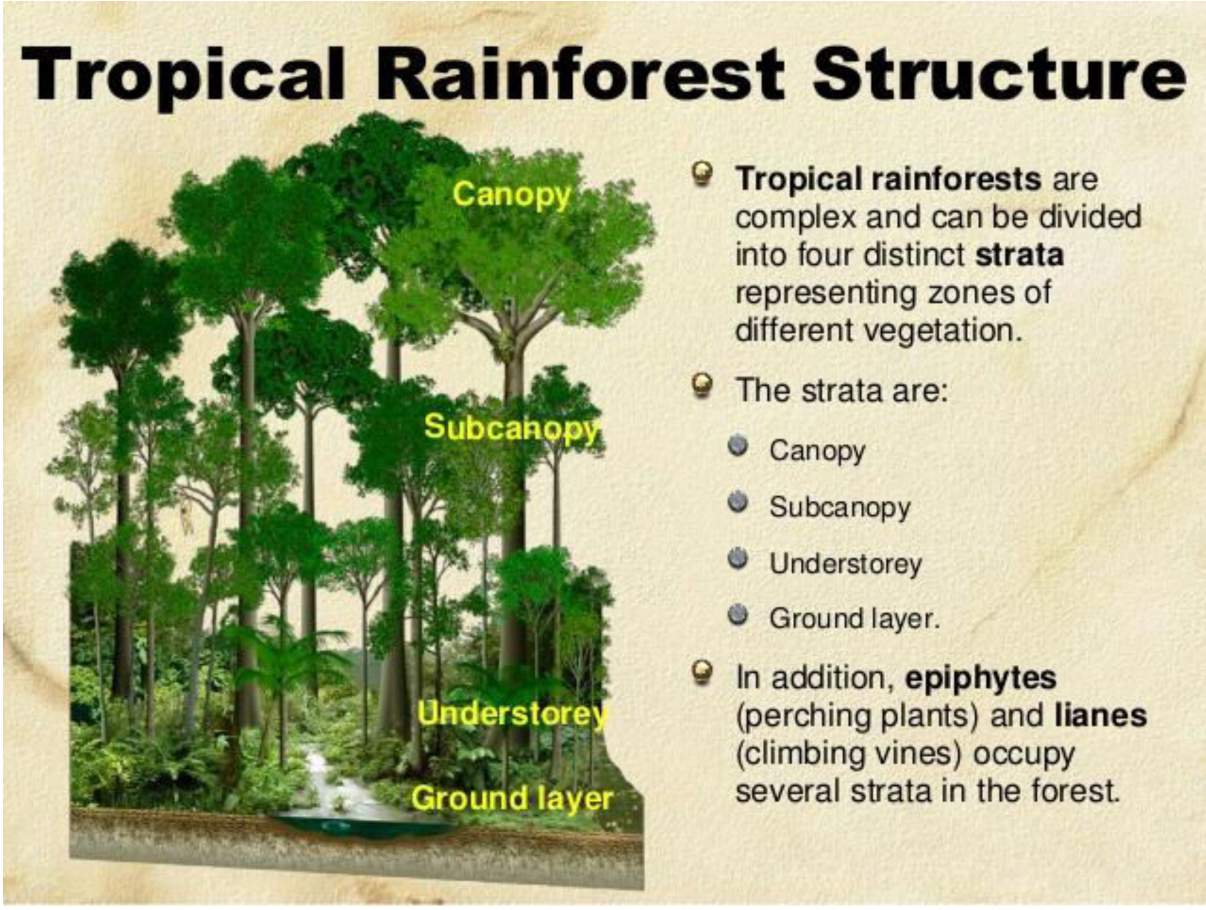
Abundance is in simplest terms usually measured by identifying and counting every individual of every species in a given sector. And relative species abundance is calculated by dividing the number of species from one group by the total number of species from all groups.

## VERTICAL STRATIFICATION

Most communities show vertical differentiation or stratification; that is different species occur at different heights above the ground or depths below the water surface. The species have different positions along a vertical gradient of depth in community with decreasing light intensity.

**Vertical Stratification in Plants:** The forest trees with their upper foliage in full sunlight, forms the Canopy or uppermost level. The leaves and branch surfaces of the canopy trees may absorb more than half of the sunlight energy; but beneath the canopy there is a lower layer of smaller trees utilizing some of the remaining light. This lower trees stratum usually contains both younger individuals of the canopy tree species and mature trees. Less than 10% light reaching the upper canopy may penetrate through the tree foliage of both levels, species of a third level of vegetation, shrubs are adapted in utilizing this weaker light within the forest; further reducing light reaches herbs beneath the shrub layer. The remaining light (1-5%) supports the growth of the herb layer. Below the herbs, mosses on the ground may form still another vegetation layer.

