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NAME OF SUBJECT: ENVIRONMENTAL STUDIES

SEMESTERS 4 AND 6

CHAPTERS: UNIT 4 AND UNIT 2.

UNIT 4: Biodiversity and Conservation

- **Points of Discussion →**
  - Levels of biological diversity: genetic, species and ecosystem diversity.
  - Bio geographic zones of India; Biodiversity patterns and global biodiversity hot spots.
  - India as a mega – biodiversity nation; Endangered and endemic species of India.
  - Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions;
  - Conservation of biodiversity: In – sites and Ex-sites conservation.
  - Ecosystem and biodiversity serviced: Ecological, economic, social, ethical, aesthetic and informational value.

I. Levels of Biological Diversity:

Biological diversity refers to the richness in variety and variability of species of all living organisms in a given habitat. Thus, it deals with the degree of nature's variety in the biosphere. The variety can be described at three levels →

(a) Genetic diversity

(b) Species diversity

(c) Ecosystem diversity

The term 'biological diversity' was invented by Thomas Lovejoy in 1980 and the term 'biodiversity' was introduced by water G. Rosen in 1985.

Biodiversity includes genetic diversity, species diversity and ecosystem diversity. They can be described as follows:

(a) Genetic diversity: It refers to the variation of genes that occur within the species. Each member of any plant or animal species is distinct from others in its genetic makeup. Each organism has its own specific characteristics due to large number of combinations possible in the genes.

(b) Species diversity: It is the number of species of plants and animals present in a region and their diversity, in the given space. It is measured by species richness. The richness in species differs widely from one area to another. These areas that are rich in species diversity are called hotspots of diversity. India is among the world's 15 nations which have rich species diversity.

(c) Ecosystem diversity: It is the variation in different types of found ecosystem found within a particular region. Ecosystem diversity can be specified for a geographical region, country or state. Eg: Sunderban forests which include forests, wetlands, estuaries and rivers.

II. Biogeographic Zones of India

India is one of the most diverse regions of the world and is among the 12 mega – biodiversity countries of the world. The bio –geographic classification of India was carried out by Rodgers and Panwar (1988). The diverse and varied conditions across the country led to classification into 10 bio – geographic zones, which are as follows :

A. Trane – Himalayan Region →

This region covers around L.S million km2 of area within and outside of India. It is a vast stretch of cold, mountainous snow – covered region covering the entire Tibetan plateau, Ladakh and Lahul – Spiti district of Himachal Pradesh (India). Vegetation is sparse in this area. The mountains here have the richest habitat of wild sheep and goats. The region has a herbivore community (rabbits) consisting of Tibetan antelope, gazelle, wild yak and blue sheep. Other characteristic animals found are snow leopard, Tibetan wolf, ibex, marbled pole cat, Himalayan marmot etc.

B. The Himalayan Rangers →

This region extends from Jammu and Kashmir covering Himachal Pradesh, Sikkim, WB, Arunachal Pradesh, Mizoram and Assam to Manipur. They represent the world's youngest and highest mountain chains. The western Himalayas stretch from central

region of Kumaon to North West region of Kashmir. On the other hand, the Eastern Himalayas extend from Sikkim to NEFA. Rainfall is higher and conditions are warmer in the eastern part of Himalayas. Species diversity is also higher in the eastern part. Thus, there is a lot of variation in geology and climatic conditions in this zone.

Flora present in this region consists of Coniferous – pine forests, birch forests, oaks, magnolias, rhododendrons, chestnut, fir, junipers etc. Alpine pastures are predominant in the western Himalayas.

Fauna present in this region include Red panda, ibex, Hangul stag, snow leopard, serow, Goral, Himalayan Tapir, badgers, tapir, shrew etc. A large and rich diversity of animals are found in the Himalayas However, they are endangered as a result of habitat destruction.

C. Western Ghats

This region is one of the hotspots of India and stretches from southern tip of Indian peninsula to Tapti river in the north. The average altitude of mountains in this region is around 1,200m. The Western Ghats cover the states of Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu.

This zone has highly rich biodiversity. The rainfall is heavy and exhibits mostly moist evergreen forests. Apart from evergreen forests, deciduous forests and mangrove forests are also present. Many major rivers originate from Western Ghats such as Godavari, Kaveri, Krishna and Tungabhadra. These rivers are the source of hydro – electricity generation and irrigation projects.

The Western Ghats are characterized by many endemic species. Significant species present in this region are Malabar Civet, Nilgiri Languor, Lion – tailed macaque, Niligiri tahr, Malabar grey hornbill, gaur etc. The hill ranges also form an important part of Project Elephant and Project Tiger reserves.

D. The Desert Regions :

This region consists of parts of Rajasthan, Kutch, Delhi and parts of Gujrat. The Climate is characterized by extremely hot and dry summers and cold winters. Rainfall is less than 70 cm. Kutch, Thar, Ladakh and parts of Delhi comprises the desert gone.

Xerophytic plants are found in this region such as Acacia nelotica, Tecomella spp. Salvadora oleoides, prosopis cineraria, Babul, Kikar and wild palms.

Fauna present are Great Indian Bust and (endangered) blackbuck, camels, desert fones, Chinkara, nilgai, Indian desert Cat, Lizards etc. Flamingoes are extensively found in Rann of Kutch.

E. The Deccan Plateaus :

The Deccan plateau cauets the largest area in the country among all biogeographic zones. It comprises Deccan plateau (south), Central plateau, East plateau, Chota Nagpur and Central Highland. It consists of dry deciduous forests and produces many forest products. Evergreen forests are very rare in this area. Trees like Sal, teak, Acacia are found here mainly.

Fauna present here consists of Tigers, sloth bear, nilgai, sambar, chital, eleplhant, wild buffaloes, barasingha and gaur.

