UNIT 3: Ecosystems

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3.1 Concept of an Ecosystem:

The term ecosystem was coined in 1935 by the Oxford ecologist Arthur Tansley to encompass the interactions among biotic and abiotic components of the environment at a given site. The living and non-living components of an ecosystem are known as biotic and abiotic components, respectively.

Ecosystem was defined in its presently accepted form by Eugene Odum as, "an unit that includes all the organisms, i.e., the community in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles, i.e., exchange of materials between living and non-living, within the system".

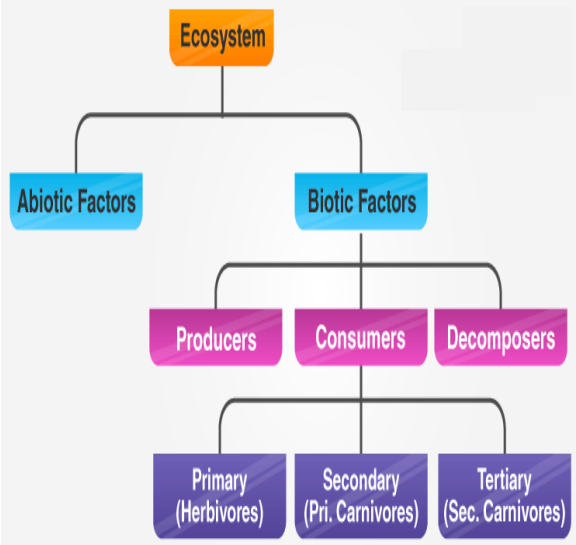
OR

The ecosystem is the structural and functional unit of ecology where the living organisms interact with each other and the surrounding environment. In other words, an ecosystem is a chain of interaction between organisms and their environment. The term "Ecosystem" was first coined by A.G.Tansley, an English botanist, in 1935.

Definition: The living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water, constitute the ecosystem.

Some ecosystems are equally vigorous and are less affected by a certain level of human disturbance. Others are highly fragile and are quickly destroyed by human activities. Mountain ecosystems are extremely fragile as degradation of forest cover leads to severe erosion of soil and changes in river courses. Island ecosystems are easily affected by any form of human activity which can lead to the rapid extinction of several of their unique species of plants and animals. Evergreen forests and coral reefs are also examples of species rich fragile ecosystems which must be protected against a variety of human activities that lead to their degradation. River and wetland ecosystems can be seriously affected by pollution and changes in surrounding land use

Structure of the Ecosystem



The structure of an ecosystem is characterised by the organisation of both biotic and abiotic components. This includes the distribution of energy in **our environment**. It also includes the climatic conditions prevailing in that particular environment.

The structure of an ecosystem can be split into two main components, namely:

- Biotic Components
- Abiotic Components

The biotic and abiotic components are interrelated in an ecosystem. It is an open system where the energy and components can flow throughout the boundaries.

3.1.1 Understanding ecosystems

Ecosystems generate the Earth's biosphere and support human existence. Knowledge of ecosystems is critical to the well-being of the Nation because ecosystems supply the natural resources and other goods and services that humans require. Healthy, functioning ecosystems build soil, enhance pollination of crops, purify water, supply raw materials, regulate the atmosphere, cycle nutrients, and detoxify waste. These and other ecosystem processes collectively form the basis for all life on Earth. For terrestrial, freshwater, and coastal/marine ecosystems to continue supplying these benefits, human interactions with ecosystems need to be well managed, especially in the face of increasing global pressures. An optimistic approach to managing ecosystems will require an advanced understanding, gained through research, of ecosystem structure, function, condition, and distribution. The ability to project future ecosystem states in response to societal pressures is vital to ensuring that ecosystems continue as the essential life-support systems for the Earth. Land change affects ecosystems in critical ways. It alters their structure and function; can limit the availability of goods and services that are essential for ecosystem health and societal welfare; directly impacts habitat quality and biodiversity; creates pathways for the spread of invasive species; and affects atmospheric chemistry, weather and climate, water quality and quantity, and other environmental systems. Because the resilience of ecosystems varies geographically, understanding change in a geographical and ecosystems framework is essential for managing its consequences.