**Vertical Stratification in Animals:** As different plant species are adapted to different positions in vertical gradient, the different animal species also occupy different level in the forest. For example, different group of bird species found feeding and nesting near the ground, in the shrub and small tree foliage beneath the canopy and in the canopy itself. Different arthropod species occur at different levels from the canopy downward to the herb stratum and below the ground surface. A group of animals – mites, spring tails, centipedes, ground beetles etc. occur in the leaf litter on the soil surface.




**Vertical Stratification in Plants**

## ECO TONE AND EDGE EFFECT

The intermediate transitional zone between two distinct communities is called as **Eco tone** or a Tensional zone. An ecotone can be defined as a zone of transition between adjacent ecological systems.

For example: the boundary between a forest community and a grassland community where the two meet and compete.

An estuary is another example, where the river water and the sea water meet.

The environment conditions of the boundary community are more or less intermediate between the two main communities; in this ecotone contains species of both the communities and also its own endemic (native) species. Therefore the ecotone is richer in life than either of the two communities. This phenomenon in which the ecotone has greater number of species and population density than in either of the two main communities is called as **edge effect**. The endemic species present ecotones are called edge species.

# ECOLOGICAL SUCCESSION

The process of formation of new communities is called ecological succession. It is defined as an orderly and progressive replacement of one community by another till the development of a stable community in that area. The stable community is called climax community. Thus, succession is the birth of ecosystem and subsequent aging process of its biotic and abiotic factors. The biotic communities are not stable. They are changing into different communities or forms in a longer time span. Thus, in a particular geographical area, one community may be replaced by another community or by a series of communities.

Example: A pond or lake community which fills with silt and changes gradually from deep to a shallow pond or lake, then transformed into a marshy land community if it is filled with sand and mud. In the course of time, the marshy land may be converted into grassland or a dry land forest community. If forest is completely burned over, it remains as a plot of bare ground, on which after some period series of plant communities grow up and replace one another first annual weeds, then perennial weeds and grasses, then shrubs and trees, and formation of forest community.

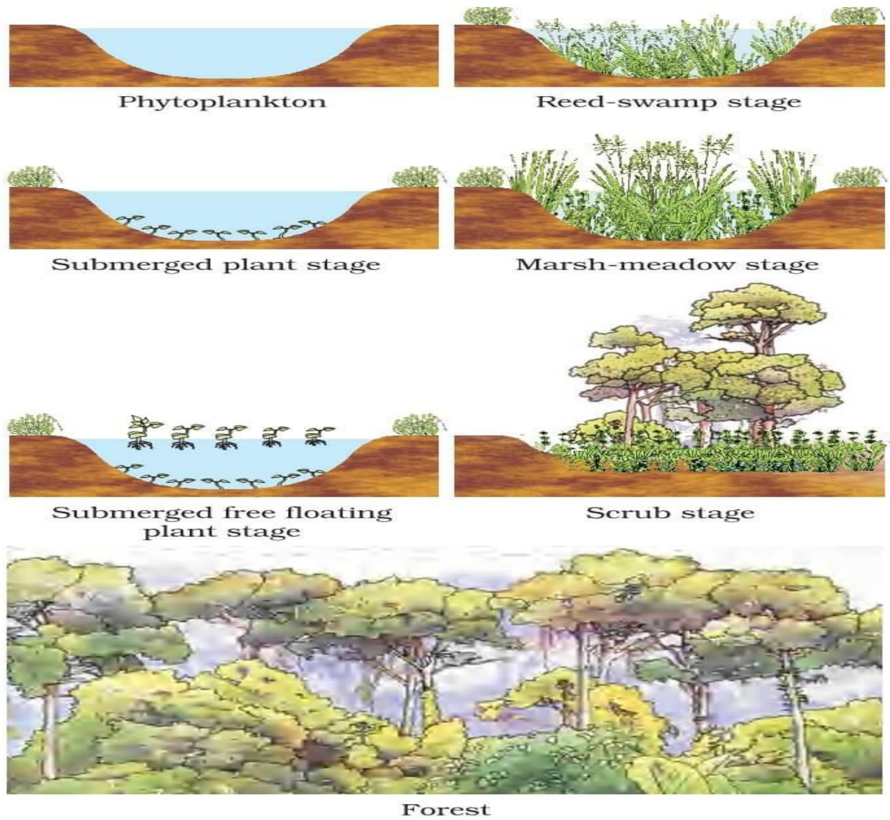



**Figure 14.5** Diagramatic representation of primary succession

# TOPIC NO.5 - ANIMAL INTERACTIONS

## INTRODUCTION

Animals interact with each other in numerous complex ways. However, we can make some general statements about these interactions. This enables us to understand the role that species play within their ecosystems and how individual species can positively or negatively affect the species around them. Of the various types of interactions between species, most involved resources and consumers. A resource, in ecological terms is something (such as food, water, habitat, sunlight or prey) that is required by an organism to perform a vital function such as growth or reproduction. A consumer is an organism that consumes a resource (such as predators, herbivores and detrivores). Most interactions between animals involve one or more competitor species competing for resources.