It is the catchment area for rivers like Narmada, Tapti, Mahanadi and Godavari.

F. The Gangetic Plain :

The Gangetic Plains are the most fertile region and comprises the regions of uttar Pradesh, Bihar and Bengal. The plains are fertile due to alluvium sediments deposited across the region by rivers. The region has high population density and orgiculture is an important occupation. Ganga is the main river system here alonggeuidh Brahmaputra. Rainfall is varied across the region.

Important trees found in this region includes sal, mahua, arjun, teak, shishan, neem, khair, tendu etc. Animals found are elephant, black buck, buffalo, gazelle, chinkara, freshwater turtle, Bengal florican etc.

G. North – East India :

This is one of the hotspots of India and is richest in terms of vegetation and species. It is distributed in the states of Assam, Meghalaya, Nagaland, Manipur, Mizoram and Tripura. The region is actually a transition zone between the Indian, Indo – Burma and Indo – Chinese region. Rainfall is high and presence of evergreen and semi – evergreen forests are abundant.

Animals found here are rhinoceros, buffalo, elephant, swamp deer, pygmy hog, elephants, hornbill and many more. Floral species include orchids, bamboos, ferns, banana, diverse fruits etc.

H. Islands :

This zone comprises the islands of Lakshadweep and Andaman and Nicobar. The Andaman and Nicobar Islands are situated in Bay of Bengal. It is one of the hotspots

of India. They have a wide variety of mangroves, evergreen, and deciduous forests. Species richness is the characteristic of the island with distinct faunal species. Animals residing in this region include Andaman water monitor, Nicobar macaque, Narcondam hornbill, Nicobar parakeet etc.

Lakshadweep Islands are located in the Arabian Sea and exhibits evergreen forests. They form a distinct botanical region and contain many coral reefs. Faunal species include sea turtles, pygmy blue, orca, crabs, lobsters and pelagic birds.

I. The Semi – arid area :

This zone comprises the states of Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujrat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu.

Floral components include grasses, shrubs, thorny scrubs and bamboo trees. Trees include Tectonia grandis, Acacia, Anogeisus, Capparis, and Caltrops etc.

Herbivores like blackbuck, nilgai gazelle etc. are present. Other animals include jackals, leopards, fones, snakes, lions etc. The Asiatic lion is the endemic species found in the air national reserve.

J. Coasts :

India has a vast and elaborate coastline of approximately 7,500 km along the Arabian Sea in the west and the Bay of Bengal in the west.

The western coast is much narrower than the East coast. They have an average width of about 65 km. It extends from Gulf of Cambay in the north to Cape Comorin (Kanya kumari). It is characterised by the presence of estuaries, lagoons and backwaters. The largest lake present have is Vembanad lake.

The eastern coastal plains extent from Subarnarekha river to Kanyakumari. It is formed by alluvial fillings of rivers like Mahanadi, Godavari, Krishna and Kaveri. They are wider and extensive than the western coats with an average width of 120 km.

The Coastal plains are covered by fertile soils on which a variety of crops are cultivated. Rice is the main crop of these areas. Coconut trees grew along the coast. This region has high tiger population along with the presence of animals like Dugong, dolphins, salt-water crocodile, marine turtles, tortoises, hump – back dolphin etc.

IV. Threats to Biodiversity:

(1) **Habitat loss** → The primary cause of loss of biodiversity is habitat destruction, resulting from expansion of human population. Loss of habitat, habitat degradation and fragmentation represents significant causes of known extinctions – continuous increase of deforestation in the tropical forests has become the chief cause of mass extinctions. Fragmentation of landscape by construction of roads, infrastructure also results in biodiversity loss. Environmental fluctuations, disease outbreak leads to extinction of small isolated habitats.

(2) **Poaching of Wildlife** → Wildlife is being continuously hunted and poached for food, profit and other needs. This illegal trade in projected species operates as one of the most profitable illicit markets in the world. Specific invests to certain animals are related to large economic benefits. The skin and bones of tigers, ivory of elephants, horns of rhinos and perfume of the musk deer are extensively used and in high demand. Corals and shells are collected for export on beaches of Chennai, Kanyakumari and A. Nicobar Islands. A variety of wild plants with medicinal values are being overharvested eg : Nux Vomica, Datura.

(3) **Man – Wildlife Conflicts:** The loss of species occur due to the destruction of natural ecosystems, either for conversion to agriculture or industry by humans. Human – wildlife conflict is defined by the world wide Fund for Nature (WWF) as 'any interaction between humans and wildlife that result in negative impacts on human, social, economic or cultural life, on the conservation of wildlife populations, or on the environment. As human populations expand into wild animal habitats, natural wildlife territory is displaced.

(4) **Biological invasions:** The introduction of exotic or invasive species is a significant reason of extinction. Great majority of invasive species do not become established in the new environment. Alien species become 'invasive' when they displace the native species and upset the ecological balance. Same successful exotic species may kill or eat native species to the point of extinction; or may 80 after the habitat that many natives are no longer able to persist. Non – native invasive species are particularly destructive on islands.

eg : Introduction of Nile Perch in Lake Victoria has made way for extinction of most of the indigenous species.

Ship Rat (Rattus rattus) has caused declines of native birds on islands in the Indian subcontinent.

African apple snail (Achatina fulica) us the most invasive among allalien fauna in India.

V. Conservation of Biodiversity: In – sites and Ex – sites conservation of biodiversity.

In – Sites Conservation → It refers to the protection and maintenance of organisms in their natural habitats. In this type of conservation isolation of organisms is not required but it requires elimination of harmful factors in the ecosystem. In-sites Conservation is practised in the form of sanctuaries, National Parks and Biosphere Reserves.

