IAS BABA

PEP – 2024

PRELIMS EXCLUSIVE PROGRAMME

ONE STOP DESTINATION FOR PRELIMS PREPARATION

ENVIRONMENT

HANDOUTS

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Notes

TOPICS:

Ecology,
Ecosystems & its types,
Ecotones,
Ecosystem dynamics –Food Chain & Food web,
Flow of energy,
Tropic Levels,

Contents

KEY DEFINITIONS

Ecology	A branch of biology that studies the interactions among organisms and their biophysical environment.
Ecosystem	A community or organisms together with the environment in which they live.
Ecotone	Is a zone of junction between two or more diverse ecosystems. Eg. marshlands (between dry and wet ecosystems), mangrove forests (between terrestrial and marine ecosystems).
Ecocline	A gradation from one ecosystem to another when there is no sharp boundary between the two.
Ecotype	A plant or animal species that occupy a particular habitat which is adapted to local environmental conditions. Eg. common grasses such as Agrostis tenuis
Ecological Niche	Is the unique functional role or place of a species in an ecosystem. No two species can have same ecological niche within a habitat.
Ecotopes	The smallest ecologically-distinct landscape features in a landscape mapping and classification system. They represent relatively homogeneous, spatially-explicit landscape functional units.
Ecophene	Population which is characterised by the same genotype but different phenotype (individual's observable traits, such as height, eye color, blood type) in a particular habitat.
Ecozones	It delineates large areas of the Earth's surface within which organisms have been evolving in relative isolation over long periods of time, separated from one another by geographic features, such as oceans, broad deserts, or high mountain ranges, that constitute barriers to migration
Habitat	It is the type of natural environment in which a particular species of organism lives.

Biotope	It is an area of uniform environmental conditions providing a living place for a specific assemblage of plants and animals.
Home range	The area in which an animal lives and moves on a periodic basis. It is related to the concept of an animal's territory which is the area that is actively defended.
Biocoenosis	It is an association of different organisms forming a closely integrated community Biotic community is also called as Biocoenosis, all interacting organisms living together in a habitat.

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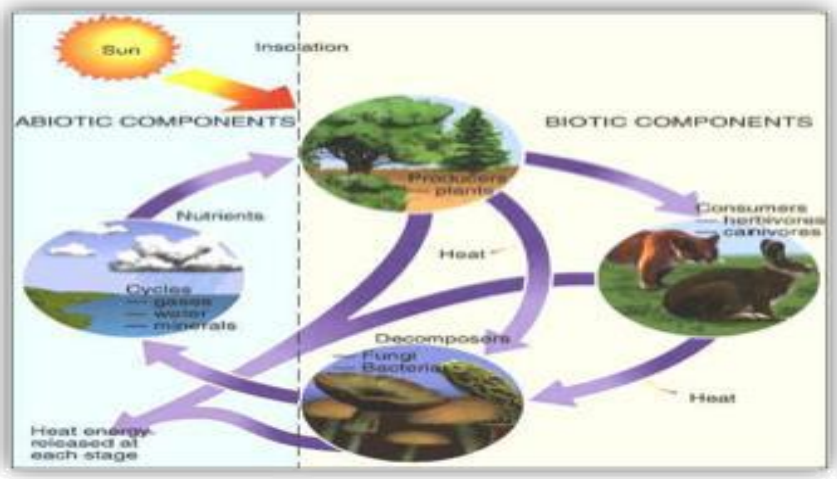
SPECIES/BIOTIC INTERACTIONS

Type of Interaction	Sign	Effects	Examples
Mutualism	+/+	Both species benefit from interaction	Pollinator and Plants, Plants and mycorrhizal fungi, clown fish and anemone
Commensalism	+/0	one species benefit, one unaffected	Sucker fish on shark, Beetles on cow dung
Amensalism	-/0	one species is harmed, the other is unaffected	Large tree shades a small plant, retarding growth of small plant.
Parasitism	+/-	one species benefit, one is disadvantaged	Ticks on dog
Competition	-/-	each species affected negatively	Lions and Tiger.
Predation	+/-	one species benefit, one is disadvantaged	Lion and Zebra
Neutralism	0/0	no net benefit or harm to either species	Sparrow and Humans.

ECOSYSTEM

Ecosystem A structural and functional unit of biosphere consisting of community of living beings and the physical environment, both interacting and exchanging materials between them.	**Components**	**Abiotic (Non-Living Things)**	Energy, Rainfall, Temperature, Atmosphere, Substratum, Latitude and altitude and Materials.
		Biotic (Living Things)	Primary producers (Autotrophs), Consumers (Heterotrophs), Saprotrophs (decomposers).
	Classification	**Terrestrial**	Forests, Grasslands, Deserts.
		Aquatic	Fresh water, Coastal, Marine water.



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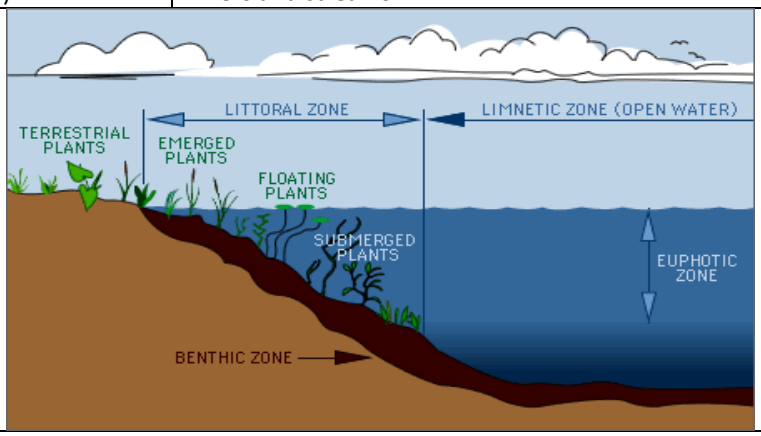
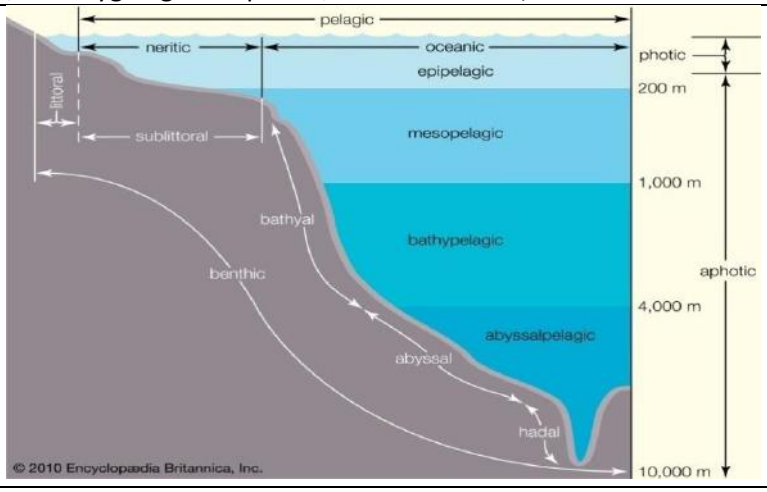
Ecosystem services	**Provisioning services**	Eg. Food, water, fuel, wood, biochemicals and genetic resources
	Supporting services	Eg. Nutrient cycling, Biomass Production, soil formation, primary production.
	Regulating services	Eg. Climate, flood, disease and water regulation, water purification, pollination
	Cultural services	Eg. Spiritual, religious recreation, ecotourism, cultural heritage

Fresh water Ecosystem	**Lentic** (standing bodies)	Lakes, Ponds, Inland wetlands
	Lotic (flowing bodies)	Rivers and streams
Fresh water life zones Defined by their depth and distance from shore	**Littoral Zone** **Limnetic Zone** **Benthic Zone**	
Lakes	**Oligotrophic Lake**	Newly formed, poorly nourished lake.
	Eutrophic Lake	Lake with large or excessive supply of nutrients.
	Mesotrophic Lake	Fall somewhere between Oligo and Eutrophic lake.
Factors Limiting the Productivity of Aquatic Habitats	• Sunlight – photic and aphotic zones • Dissolved Oxygen • Temperature • Winterkill (An ice layer on the top of a water body can effectively cut off light, Photosynthesis stops but respiration continues in such water body. If the water body is shallow, the oxygen gets depleted, and the fish die)	
Biological Zones of Marine Ecosystem	**Littoral Zone (close to shore)** **Bathyal Zone** **Abyssal Zone**	

Aquatic life forms	**Neuston**	These are unattached organisms which live at the air-water interface such as floating plants, etc. E.g., beetles and back-swimmers.
	Periphyton	Organisms which remain attached to stems and leaves of rooted plants or substances emerging above the bottom mud such as sessile algae and their associated group of animals.
	Plankton	• "Plankton" term is used for all the organisms found in

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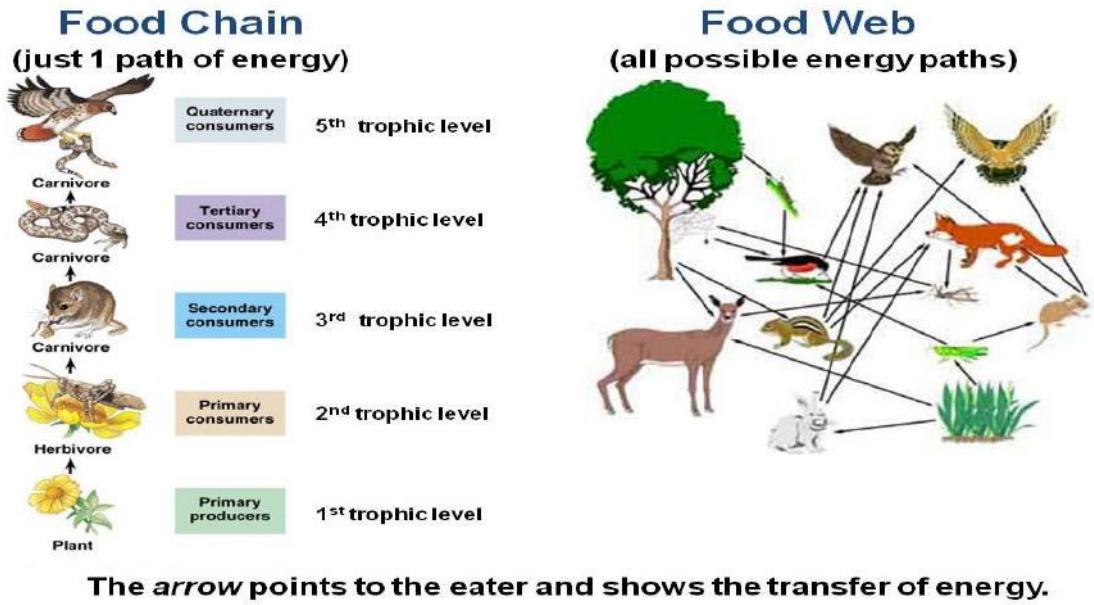
		marine as well as freshwater, which are non-motile and cannot swim against the water current (drifted by water currents) • This group includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton) • Vary widely in size, from 0.2 μm to more than 20 cm. From microscopic bacteria to large organisms such as jellyfish • Account for 50% of total oxygen produced by photosynthesis • Large aquatic organisms are dependent on planktons and feed on them
	Nekton	Contains animals which are swimmers.
	Benthos	Organisms found living in the bottom of the water mass.