## TYPES OF ANIMAL INTERACTIONS

Animal interactions can be classified into four basic types based on how the participating species are affected by the interaction.
They are:

1) **Competitive Interactions:**
   Competitive interactions are interactions involving two or more species that are competing for the same resource. In these interactions, both of the species involved are negatively affected. Competitive interactions are in many cases indirect, such as when two species consume the same resource but do not directly interact with each other. Instead, they affect each other by reducing the availability of the resource.
   For example: Interaction between lions and hyenas. Since both species feed on the same prey, they negatively affect each other by reducing the amount of that prey. One species may have trouble hunting in an area where the other is already present.
2) **Consumer-Resource Interactions:**
   Consumer-resource interactions are interactions in which individuals from one species consume individuals from another species. Classical examples of this type of interaction include predator-prey interactions and herbivore-plant interactions. These consumer-resource interactions affect the species involved in different ways. Usually this type of interaction has

a positive impact on the consumer species and a negative impact on the resource species.

For example: A lion eating a zebra, or a zebra feeding on grass. In the first example the zebra is the resource, while in the second example, it is the consumer.

3) **Detritivore-Detritus Interactions:**

Detritivore-detritus interactions involve a species that consumes the detritus (dead or decomposing organic matter) of another species. This interaction is a positive interaction for the consumer species. It has no impact on the resource species since it is already dead. By cleaning up decomposing plant and animal matter, they play an important role in maintaining the health of ecosystems.

For example: Detritivores include small creatures such as millipede, slugs, wood lice and sea cucumbers.

4) **Mutualistic Interactions:**

Mutualistic interactions are interactions in which both species-resource and consumer are benefitted from the interactions. The interaction is beneficial to the species, plants and animals.

For example: Interaction between plants and pollinators. Large number of flowering plants depends on animals to help them to pollinate. In exchange for this service, animals such as bees and butterflies are rewarded with food in the form of pollen or nectar.

## INTERSPECIFIC COMPETITION

Members belonging to different species or population compete for many factors in the environment. Competition between members of different populations for living space, better feeding grounds, and better breeding place and so on is called as interspecific competition. Here both the populations are engaged in actively inhibiting each other and therefore this is a negative interaction. During this process each of the two populations of the interaction affects the other population adversely in the attempt to reach out to the resources which are in short supply in the given area.

## INTRASPECIFIC COMPETITION

Intraspecific interaction is simply the mass assemblage of the individuals of the same species. In this most associations are beneficial to the species and to the individuals, but under extreme conditions may prove to be harmful. This type of association may be either temporarily or permanently affecting the biological environmental factors due to competition for food, competition for space, moisture, light, protection or competition between sexes.

## BENEFICIAL ASSOCIATIONS

Animal associations may occur between the individuals of the same or different species, ages, sizes or sexes. They live together for variety of purposes such as reproduction, feeding, protection, transportation etc. Animal associations are sometimes very intimate or very casual and mutually beneficial or may not be beneficial or extremely one sided, i.e. one member gets benefits and other gets harmed.

## COMMENSALISM

It is a latin term which means eating on the same table. This occurs when one member of the associating pair usually the smaller receives all the benefit and the other member is neither benefitted nor harmed. The commensal eats the food of its host, not vice versa. The basis for a commensalism relationship between two organisms may be space, substrate, defense, shelter, transportation or food.

**Example:** An association between sucker fish *Remora* and large, powerful host Shark. *Remora* is a carnivorous fish growing to about 50 cm in length. It can swim independently but is more often carried about by the large host Shark. For this purpose the first dorsal fin of the *Remora* is modified into a flat, adhesive disc or sucker. The food of *Remora* consists of other small fishes and probably scraps of food that becomes available as the host tears apart its prey.

**Example:** Another popular example of commensalism is the relationship between cattle Egrets and livestock like Cow, Buffalo, and Horse. The cattle Egret is a common species of *Heron* that is mostly seen moving along with herds of cattle. This bird moves about in the pastures, and follows livestock. The cattle Egret eats up the insects hiding under vegetation close to the grounds, which gets stirred up when cattle walk through them. The movement of foraging livestock also dislodges various insects like flies, mites and bugs from the field, which cattle Egrets feed on.

**Shark and Remora fish** **Cattle egret and livestock**

**Commensalism**

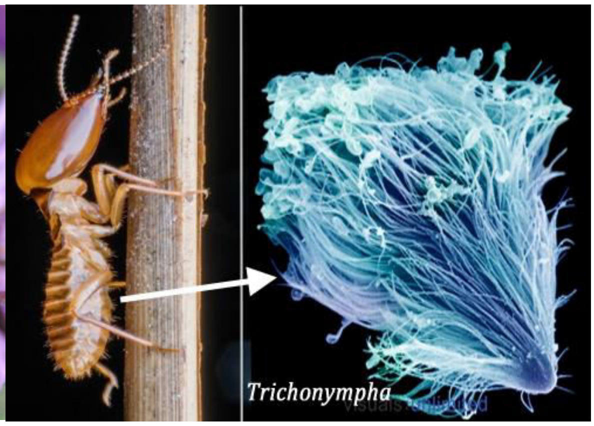
## MUTUALISM

It is a latin term which means exchange. In this association, both the partners are beneficial to each other by exchanging the metabolites. In this association, each of the interacting species functions as host as well as parasite. Without this association the individuals usually cannot survive independently.

**Example:** Association between Termite and protozoan flagellate *Trichonympha* is a classic example of mutualism. Termite is a wood eating insect which lives in moist decaying trunks of wood. Its partner *Trichonympha* lives in the intestine of termite which produces the enzyme cellulose useful for digestion of cellulose. The cellulose is a major food of the termite but it is unable to digest it. *Trichonympha* gets shelter and it hydrolyses cellulose into glucose, which can be readily digested by termites. If the *Trichonympha* is removed from the intestine of the host termite, it suffers from starvation or even death occurs. Similarly, the *Trichonympha* cannot exist anywhere else except in the intestine of termite.

**Example:** Another example of mutualism is found between bees and the flowers. The bees fly from flower to flower in search of nectar, which they can transform into food. On the other hand, whenever the bees are placed on a flower, particles of pollen adhere to their body. Such particles are transported to other flowers, resulting into flower pollination. This is the relationship of mutualism in which the bees obtains food and the plant reproduces itself.

**Example:** Mutualism is also found by the cleaning symbiosis in fish by prawns. Cleaning symbiosis is a mutually beneficial association between individuals of two species, where one (the cleaner) removes and eats parasites and other materials from the surface of the other (the client). These prawns or shrimps exhibit a cleaning symbiosis with client fish where they clean parasites from the fish. The fish is benefitted by having parasites removed from them, and the prawns gain the nutritional value of the parasites.




**Bee and Flower** **Termite and *Trichonympha***

**Mutualism**

## ANTAGONISTIC ASSOCIATIONS

In this interspecific association, one of the partners is benefitted and the other is harmed or injured, therefore this type of relationship is also called by the name Antagonism or Antagonistic association.

## PARASITISM

Parasitism is a unique kind of symbiotic association in which the parasite remains very close to its food or host. Parasite is defined as an animal or plant which lives partially or wholly at the cost of another living organism called as host. The parasite is always benefitted in this association and the host is injured or harmed. This relationship between parasite and host is called as parasitism. When the parasite lives on the surface of the body of the host, it is called as ectoparasite. Examples of ectoparasites are head louse, tick, mite, bedbug, leech etc. When the parasite lives inside the body of the host, it is called as endoparasite. Examples of endoparasites are plasmodium, entamoeba and ascaris.

**Example:** A common example of parasitism is found between Ascaris and man. A round worm *Ascaris lumbricoides* is one of the common intestinal worms of the human being. It is more common in children than adults. The worm feed on the semi-digested food of the host in small intestine. Ascaris protect themselves from being digested by their host by the presence of thick cuticle on their body and secretes antienzymes which protects from being digested. Thus, Ascaris is an obligatory endoparasite of man living in the intestine and leads successful parasitic life, but man gets injured by suffering from intestinal diseases.
**Example:** Another example of parasitism is found between lice and human. Lice are a human ectoparasite, benefitting at the expense of its human host. This is because the lice get food and shelter but the head of human becomes itchy. As the lice gets food, shelter and place for their nasty eggs while human is harmed.


**Ascaris in intestine of Man** **Head lice on head of Man**

**Parasitism**

## PREY PREDATION

Predation is a biological interaction where one organism (predator) kills and eats another organism (prey). Predators choose prey selectively based on age or condition. The predator typically hunts live prey, which it kills and feed on its flesh or drinks the blood. The predation is commonly associated with the idea of strong attacking the weak. Predation is helpful in the regulation of population size. Predators do exert an influence on prey population; they often keep prey populations below the level of the carrying capacity of the ecosystem.

**Example:** The mountain Lions selectively prey upon mule Deer. Young deer are most vulnerable to mountain lion predation. A lion (predator) is an animal that attacks, kills and feed on another organism deer (prey). Similar examples are found as the hawk eats the sparrow, the frog eats insects etc.

**Lion feeding upon deer**