Ex – Sites Conservation of components of biodiversity outside their national habitats. Species are conserved outside their natural habitats in a carefully controlled situation such as botanical garden for plants, a zoological park for animals. It is beneficial for species which are on the verge of extinction and must be immediately projected.

- **Examples of Wildlife Sanctuaries** →
  (1) Dachigam Sanctuary (Hangul/Kashmiri Stag)
  (2) Keoladeo Ghana Bird Sanctuary (Bharatpur) → Most famous water – bird sanctuaries in the world.
  (3) Manas Wildlife Sanctuary in Assam : Rare golden langur, Rare pygmy hog.
  (4) Periyar Wildlife Sanctuary, Kerala.
- **Examples of National Parks** →
  (1) Corbett National Park (Uttrakhand) [1936]
  (2) Kaziranga National Park (Assam) [1974]
  (3) Bandhavgarh National Park (M.P) [1968]
  (4) Sunderbans National Park (Rajasthan) [1981]
- **Examples of Biosphere Reserves :**
  (1) Nilgiri Biosphere Reserves: Tamil Nadu, Karnataka, Kerala. [1986]
  (2) Great Rann of Kutch : Gujarat [2008]
  (3) Nandadevi : Uttrakhand [1988]
  (4) Nokrek : Meghalaya [1988]
  (5) Panna : Madhya Pradesh [2011]
  (6) Sunderban: West Bengal, 1989.

VI. Ecosystem and Biodiversity Services:

- **Ecological Value :**
  (a) Safeguarding water resources through maintenance of water cycle.
  (b) Recycling of nutrients and storing.

(c) Degradation of Pollutants and its incorporation.
(d) Restoring Climate and preserving ecosystem.
(e) Protection of Soil.
(f) Resilience from unpredictable events like Tsunami, earthquakes and wildfires.

- **Economic Value :**
  (a) Direct utilisation of timber, food, fuel wood and fodder by local communities.
  (b) Biodiversity contained in the ecosystem provides forest dwellers with their daily needs food, material, medicines and other products.
  (c) Dried biomass and the petrified products of coal, petroleum and natural gas that serve as fuel are all derived from biodiversity.
  (d) Different varieties of creeds, pulses, vegetables, spices etc. comes directly from the diverse forms of wildlife.
  (e) Wildlife trade, farming and extraction of medicinal products are other benefits.
- **Social Value :**
  (a) Biodiversity has been presented by traditional societies till today. For example, many of the plants like banyan, peepal, tulsi etc. and animals like cow, snake etc. are regarded as holy and served.
  (b) Policy measures and resources utilization should be implemented in the aspect of social value.
  (c) Indian lifestyle, songs, dance, scriptures and customs are closely related with wildlife.

- Ethical Value :
  (a) Ethical values related to biodiversity are based on importance of protecting all forms of life.
  (b) All species were created equal and have the moral right to live, procreate and grow. However, being at the top of the food chain, humans have played havoc with the fragile ecosystems.
  (c) Humans should take a holistic view of the consequences of their actions and do things that are sustainable, inclusive and honour the rights of every living organism.
- Aesthetic Value :

(a) The appreciation of the presence of biodiversity for its inherent value and beauty.

(b) Biodiversity is instrumental in promoting the tourism industry. Tourists from all parts of the world spend a lot of money to visit the wilderness. They enjoy the tranquillity, the natural and the aesthetic beauty of the forests and wildlife.

(c) Plants and animals are often used as symbols in paintings, flags, sculptures, stamps etc.

(d) Species like Asiatic lion, panda are chosen as flagship species for their attractiveness and distinctiveness to represent an environmental cause.

Unit 2: Ecology and Ecosystem

- Points of Discussion :

1) Concept of Ecology and Ecosystem
2) Structure and Function of Ecosystem
3) Energy Flow in an Ecosystem
4) Food Chains and Food WEBS.
5) Basic Concept of Population and Community Ecology.
6) Ecological Succession.
7) Characteristic Features of the Following :
   (i) Forest Ecosystem.
   (ii) Grassland Ecosystem
   (iii) Desert Ecosystem
   (iv) Aquatic Ecosystem. (Ponds, streams, lakes, wetlands, rivers, oceans, estuaries).

1) Concept of Ecology and Ecosystem :

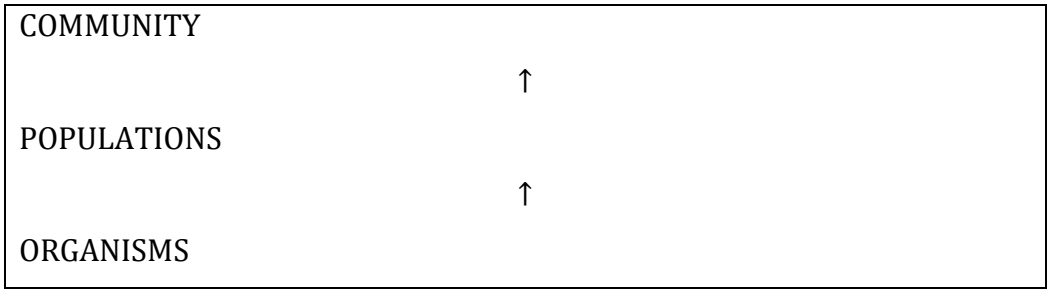
- Ecology: It is a branch of science which deals with the study of animal and plant inter-relationship and also their relation to the surrounding environment. The term was introduced by Hans Reiter, a German scientist, by combining two words 'Oikos' (house or dwelling place)' and 'logos' (to study). Ernst Haeckel in 1866 first used and defined the term in his book "Morphology of organisms" as – "By Ecology we mean the body of knowledge concerning the economy of nature – the total relations of the animal to both it's inorganic and organic environment".
- Some Definitions of Ecology :

- Andrewartha (1961) defined ecology as the "scientific study of the distribution and abundance of organisms".
- Odum (1963) defined ecology as "the study of the structure and function of nature".
- Charles J. Krebs (1978) proposed a practical version of Andrewartha's definition and defined ecology as the "Scientific study of the interactions that determine the distribution and abundance of organisms".

- The two subdivisions of ecology are autecology and synecology :
  (a) Autecology – Deals with the study of individual organisms or spices in an environment.
  (b) Synecology – Deals with the study of a group of organism in relation to the environment.
- Realm of Ecology :

  The following five levels of organisation make up the realm of ecology →
  (a) Organism/Individual: It is the lowest level of organisation which includes any form of life with cell as its basic unit.
  (b) Population: Denotes a group of individual organisms of the same species in a given area. Populations include individuals of the same spices, but may have different genetic makeup.
  (c) Community: It includes all the populations of different spices residing together in a specific area at a given time.
  (d) Ecosystem: The community of living organisms (biotic) interact with the non-living (abiotic) factors and together form the ecosystem. Thus an ecosystem consists of the whole biotic community in a given area plus its abiotic environment.
  (e) Biosphere: All the ecosystems functioning in Earth combine together to form a giant, closed, self-sufficient biological system, known as the biosphere.

BIOSPHERE ↑ ECOSYSTEMS ↑



Levels of Organisation

- Ecosystem: The living organisms and their non – living environment are inter – related and interact with each other closely to form a system. The biotic and abiotic components are linked through nutrient cycles and energy cycles. This ides of ecosystem was first introduced by the British ecologist, A.G.T ansley in 1935. He defined the term ecosystem as "the system resulting from the integration of all living and nonliving factors of the environment". The concept of ecosystem is based on the interactions and exchanges of materials. It gives importance to both the structural and functional aspects. An ecosystem is the basic functional unit in ecology and it includes both organisms and their abiotic environment. Thus, ecosystem represents the highest level of ecological integration.
- Some Definitions of Ecosystem :
  - Woodbury (1954) – "Ecosystem is a complex in which habitat, plants and animals are considered as one interesting unit, the materials and energy of one passing in and out of the others".
  - E.P. Odum – "The ecosystem is the basic functional unit of organisms and their environment interacting with each other and with their own components".
  - Chapin et al (1997) – "Populations do react to environmental stimulus and so ecosystems can also be defined by biota and by the environment".
- Types of Ecosystems :

  (a) Natural ecosystems: These ecosystems operate independently under natural existing conditions without any disruption from external factors (human interference).

  These ecosystems may be further dividend as:

  (i) Terrestrial ecosystems e.g.: forests, grasslands and deserts.

(ii) Aquatic ecosystems: They include both freshwater and marine ecosystems.

- Freshwater ecosystem consists of Lotic (running water as springs, streams or rivers) and lentic (standing water like lakes, ponds, swamps, ditches etc.)
- Marine ecosystems include oceans, sea bodies, estuary etc.

(b) Artificial (Man – cultured) Ecosystems: These ecosystems are maintained and managed artificially by humans. In these cases, man tries to control the biotic community as well as the physico – chemical environment e.g.: croplands, orchards, farmlands, garden etc.

2) Structure and Function of Ecosystem :

The structure of an ecosystem includes:

- The composition of biotic community which comprises spices diversity, their numbers, biomass and distribution.
- The amount of non – living materials (nutrients, water) and their distribution.
- The conditions of existence, i.e. temperature PH level intensity of sunlight etc.

The function of an ecosystem includes:

- Rates of energy flow i.e. the productivity and respiration rates.
- Rates of nutrient (material) cycles e.g.: Carbon, nitrogen, phosphorus etc.
- Ecological Regulation → Regulation of organisms by the environment and vice-versa.

In an ecosystem, the structure and function are inter – related and considered to be one unit.

- Components of Ecosystem :

  An ecosystem has the following two major components:

  (a) Abiotic (Non – living) Component: The non – diving factors or the physical environment prevailing in an ecosystem form the abiotic components. They have a strong influence on structure, distribution and inter – relationships of organisms. They include –

  - Inorganic substances (C, N, H, P, S, O) involved in nutrient cycles.
  - Inorganic chemicals e.g. : Chlorophyll,
  - Organic materials e.g.: Proteins, fats, vitamins, coenzymes etc.

The quantity of inorganic substances present of any given time in the system is known as standing state or standing quality.

(b) Biotic (living) components: The various living organisms (plants, animals, micro organisms) inhabiting the ecosystem from the biotic components. They are distinguished on the basis of their nutritional relationships, such as :

(i) Producers (Autotrophs) – These organisms have the ability to fix light energy and manufacture their own food from simple inorganic substances (H_2O, Co_2) by the process of photosynthesis. They include mainly green plants, algae, planktons, photosynthetic bacteria, chemosynthetic microbes etc.

(ii) Consumers (Heterotrophs): These organisms lack chlorophyll and 80 unable to synthesize their own food. They obtain nutrition and energy by feeding upon other organisms. The consumers are of the following two types →

- Macro consumers: They are phagotrophs and feed on other organism or particulate organic matter. In order of their occurrence in the food chain they are – herbivores (food on plants), carnivores (feed on other animals) and omnivores (feed on both plants and animals). Herbivores are also known as primary consumers. Carnivores and omnivores fall in the category secondary and tertiary consumers.
- Micro consumers: These are microscopic heterotrophic organisms also known as decomposers or saprotrophs. Micro consumers comprise bacteria, actinomycetes, fungi, small insects etc. They obtain energy from decomposed organic remains and wastes of other organism. During the process of decomposition of complex organic compounds, they release inorganic nutrients in environment, which can be utilized by the autotrophs again.

The function of an ecosystem includes: (mentioned before).

The function of an ecosystem is based on energy flow, exchange and the cycling of nutrients. Theses exchanges help to sustain life on planet and production of biomass. Ecosystem functions are essentially an integral part of ecological process and structures. The two ecological processes of energy flow and material cycling involves interaction between the physical environment

and the biotic components. The energy flow through the ecosystem is unidirectional whereas the minerals keep circulating in a cyclic manner.

- Productivity of an Ecosystem →

The amount of biomass (biological material) produced in a specific area during a given period of time denotes the productivity of an ecosystem. It is expressed in mass per unit area (or volume) per unit time.

E.g.: grams / square metres/day . A constant input of solar energy is required for any ecosystem to sustain.

Productivity at producer level (plants) is called primary productivity, whereas at consumer levels (animals) it is known as secondary productivity.

(i) Primary productivity: This type is generally associated with autotrophs (green plants), phytoplankton, photosynthetic bacteria, blue – green algae etc. These organisms have the ability to manufacture new organic materials from inorganic molecules such as H_2O and Co_2 by the process of photosynthesis. Photosynthesis is chiefly responsible for primary productivity as it sustains all subsequent life processes of other organisms. It is defined as "the rate at which radiant energy is stored by photosynthetic and chemosynthesis activity of producers".

It is of the following two types →

- Gross primary productivity: It is the total rate of organic matter produced during photosynthesis. A significant amount of GPP is used by plants for respiration. It is also known as total photosynthetic or total assimilation.
- Net primary productivity: Gross primary productivity (GPP) minus respiration losses CR is the net primary productivity (NPP).

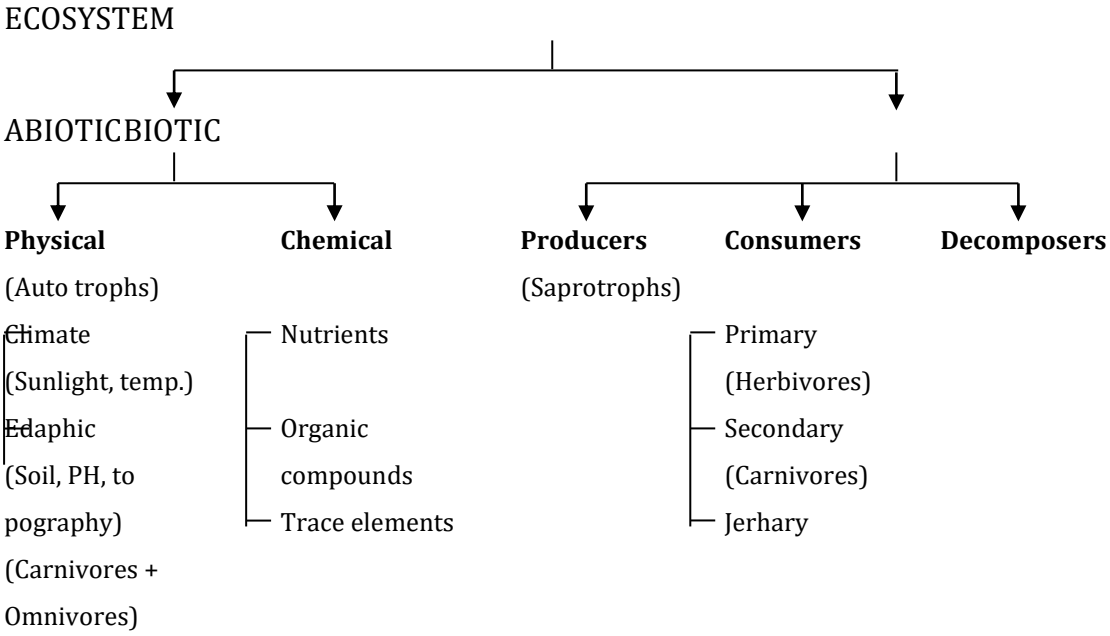
NPP = GPP – R

NPP can be measured as the difference between the rate of photosynthetic by plants and their rate of respiration. Thus, NPP is the rate of storage of organic matter in plant bodies in excess of the respiratory utilization by plants during the measurement period. It is also known as apparent photosynthesis or net assimilation.

(ii) Secondary productivity: This refers to the productivity at the consumer level. It is the total amount of energy assimilated by consumer organism. It can also be

referred to as the net rate of increase in biomass of consumers. Consumers utilize already produced food materials in their respiration and also convert primary organic matter into animal tissue per unit area in a given time.

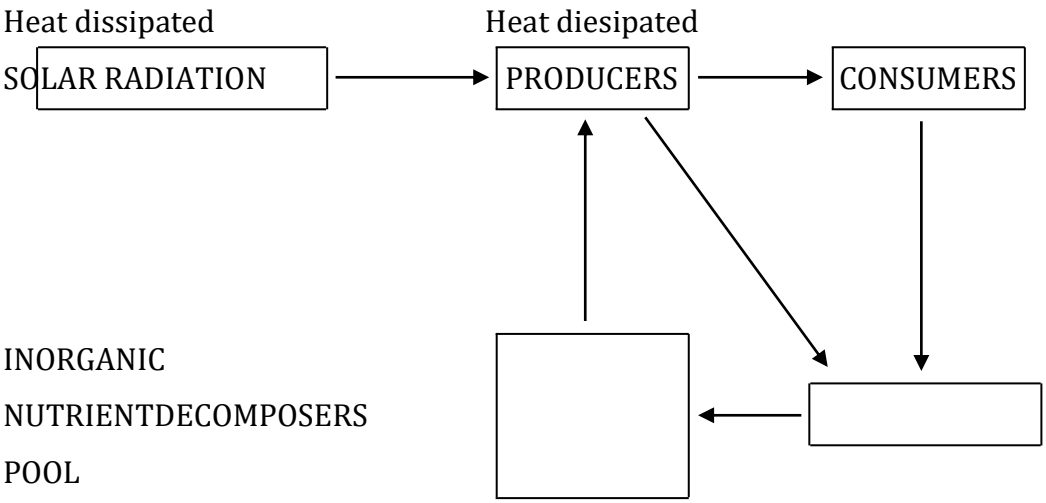
(iii) Net Productivity: The assimilated energy of the consumers is utilized in cellular respiration. All of the biomass is not consumed by the animals. Some are released in the form of faeces. Thus, the rate of storage of organic matter not used by the heterotrophs during the unit period of time (season/month/year) is the net productivity. It is expressed as production of ($g/m^2/day$). The period of time may be monthly, seasonal or yearly.



3) Energy Flow in an Ecosystem :

All living organisms including human beings require energy to exist and perform essential functions. Solar radiation is the major source of energy for almost all organisms. Less than 50 percent of incident solar radiation is photo synthetically active radiation is photosynthetically active radiation (PAR). Autotrophs have the ability to fix sun's radiant energy to make food from simple inorganic materials. Plants capture only 2 – 10 percent of the PAR and this miniscule amount supports all living organisms on Earth. Thus, Energy flow is the unidirectional transfer of energy through a series of organisms up the trophic

level. There is a progressive decrease in energy content at each trophic level due to dissipation of heat used up in metabolic activities.



Energy Flow in an Ecosystem

The flow of energy in an ecosystem is governed by the following laws :

(a) First Law of thermodynamics: Energy can neither be created nor destroyed but can only be transformed from one form to another. True, in a system total inflow of energy should be equal to total output of energy.

(b) Second Law of thermodynamics: The energy transfer in a system is always followed by a dissipation of energy into unavailable heat (i.e. entropy).

4) Food Chains and food WEBS :

Trophic Structure: Trophic structure demonstrates the various feeding levels in the biotic community in an organised and systematic manner. The organisms are classified into different trophic levels based on their nutritional habits. This pattern of organization helps in the transfer of energy through a series of organisms.

The Trophic Levels:

- 1^{st} → Primary Producer (Autotrophs / Green plants).
- 2^{nd} → Primary Consumer (Herbivores)
- 3^{rd} → Secondary Consumer (Carnivores / Omnivores)
- 4^{th} → Tertiary Consumer (“)

Food Chain: Food chain is a linear arrangement illustrating the flow of energy through a series of organisms which feed upon one another. The energy is transferred in a systematic manner up the various trophic levels. Autotrophs

(Green plants) occupy the first trophic level as they have the ability to fix sun's radiant energy. In any food chain energy flows in the following manner →

Primary Producers → Primary Consumers → Secondary Consumers

Tertiary Consumer

At each level in the food chain, a significant amount of energy is lost due to metabolic activities of the organisms.

Food chains can be of the following two types:

(a) Grazing food chain → This type of food chain starts from living green plants, goes to grazing herbivores (i.e. organisms eating living plants) and finally to carnivores (animal eaters).

Ecosystems with such type of food chain are directly dependent on influx of solar radiation. This type of food chain thus depends on autotrophic energy capture and the movement of this captured energy to herbivore. Usually, most of the food chains in nature are of this type.

eg : Grasses → Rabbit → Fox → Lion

(Producers) (Herbivores) (Carnivores) Jertiary Consumers

PrimarySecondary ConsumerConsumer

(b) Detritus food chain → This type of food chain begin with dead organic matter, which is fed on by microorganisms to detritivores to organisms feeding on detritivores. This type is less dependent on direct solar radiation. The detritus food chain is more complex.

Food Web: The concept of food web was first introduced by Charles Elton food chains exist in an ecosystem. These food chains cannot operate independently but are interlinked to each other in an organized manner and function simultaneously. It depicts how energy flows between various organisms residing in an ecosystem.

5) Basic Concept of Population and Community Ecology

- Population ecology: It is the study of population dynamics in relation to the environment, including environment influences on population density and distribution, age structure and population size.

The density of a population is measured as the number of individual per unit area or volume.

Ecologists use a variety of sampling techniques to estimate densities and total population sizes. Demography is the statistical study of factors that affect population density and dispersion patterns of human beings. In population ecology units of study are individuals of a single species.

- Community ecology: Here the units of study are groups of individuals belonging to different species plants as well as animals. Populations that interact within a given habitat form a community. The number of spices occupying the same habitat and their relative abundance is known as the diversity of the community. Scientists study ecology at the community level to understand how species interact with each other and compute for the same resources. It is also known as synecology.

6) Ecological Succession :

Studies by ecologist have shown that there have been gradual processes of change in ecological communities. Ecological succession is the process of change through which an ecological community evolves over time towards a stable condition. These changes are fairly predictable and progressive in nature. The time range can be years, decodes or even hundreds of years. Along with the changes in species composition, of the community the physical and chemical environment of the area also changes. The community moves towards a stable condition known as “Climax”.

- “Climax Community”: In the concept of ecological succession, ecosystems advance until they reach a climax community. In the climax community, all of the resources are efficiently used and the total mass of vegetation maxes out. Many forests that have been undistributed in many years are examples of a climax community. It is a stable community dominated by a small number of prominent species.
- Why does this change occur?

  Every species has a set of environmental conditions under which it will grow and reproduce most optimally. When the conditions of an environment change suddenly and drastically the existing species are dominated by another set of new species which are most suited to the new environment.

Two basic types of succession are as follows →

(a) Primary Succession: The series of community changes which occur in an entirely new habitat that has never been colonized before. Primary succession happens when new land is formed or bare rock is exposed, providing a habitat that can be colonized for the first time.

eg: Primary succession may take place in newly formed islands, or new volcanic rocks exposed by volcanic eruption.

(b) Secondary Succession: It occurs after a disturbance disrupts ecosystem processes and removes part of the existing biotic components. Thus the series of community changes takes place in a previously colonized, but disturbed or damaged habitat. Disturbances such as forest thinning, floods, forest fires and wind can all lead to secondary succession.

eg : Oak forests are cleared by wildfire in an ecosystem. Wildfires will burn most vegetation and kill animals unable to flee the area. Their nutrients, however, are returned to the ground in the form of ash. Since, the disturbed area already has nutrient – rich soil, it can be recolonized much more quickly than the bare rock of primary succession.

7) Characteristic Features of the Following :

(i) Forest Ecosystem

(ii) Desert Ecosystem

(iii) Grassland Ecosystem

I. Forest Ecosystem →

(i) Forests occupy roughly 31% of the Earth's land. In India forests occupy about 24.39% of the total geographical area of the country. Forests are among the most complex ecosystems in the world.

(ii) Forests assist in maintaining climatic conditions and rainfall of a particular area. Soil is rich in organic matter and minerals.

(iii) Forest canopy is an important distinguishing feature. IT denotes the top portion of a community of trees. This serves as a connection between the gaseous atmosphere and land. Moet organisms are able to survive in forest canopy because it is directly in contract with sunlight and water.

(iv) Forest floor is another distinct feature. It comprises fallen leaves, stems, branches and bark on the surface of soil. Many microorganisms also occupy the forest floor increasing the nutrient and mineral content of the soil. The major part of the nutrients of the forest ecosystem comes from forest floor due to decomposition of organic substances.

(v) Forest Soil → Soil type in various forests differs widely. The soil of temperate forests is much more fertile as leaves drop to the ground every winter. This litter contributes to increase of organic matter. On the other hand, soil in tropical rain forests has poor quality because of torrential rains. The rains dissolve the soil nutrients before trees can benefit. Decomposition by microorganisms enriches the forest soil.

(vi) The forest ecosystem supports the existence of many wild organisms and thus helps in protecting the biodiversity.

(vii) Penetration of light is fast, so conversion of organic matter into nutrients is fast.

II. Desert Ecosystem :

(i) Deserts occupy about 17 percent of our world's land area and about 10 percent of total geographical area of India.

(ii) Rainfall is very irregular. Annual rainfall is less than 25 centimetres (10 inches).

(iii) Abiotic components are characterised by low amount of nutrients in soil, scarcity of water, and high fluctuation in temperature.

(iv) In deserts many succulent (e.g. Cacti) plants are present along with shrubs, bushes and few xerophytic trees. They have water stored inside them to stay alive and a waxy layer externally to protect them from sun.

(v) The most common animals found are reptiles and insects, able to persist under xeric conditions. In addition, some nocturnal rodents and birds are also found. The ship of the desert', camels food on tender shoots of the plants. Some thermophillic fungi and bacteria are present.

(vi) The soil is very poor in nutrients and organic matter. So, vegetation is also poor.

(vii) High degree of fluctuations in day and night temperatures and also in seasons.

(viii) High wind velocity because of open spaces.

(ix) Highly arid conditions due to lack of water vapour in air.

(x) Soil is loose, sandy, devoid of organic carbon, nitrogen, moisture etc.

(xi) Solar radiation is very intense due to absence of clouds.

(xii) Drought is an important feature. The duration of drought is long in the extreme arid-zone and decreases towards the margins. Drought is a prolonged period of abnormally low rainfall, leading to a shortage of water.

(xiii) A few of world's deserts are → Sahara Desert, Sunoran Desert, Mojave Desert, Atacama Desert, Thar Desert, Gobi Desert, Siberia (cold does not) etc.

III. Grassland Ecosystem :

(i) Grasslands occupy around 19 to 25 percent of the Earth's surface. In India, they occupy 24 percent of the geographical area. A grassland is a type of ecosystem dominated by grasses and other Herbaceous (non – woody) flowering plants and a variety of scattered trees and bushes.

(ii) Grasslands are highly dynamic ecosystems.
They are of mainly two types →
Tropical Grasslands (Savannah) → located near Equator
Temperate Grasslands →
(i) Pampas (south America)
(ii) Prairies (North America)
(iii) Steppes (Central Asia)
(iv) Veldt (Africa)

(iii) Grasslands occur in areas where there is not enough rainfall to support the growth of a forest, but not so little as to form a desert. On an average they receive around 25 – 75 cm rainfall per year. In such low amount of rainfall big trees cannot survive. Mean annual temperature is between 0^{o} C and 25^{o}C.

(iv) Grasslands separate forests from deserts. Grasslands act as barrier towards desertification of land as they have plants which bind the soil and prevent erosion of the land.

(v) No other habitat is agriculturally as useful to humans as grasslands. Soils tend to be deep and fertile. Much of the North American Prairie Lands have been converted into one of the richest agricultural regions on Earth.

(vi) Savannahs have scattered trees and predominate in certain parts of Africa, South America and Asia. Temperate grasslands are largely devoid of trees, receive less rainfall than Savannah's and exhibit broader temperature extremes.

(vii) In tropical grasslands, growing season is usually in the monsoon. In temperate grasslands, the growing season is usually the short period between the cold, damp winter and the hot, dry summer.

(viii) The animals that live in grasslands have adapted themselves to the dry, windy conditions with time.

(ix) There is a large variety of animals found in tropical grasslands, especially Africa. Over forty different species of animals are found in African Savannahs. e.g.: Impala, Zebra, Elephant, Lion, Leopard and Cheetah.

The temperate grasslands have lower diversity of animal species in comparison to the tropical regions. e.g.: Some of the animals found here are → Bison, Antelope, Coyote, Wild horse and Polecats.

(x) Examples of Grasslands in India → Himalayan Pasture belt/semi – arid plains of Western India, Central India and the Deccan are covered by grassland tracts with patches of thorn forest.

Unit 2 → Ecology and Ecosystems (MCQ's)

(1) The term ecosystem was coined by →

(a) Ernst Haeckel (b) A.G. Tansley

(c) Fourier (d) H. Reiter

(2) The term ecology was coined by →

(a) Alexander Fleming (b) A.G. Tansley

(c) Ernst Haeckel (d) H. Reiter

(3) Which of the following fall under functional aspect of Ecosystem →

(a) Producers (b) Climatic factors

(c) Energy cycles (d) Micro - consumers

(4) Which of the following fall under structural aspect of Ecosystem →

(a) Saprotrophs (b) Food chains

(c) Evolution (d) Energy cycles

(5) Ecosystem comprises :

(a) Biotic components (b) Abiotic components

(c) Both a and b (d) None

(6) The study of group of organisms is known as :

(a) Synecology (b) Limnology

(c) Autecology (d) Pedology

(7) On Earth autotrophic components can directly fix :

(a) Mechanical energy (b) Light energy

(c) Chemical Energy (d) None

(8) Which of the following feed on 'detritus' :

(a) Producers (b) Consumers

(c) Decomposers (d) None

(9) A group of individual of the same species in a given area :

(a) Organism (b) Community

(c) Population (d) None

(10) Which of the following are producers in aquatic ecosystems

(a) Zooplanktons (b) Phytoplankton

(c) Cyanobacteria (d) None of these

(11) Energy flow in an ecosystem is :

(a) Multidirectional (b) Bidirectional

(c) Unidirectional (d) None of these

(12) Grazing animals are primarily found in :

(a) Desert Ecosystem (b) Grassland Ecosystem

(c) Forests (d) None of these

(13) Amount of rainfall in desert ecosystem is →

(a) More than 100 cms. (per year)

(b) 50 – 100 cms. (per year)

(c) Less than 25 cms. (per year)

(d) 25 – 50 cms

(14) Rainforests of the sea' are →

(a) Estuaries (b) Lagoons

(c) Coral Reefs (d) Mangroves

(15) Which of the following is an important feature of deserts :

(a) Canopy (b) Drought

(c) Rainforests (d) Estuaries

(16) Benthos are →

(a) that flows with water current

(b) strong swimmers

(c) bottom dwellers

(d) Rest or swim on the water surface

(17) Prairies (Grassland) are found in :

(a) Australia (b) North America

(c) Russia (d) Africa

(18) Largest hot desert in the world is →

(a) Mojave (b) Atacama

(c) Thar (d) Sahara

(19) Process through which an ecosystem tend to change to change over a period of time →

(a) Energy Cycle (b) Ecological Succession

(c) Ecotone (d) None

(20) Special ecosystems in which the water level fluctuates dramatically in different seasons :

(a) Estuaries (b) Deltas

(c) Wetlands (d) Lakes

(21) Immobile, still or stagnant water bodies fall under :

(a) Lotic (b) Lentic

(c) Marine (d) None

(22) Amount of rainfall in Savannah type of grasslands :

(a) 0 – 25 cms (b) 25 – 50 cms

(c) 50 – 75 cms (d) 75 to 100 cms

(23) Transfer of energy through a series of organisms takes place through →

(a) Food web (b) Food pyramid

(c) Trophic Level (d) Food chain

(24) Which of the following depends primarily on sunlight :

(a) Grazing food chain (b) Detritus food chain

(c) Both (d) None of the above

(25) Large number of food chains are interlinked to form :

(a) Biome (b) Food web

(c) Food pyramid (d) none

(26) Veldt grassland is located in →

(a) Russia (b) South Africa

(c) Canada (d) Europe

(27) Savannah's are found near →

(a) Equator (d) Poles

(c) Tropic of Capricorn (d) None

(28) Zone of junction or transition area b/w two diverse ecosystems :

(a) Ecocity (b) Ecological Niche

(c) Ecocline (d) Ecotone

(29) Which of the following describes the functional position and role of an organism within it's environment :

(a) Ecocity (b) Ecotone

(c) Ecological Niche (d) Ecotype

(30) In concept of ecological succession, ecosystems advance until they reach →

(a) Stable Community (b) Climax community

(c) Zero populations (d) none of the above

(31) Area which remains under water only at high tide conditions :

(a) Oceanic zone (b) Benthic zone

(c) Intertidal zone (d) Neritic zone

(32) Freshwater contains – % of the world's known fish species →

(a) 65% (b) 32%

(c) 41% (d) 82%

(33) Edaphic factors in an ecosystem is related to →

(a) Climate (b) Soil

(c) Light (d) Temperature

(34) Which of the following forests grow in coastal environment :

(a) Deciduous (b) Temperate

(c) Mangroves (d) Evergreen

(35) Simplest aquatic ecosystem :

(a) Wetland (b) Streams

(c) Lakes (d) Ponds

(36) The organisms which feed on waste product are :

(a) Herbivores (b) Carnivores

(c) Detritivores (d) None

(37) Sharp temperature boundary between two layers of lake :

(a) Hypolimnion (b) epilimnion

(c) thermostat (d) thermocline

(38) The study of freshwater ecosystem :

(a) Cryology (b) Oceanology

(c) Limnology (d) Hydrobiology

(39) Animals that lack chlorophyll and unable to synthesis their own food :

(a) Autotrophs (b) Heterotrophs

(c) Saprotrophs (d) Both (b) and (c)

(40) Primary consumers are basically

(a) Carnivores (b) Herbivores

(c) Both a and b (d) None

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