KEY CONCEPTS

Food Chain	The sequence of organisms that feed on one another, form a food chain. Each step in the food chain is called trophic level.
Types of Food Chain	**Grazing food chain** - starts with green plants which are producers. Eg. Eg. Grass – Grasshopper – Mouse –Snake - Hawk
	Detritus food chain - starts with dead organic matter. Eg. Litter – Earthworm – Chicken – Hawk
Food Web	Natural interconnection of food chains and a graphical representation (usually an image) of what-eats-what in an ecological community.



Trophic Levels	• Trophic level of an organism is the position it occupies in food chain. • It is the representation of energy flow in an ecosystem • Producers – Primary Consumers – Secondary Consumers – Tertiary Consumers. • Energy flows through the trophic levels from producers to subsequent trophic

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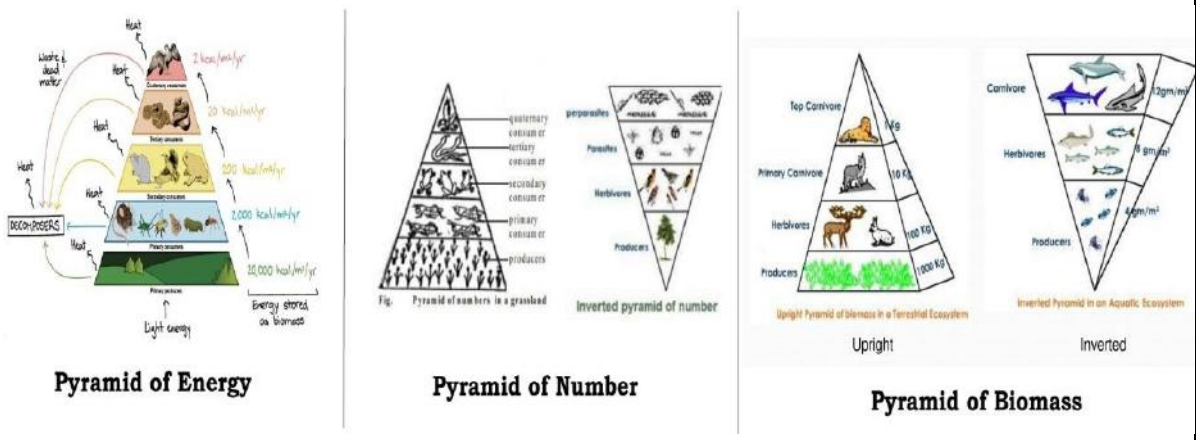
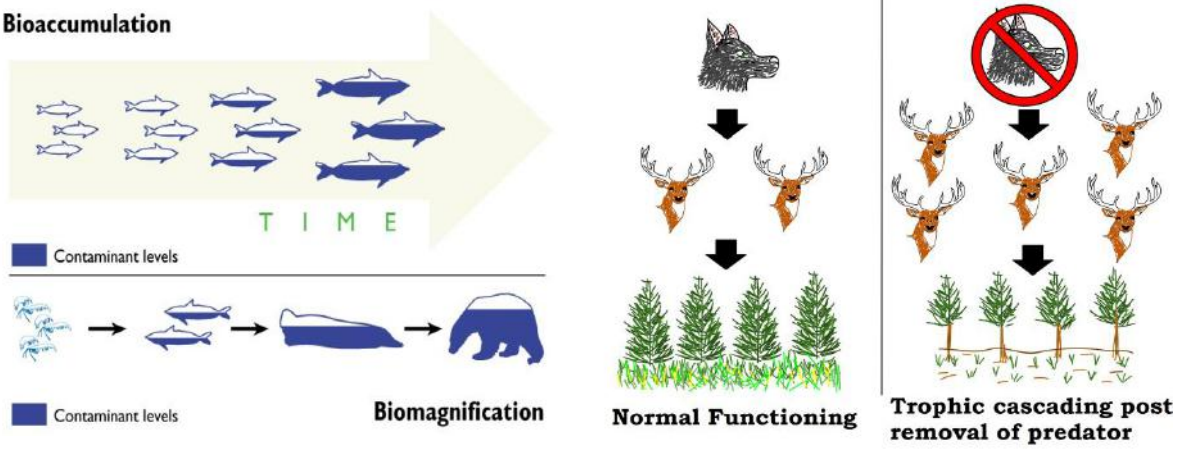
	levels is unidirectional. • Energy level decreases from the first trophic level upwards due to loss of energy in the form of heat at each trophic level. • Tropic level interaction involves three concepts – Food Chain, Food Web, Ecological Pyramid	
Ecological Efficiency	Efficiency with which energy is transferred from one trophic level to the next.	
Ecological Pyramid	Graphical representation of the relationship between different organisms in an ecosystem.	
Types of Ecological Pyramid	**Pyramid of Energy**	Shows the rate of energy flow and/or productivity at successive trophic levels. It is always upright.
	Pyramid of Numbers	Shows the number of individual organisms at successive trophic levels. It can be upright or inverted.
	Pyramid of Biomass	Shows the biomass at successive trophic levels. It can be upright or inverted.



Bioaccumulation	Gradual accumulation of substances, such as pesticides, or other chemicals in an organism.
Biomagnification or Bioamplification	Refers to the tendency of pollutants to concentrate as they move from one trophic level to the next.
Trophic Cascading	An ecological phenomenon triggered by the addition or removal of top predators and involving reciprocal changes in the relative populations of predator and prey through a food chain.



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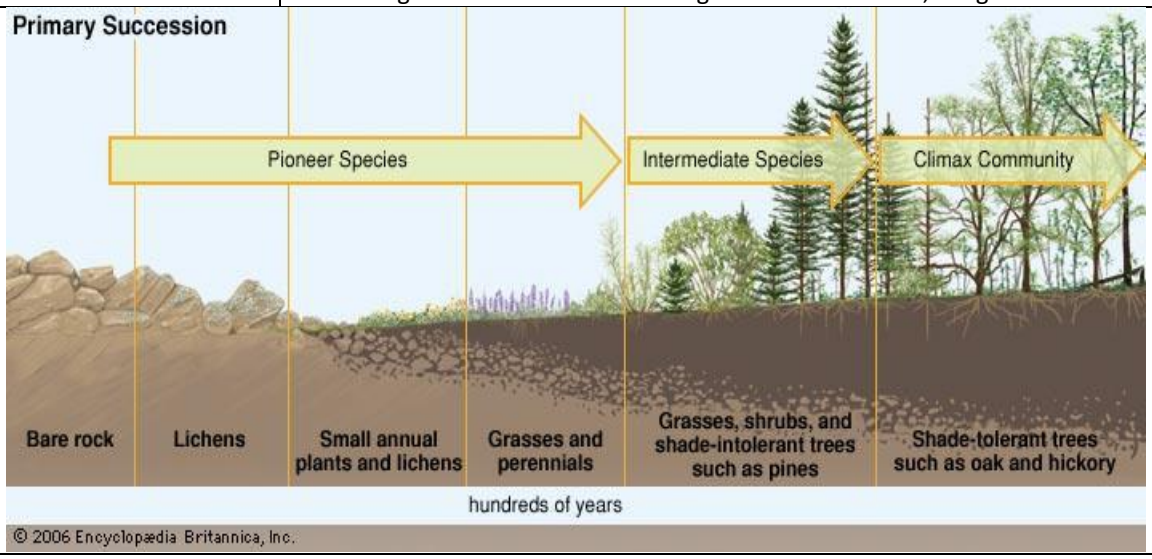
Ecological Adaptation	Any physiological, behavioural or morphological attribute of an organism that enables it to survive and reproduce in its respective habitat.	**Physiological** - Based on body chemistry and metabolism.
		Morphological – characteristics like appearance, body shapes.
		Behavioral - adaptations that affect how an organism act.
Acclimation	Small changes that take place in the body of a single organism over short periods, to overcome small problems due to changes in the surrounding.	
Ecological Succession A process by which the structure of a biological community evolves over time.	**Primary succession**	Occurs when new land is formed or bare rock is exposed, providing a habitat that can be colonized for the first time.
	Secondary succession	A previously occupied area is re-colonized following a disturbance that kills much or all of its community.
	Autogenic succession	When succession is brought about by living inhabitants of that community itself.
	Allogenic succession	When succession is brought about by outside forces.
	Autotrophic succession	Succession in which, initially the green plants are much greater is quantity.
	Heterotrophic succession	Succession in which the heterotrophs are greater in quantity.
Sequences of Ecological Succession	Nudation (bare area without any life form) – Invasion – Competition and Coactions – Reaction – Stabilisation (Climax).	
Sere or **Seral Community**	It is an intermediate stage found in ecological succession in an ecosystem advancing towards its climax community.	
Serule	It is ecological succession for microorganisms like Bacteria, Fungi etc.	



Bioaccumulation	Bioaccumulation refers to the **increase in concentration of a pollutant in an organism.** It usually occurs when an organism ingests a particular substance at a faster rate than it can metabolize or excrete.
Biomagnification	**Biomagnification is also called Bioamplification.** It is simply the increase in concentration of a substance in a food chain, not an organism.

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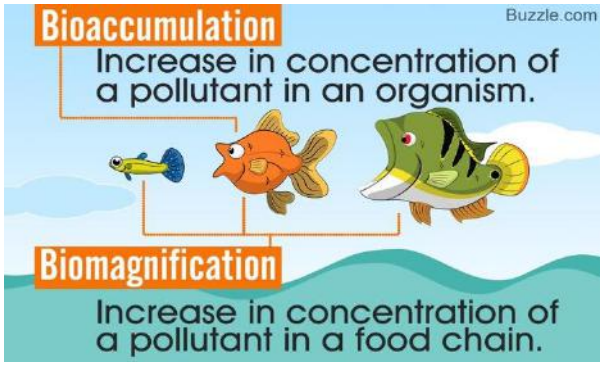
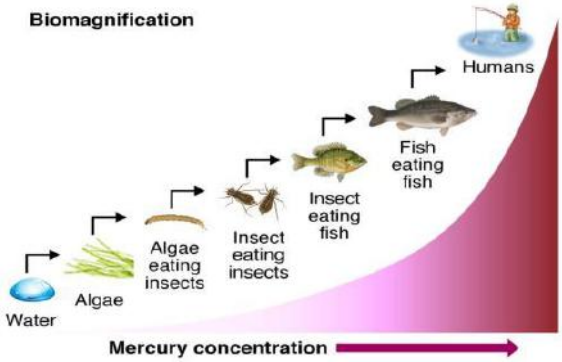




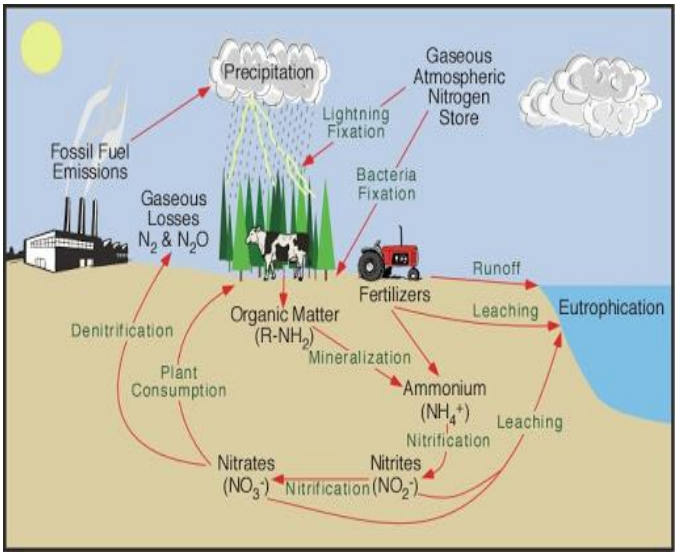
ECOLOGICAL CYCLES

Bio-Geo-Chemical Cycle The ways in which an element moves between its several biotic and abiotic forms and locations in the biosphere. NOTE: Energy flows through an ecosystem and is dissipated as heat, but chemical elements are recycled.	**Gaseous Cycles** (Atmosphere or the hydrosphere is the reservoir)	Hydrological cycle	Cycle that involves the continuous circulation of water in the Earth-atmosphere system.
		Carbon cycle	Carbon and its compounds are continuously exchanged between three spheres of the earth.
		Nitrogen cycle	Cycle by which nitrogen is converted into multiple chemical forms as it circulates among three spheres of the earth.
	Sedimentary Cycle (Earth's crust is the reservoir)	Phosphorus cycle	Cycle that describes the movement of phosphorus through the litho, hydro, and biosphere.
		Sulphur cycle	Is the collection of processes by which sulphur moves between rocks, waterways and living systems.

Nitrogen Cycle

Processes involved:

- **Nitrogen fixation** - process of converting N_2 into biologically available nitrogen.
- **Nitrification** - process that converts ammonia to nitrite (NO2-) and then to nitrate (NO3-).
- **Assimilation** – process by which plants and animals incorporate the NO3- and ammonia formed.
- **Denitrification** - process that converts nitrate to nitrogen gas
- Nitrogen fixation done by microorganisms (bacteria and blue-green algae) or atmospheric phenomenon (thunder and lightning) or industrial processes (fertilizer factories).
- N_2 fixing bacteria Eg. – Nitrozomanas, Rhizobia, Cyanobacteria, Azotobacter vinelandii, Nostoc, Clostridium spp, Klebsiella pneumonia etc.

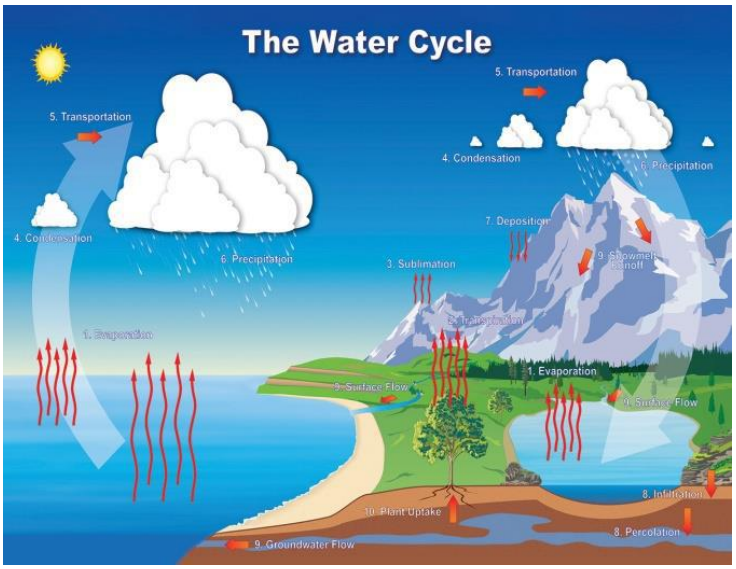


- Denitrifying bacteria Eg. – Pseudomonas.

Hydrological cycle

Processes involved:

- **Evaporation -** conversion of water from liquid to gas stage.
- **Transpiration** - water vapour discharged from plant leaves.
- **Condensation -** the transformation of water vapour to liquid water droplets in the air, forming fog and clouds.
- **Precipitation** - the condensed water vapour falling to the Earth surface.
- **Percolation -** water flows vertically through the soil and rocks under the effect of gravity.
- **Sublimation** - process in which solid water such as snow or ice directly changes into water vapour.
- **Runoff -** is a visible flow of water in rivers, creeks, and lakes.

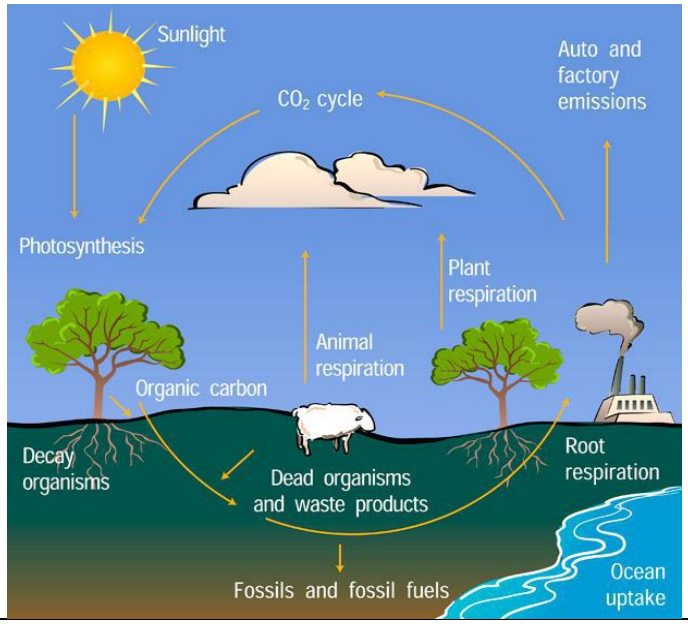


- **Snowmelt -** the runoff created by melting snow.
- **Reservoirs** – Oceans (97.25), Ice caps and glaciers (2.05), Groundwater (0.68), Lakes (0.01), Soil moisture, Atmosphere, Streams and Rivers.

Carbon cycle

Processes involved:

- **Photosynthesis** - by land plants, bacteria, and algae converts carbon dioxide or bicarbonate into organic molecules.
- **Respiration** - animals and plants add carbon dioxide to the atmosphere through cellular respiration.
- **Combustion** – when organic material is burnt, it releases carbon dioxide.
- **Decomposition** - After death, it releases carbon into the air, soil and water.
- **Major reservoirs** – Atmosphere, Oceans, Terrestrial biosphere, Sediments.



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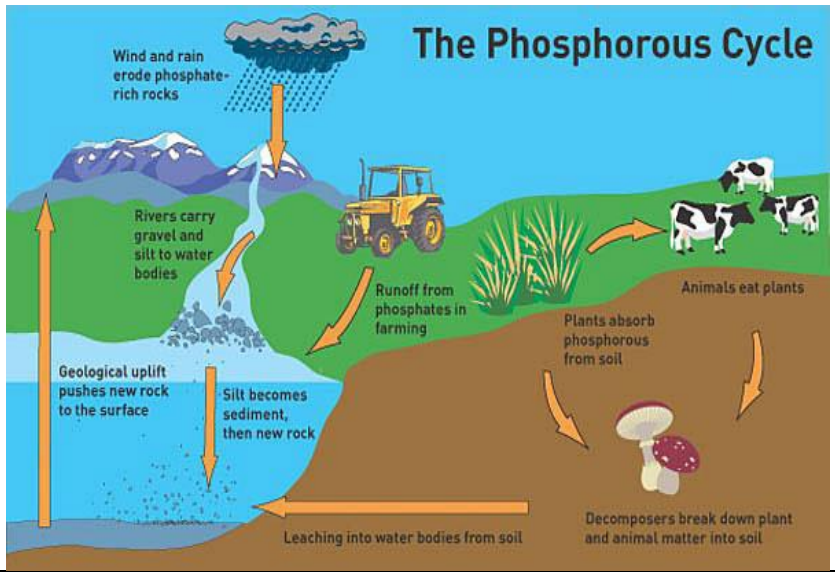
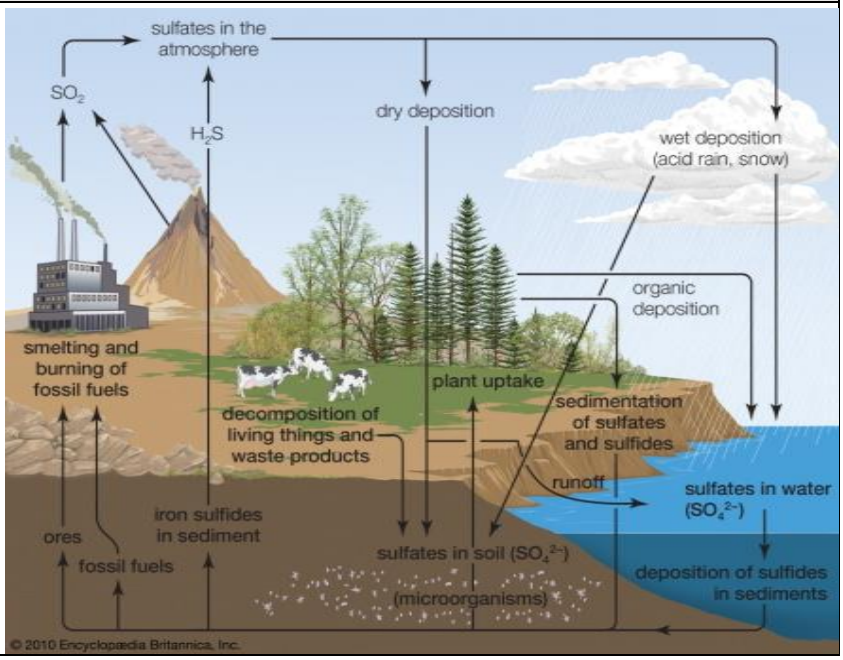
Phosphorus cycle

- **Source** - phosphate rocks, volcanic dust, sediments.
- **Processes** – Weathering, erosion, mining, decomposition.
- On land phosphorus is usually found in the form of phosphates.
- Slow process.
- No real gas phase (less role of Atmosphere).



Sulphur cycle

- **Reservoir** - organic (coal, oil and peat) and inorganic deposits (pyrite rock and sulphur rock).
- **Processes** – Weathering, erosion, mining, decomposition.
- Two of its compounds hydrogen sulphide (H2S) and sulphur dioxide (SO2) add a gaseous component to its normal sedimentary cycle.



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Ecological Productivity	The rate of generation of biomass in an ecosystem is called Productivity, which is expressed in units of energy (eg: joules per meter^2 per day) or in units of dry organic matter (eg: kg per meter^2 per year).
Primary Productivity	Generation of biomass from autotrophic organisms **Gross Primary Productivity:** All the organic matters produced by autotrophs using solar energy. **Net Primary Productivity:** NPP = GPP – Energy lost by respiration.
Secondary Productivity	The accumulation of energy at the consumer's level.
Descending order of ecosystems based on their productivity	**Terrestrial ecosystem:** Tropical rain forests, Swamps, marshes > Temperate forest > Taiga > Savannah > Agricultural land > shrub land > Temperate grassland > Tundra > Desert
	Aquatic ecosystem: Estuaries >Lakes and streams > Continental shelf > Open ocean.

Decomposition process by which organic substances are broken down into simpler organic matter. The term decomposition means "to break down"	**Fragmentation**	It is the initial stage of decomposition. Fragmentation means the breakdown of detritus into smaller pieces by the detritivores.
	Leaching	By the process of leaching, water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
	Catabolism	Various fungal and bacterial enzymes convert the **detritus into simpler inorganic compounds**. This process is called as Catabolism.
	Humification	Process of formation of a dark colored layer of amorphous substance on the soil called humus.
	Mineralization	Process of the degradation of the hummus to release inorganic nutrients.

Essential Plant Nutrients		
Non-mineral		Carbon, Hydrogen and Oxygen
Minerals	**Primary macronutrients**	N, P, K
	Secondary macronutrients	Ca, S, Mg
	Micronutrients	Zn, Cl, B, Mo, Cu, Fe, Mn, Co, Ni

DIFFERENT SPECIES/ORGANISMS

Edge species	Species which occur primarily or most abundantly in the ecotone or boundary junction of two ecosystem. Eg. Birds in grassland
Keystone species	A species that has a disproportionately large effect on its environment relative to its abundance. Eg. Elephants, Wolf, Prairie dog, Bees, Jaguars, Sea otters etc.
Foundational species	A species that has a strong role in structuring a community. A foundation species can occupy any trophic level in a food web.
Flagship species	A species chosen to raise support for biodiversity conservation in a given place or social context. Eg. Tiger for campaign in India.

Umbrella species	These species are very similar to keystone species, but they are usually migratory and need a large habitat.
Pioneer species	Hardy species which are the first to colonize barren environments or previously biodiverse steady-state ecosystems that have been disrupted. Eg. Lichens, lyme grass
Alien species	Is a species introduced outside its normal distribution.
Invasive species	A species which is able to spread beyond its introduction site and become established in new locations.
Invasive alien species	Alien species whose establishment and spread modify ecosystems, habitats, or species. Eg. Lantana Camera, Prosopis juliflora in India etc
Exotic Species	It means alien, non-indigenous, non-native species.
Ecological Equivalents	Organisms that occupy the same or similar ecological niches in different geographic regions.
Endemic species	Species that exist only in one geographic region.
Ecad	Plant species with same genetic stock and physically different. These are reversible.
Indicator species	Any biological species that defines a trait or characteristic of the environment and its problems. Eg. Mosses often indicate acid soil, Lichens indicate air pollution (SO_2).
Generalist species	Species which able to thrive in a wide variety of environmental conditions and can make use of a variety of different resources.
Specialist species	Species which thrive only in a narrow range of environmental conditions or has a limited diet. (narrow niche)
Euryphagic	The species that have a wide range of tolerance for food.
Eurythermal	The species that have a wide range of tolerance for temperature.
Euryhydric	The species that have a wide range of tolerance for water.
Euryhaline	The species that have a wide range of tolerance for salinity.
Stenothermal	The species that have a narrow range of tolerance for temperature.
Endotherms	They use internally generated heat to maintain body temperature. Their body temperature tends to stay steady regardless of environment.Ex. Humans, Polar Bear
Ectotherms	They depend mainly on external heat sources, and their body temperature changes with the temperature of the environment.
Homeotherms	Animals that have a constant body temperature.
Hydrocoles	Aquatic animals that need water like fish.
Mesocoles	Terrestrial animals that need moderate amounts of water.
Xerocoles	Terrestrial animals that can tolerate extremely dry conditions.
Ectotherms	Animals that primarily gains heat through the environment.
Poikilotherms	Animals whose body temperature adjusts depending on the environment.
Autotrophs	Organisms that can produce their own food from the substances available in their surroundings using light (photosynthesis) or chemical energy (chemosynthesis).
Heterotrophs	Organisms that cannot synthesize their own food and rely on other organisms — both plants and animals — for nutrition.
Extremophiles	They are organisms that thrive in unlikely places under extreme conditions, such as environments with intense heat, extremely low oxygen, complete darkness, extreme pressures, and even the vacuum of space. The extremophiles found attached to the Antarctic boulder are both sponge-like as well as 'stalked' or having stalk-like filaments to which their bodies are attached.

CONTEMPARY THEMES

Ecosystem Approach	A strategy for the integrated management of land, water and living resources that places human needs at its centre.
Ecosystem Resilience	Ability of an ecosystem to maintain its normal patterns of nutrient cycling and biomass production after being subjected to damage caused by an ecological disturbance (also ecological robustness)
Ecosystem Restoration	The process of assisting the recovery of an ecosystem that has been degraded,

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	damaged, or destroyed.
Ecosystem-based adaptation (EbA)	• Refers to the set of approaches that involve the management of ecosystems to reduce the vulnerability of human communities to climate change. • The restoration of mangroves and coral reefs, for example, protects coastal areas from the impacts of rising sea levels, while planting and restoring vegetation on hillsides and mountains prevents erosion and landslides during extreme rainfall. • The EbA term was coined at the UNFCCC COP 14 in Poznan in 2008 and since then has successfully been promoted into broader adaptation negotiations, policies, strategies and action plans.
Critical Ecosystem Partnership Fund (CEPF)	• Founded in 2000, the CEPF is a global leader in enabling civil society to participate in and benefit from conserving some of the world's most critical ecosystems. • CEPF provide grants for non-governmental and private sector organizations. • The fund is a joint program of French Development Agency, Conservation International, EU, the Global Environment Facility, Government of Japan and World Bank.
Ecosystem Management Programme (EMP)	• To address ecosystem degradation, IUCN promotes the sound management of ecosystems through the wider application of the Ecosystem Approach through this programme • EMP works on five key programmatic areas - Red List of Ecosystems, Ecosystem based Adaptation, Disaster Risk Reduction, Drylands, Global Island Partnership.
Red list of Ecosystems	• IUCN Compiles information on the state of the world's ecosystems at different geographic scales. • Its central objective is to assess the risk of ecosystem collapse. • This will be measured by assessing losses in area, degradation or other major changes such as land conversion. • Assessments determine whether an ecosystem is not facing imminent risk of collapse, or whether it is vulnerable, endangered, or critically endangered.
Payment for Ecosystems Services	• These are incentives offered to landowners or farmers in exchange for managing their land to provide some sort of ecological service. • It is an innovative approach to nature conservation by arranging payments for the benefits provided by forests, fertile soils and other natural ecosystems. • This encourages the maintenance of natural ecosystems through environmentally friendly practices that avoid damage for other users of the natural resources. In addition to preserving natural resources, this method improves rural areas and rural lifestyles.
Nutrient Challenge	• Nitrogen and phosphorous are key to growing crops and thus play a major role in the world's food security challenge. • To feed a growing world population, we have to intensify our crop production and food security of two-thirds of world's population depends on fertiliser availability and use. • However, in some parts of the world farmers do not have access to enough nutrients to grow crops but in many other parts of the world there is an 'excess' of nutrients in the environment as a result of industrial and agricultural activity and has profound impacts, from pollution of water supplies to the undermining of important ecosystems and the services and livelihoods they support. This is known as nutrient challenge. • Nitrogen use if properly managed enhances soil fertility, and contributes to food and nutrition security and sustainable agriculture. • GPNM has been launched to address this challenge.
Global Partnership on Nutrient Management (GPNM)	• Multi-stakeholder partnership mechanism comprised of diverse entities along with UN agencies committed to promote effective nutrient management to achieve the twin goals of food security through increased productivity and conservation of natural resources and the environment. • It is a response to the 'nutrient challenge' – how to reduce the amount of

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	excess nutrients in the global environment consistent with global development. • It reflects the need for strategic advocacy and co-operation at the global for cost effective policy and investment interventions by countries.
International Nitrogen Initiave	• optimize nitrogen's beneficial role in sustainable food production, and • minimize nitrogen's negative effects on human health and the environment resulting from food and energy production.
Oxygen through Nitrogen Cycle	• A few microbes are known to make oxygen without sunlight, but so far they have only been discovered in very limited quantities and in very specific habitats. • But the ocean living microbe Nitrosopumilus maritimus and its cousins, called ammonia oxidising archaea play an important role in the nitrogen cycle. • For this, they need oxygen. So it has been a long-standing puzzle why they are also very abundant in waters where there is no oxygen. • The researchers found that these micro-organisms make their own oxygen. • It was found that N. maritimus was using the oxygen present in water but the oxygen levels started increasing again in water. • They micro-organisms were able to make oxygen even in a dark environment. Not sufficiently high to influence oxygen levels on Earth, but enough to keep itself going. • maritimus couples the oxygen production to the production of gaseous nitrogen. By doing so they remove bioavailable nitrogen from the environment.

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