The ecosystem functions through several biogeochemical cycles and energy transfer mechanisms. Observe and document the components of the ecosystem which consists of its non-living or abiotic features such as air, water, climate and soil. Its biotic components, the various plants and animals. Both these aspects of the ecosystem interact with each other through several functional aspects to form Nature's ecosystems. Plants, herbivores and carnivores can be seen to form food chains. All these chains are joined

together to form a ‘web of life’ on which man depends. Each of these use energies that comes from the sun and powers the ecosystem.

3.1.2 Ecosystem degradation

Ecosystems are however frequently interrupted by human activities which lead to the extinction of species of plants and animals that can live only in the different natural ecosystems. Some species if eliminated seriously affect the ecosystem. These are called ‘keystone’ species. Destruction occurs due to changes in land use. Forests are deforested for timber, wetlands are drained to create more agricultural land and semi arid grasslands that are used as pastures are changed into irrigated fields. Pollution from industry and waste from urban settings can also lead to extinction of several species. The reason for the depletion of natural resources is twofold – our rapidly exploding population that needs to sustain itself on resources, and the growth of affluent societies, which consume and waste a very large proportion of resources and energy. Increasing extraction of resources is at the cost of natural ecosystems, leading to a derangement of their important functions. Each of us in our daily lives use a variety of resources. If tracked back to their source, one finds that the resources were originally obtained from nature and natural ecosystems. Our insensitivity to using resources carefully has produced societies that nature can no longer sustain. If one thinks before wasting resources such as water, reusing and recycling paper, using less plastics that are non-degradable, culminatively this can have positive implications on the integrity of our natural resource base and conserve the resources that nature provides.

3.1.3 Resource utilization

It is an undeniable reality that all organisms must have continuous access to resources obtained from their environment. Plants and algae, for example, require sunlight and inorganic nutrients, while animals and heterotrophic microbes must feed on the living or dead biomass of other organisms. Because their organisms must be nourished by environmental capital, the concept can also be extended to ecosystems in their totality. The necessary resources must be available in at least the minimal amounts needed to sustain life, and in larger quantities in ecosystems that are increasing in biomass and complexity, as occurs during succession.

Most traditional societies used their environment sustainably. Though inequality in resource utilization has existed in every society, the number of individuals that used a large proportion of resources was extremely limited. In recent times the proportion of ‘rich’ people in affluent societies, grew rapidly. Inequality thus became a serious problem. Whereas in the past many resources such as timber and fuel wood from the forest were extracted sustainably, this pattern has drastically changed during the last century. The economically better off sections began to use greater amounts of forest products, while those people who lived in the forest became increasingly poor. Similarly the building of large irrigation projects led to wealth in those areas that had canals, while those who hand to remain dependent on a constant supply of water from the river itself, found it difficult to survive.

The key to this issue is the need for an ‘equitable’ distribution of all types of natural resources. A more even sharing of resources within the community can reduce these pressures on the natural ecosystems.

3.2 STRUCTURE AND FUNCTIONS OF AN ECOSYSTEM

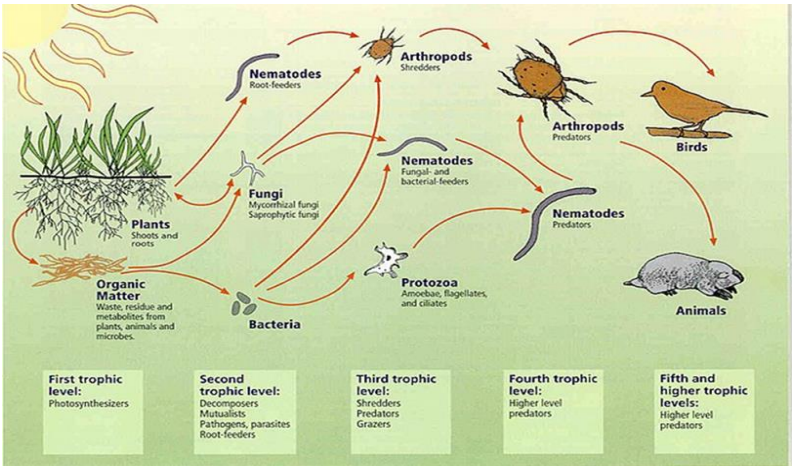
Structural aspects

Components that make up the structural aspects of an ecosystem include:

1) