For BioResire students

Life sciences Material

Elite Batch

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Ecology, Environment and Evolution

- **Organic Evolution**

Theories of Organic Evolution

a) Lamarckism (Theory of Inheritance of Acquired Characteristics):

Principle: Organisms change during their lifetime through use/disuse of organs. These acquired characteristics are then passed on to their offspring.

Evidence: Giraffes stretching their necks to reach leaves -> longer necks passed on.

Status: Largely disproven. Weismann's experiment (cutting mouse tails for generations) showed that somatic cell changes don't affect germ cells.

b) Darwinism (Theory of Natural Selection):

Principle: Evolution occurs through the interplay of:

Variation: Individuals in a population vary.

Heritability: Variations are heritable.

Struggle for Existence: More offspring are produced than can survive.

Survival of the Fittest: Individuals with variations best suited to the environment survive and reproduce more successfully.

Evidence: Fossil record, artificial selection (e.g., dog breeding), homologous/analogous organs.

c) Modern Synthetic Theory (Neo-Darwinism):

Principle: Integrates Darwin's natural selection with Mendelian genetics and the study of population genetics.

Key Factors: Mutations (raw material for variation), Genetic Recombination, Natural Selection, Genetic Drift, Gene Flow.

d) Evidences for Evolution

- Palaeontological: Fossil record (e.g., Archaeopteryx as a link between reptiles and birds).

- Morphological: Homologous organs (same structure, different function - e.g., human arm, whale flipper) vs. Analogous organs (different structure, same function - e.g., wings of birds and insects).
- Embryological: Similarities in early embryonic stages across vertebrates (e.g., presence of pharyngeal gill slits).
- Molecular: Similarities in genetic code (DNA), proteins (e.g., cytochrome c), and metabolic pathways across species.

Hardy-Weinberg Law (Genetic Equilibrium)

Principle: In a large, randomly mating population with no evolutionary forces, the allele and genotype frequencies remain constant from generation to generation.

Formula: For a gene with two alleles, A (frequency p) and a (frequency q):

The genotype frequencies are given by:

$p^2 + 2pq + q^2 = 1$

p^2 = frequency of homozygous dominant genotype (AA)

2pq = frequency of heterozygous genotype (Aa)

q^2 = frequency of homozygous recessive genotype (aa)

Conditions for Equilibrium: No mutations, no natural selection, large population size, random mating, no gene flow (migration).

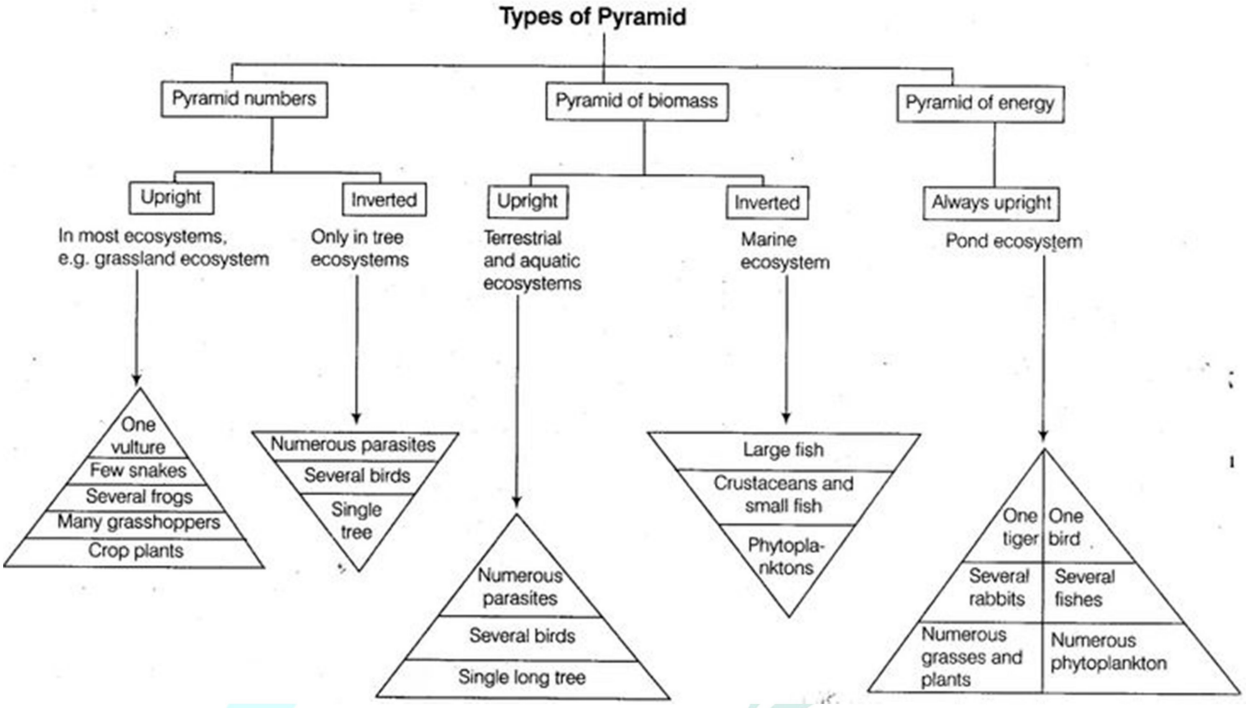
Application: Used to calculate carrier frequencies for genetic disorders (e.g., cystic fibrosis, sickle cell anemia) and to test if a population is evolving.

Key terms:

- Ecosystem: A functional unit where living organisms (biotic) interact with each other and their physical environment (abiotic). Example, A pond, a forest, a desert.
- Ecotone: A transitional zone between two adjacent ecosystems. Example, Estuary (between river and sea), grassland (between forest and desert).

- Ecotype: A locally adapted variant of a species, genetically distinct due to environmental conditions.Same plant species having hairy leaves in alpine regions and broad leaves in plains.
- Biome: A large, terrestrial community defined by its dominant vegetation and climate.Tropical rainforest, Tundra.

Ecological pyramids

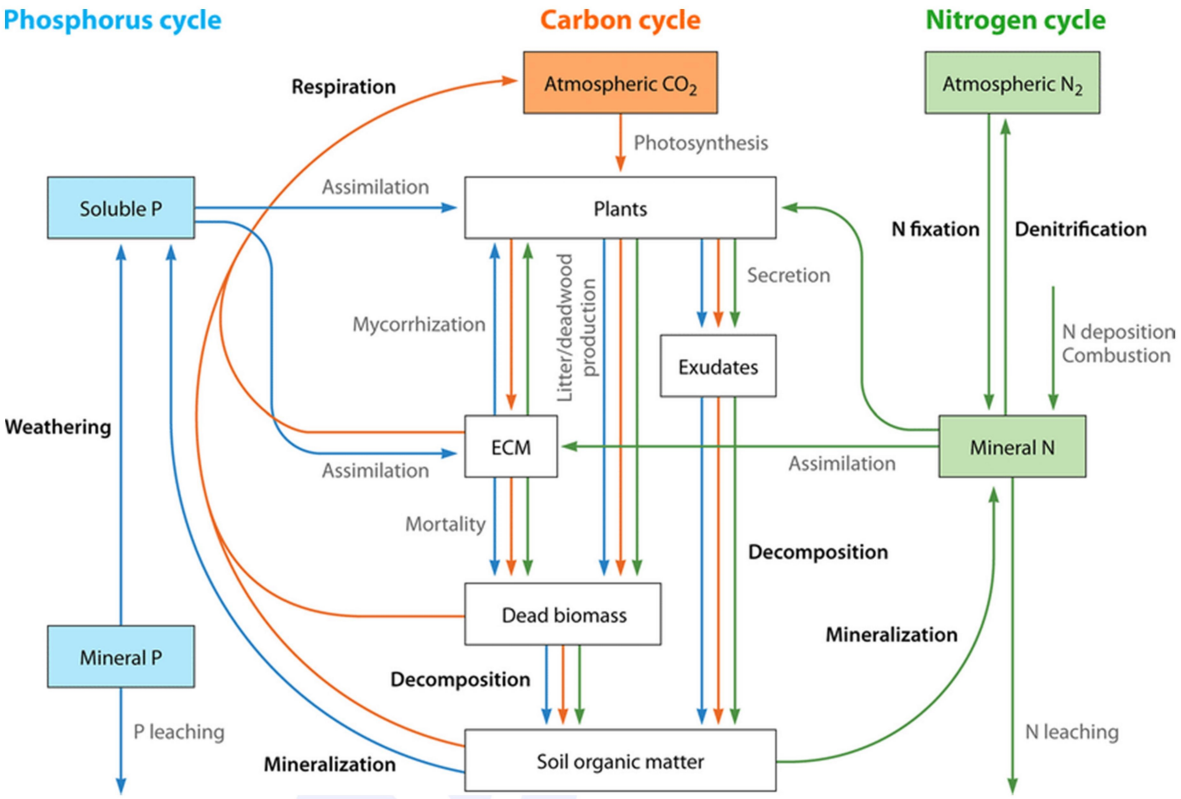


- **10% Law (Lindeman's Law):** Only about 10% of the energy is transferred from one trophic level to the next. The rest is lost as heat through metabolism.

Biogeochemical Cycles

The pathway by which a chemical substance cycles through biotic (biosphere) and abiotic (lithosphere, atmosphere, hydrosphere) components of Earth.

- Gaseous Cycles: Reservoir is the atmosphere. (e.g., Carbon, Nitrogen)
- Sedimentary Cycles: Reservoir is the Earth's crust. (e.g., Phosphorus, Sulphur)



Ecological Adaptations

Morphological, physiological, and behavioral changes that enable an organism to survive and reproduce in its specific habitat.

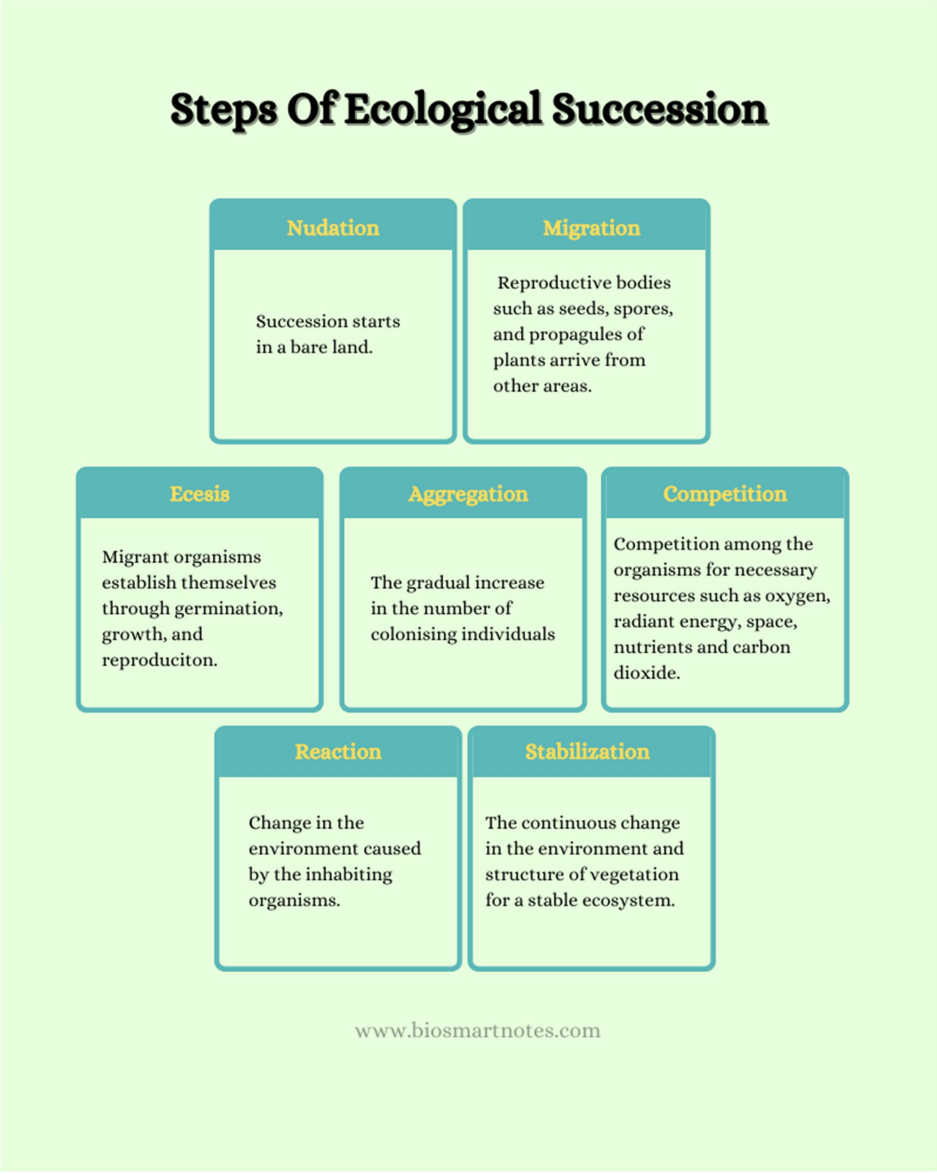
- Xerophytes: Adapted to arid environments (e.g., Cacti with thick stems, sunken stomata).
- Hydrophytes: Adapted to aquatic environments (e.g., Water lilies with air spaces for buoyancy).
- Halophytes: Adapted to saline environments (e.g., Mangroves with pneumatophores for respiration).

Ecological Succession

The process of gradual change in the species structure of a community over time.

- Primary Succession: Occurs on a previously barren area with no soil. (e.g., on bare rock, lava flow). Pioneer species are lichens and mosses.
- Secondary Succession: Occurs in an area where an existing community has been disturbed but soil remains. (e.g., after a forest fire, abandoned farmland).

- Sere: The entire sequence of communities that successively change in a given area.
  - Hydrosere: Succession starting in a watery environment (pond -> lake -> terrestrial forest).
  - Xerosere: Succession starting in a dry environment (bare rock -> lichens -> mosses -> grasses -> shrubs -> trees).



Environmental Issues

Natural Resources & Biodiversity

- **Natural Resources:** Materials or substances occurring in nature that can be exploited for economic gain.
    - **Renewable:** Can be replenished (e.g., solar energy, water, forests).
    - **Non-Renewable:** Finite in quantity (e.g., fossil fuels, minerals).
- **Biodiversity:** The variety of life at all levels of biological organization.
    - **Levels:** Genetic, Species, and Ecosystem diversity.
    - **Threats:** Habitat loss, pollution, overexploitation, invasive species, climate change (summarized by HIPPO).
    - **Importance:** Ecosystem services (pollination, water purification), source of food, medicine, and genes.

About us

BioResire (NEET | CSIR NET | Biotech Internships) is a life sciences research and training organization dedicated to bridging the gap between academic learning and industry skills. We provide internships, projects, and programs in Bioinformatics, Biotechnology, Molecular Biology, Cancer Research, Neuroscience, and related fields, helping students build job-oriented scientific careers.

"The future belongs to those who explore the unseen — where biology meets innovation and discovery begins."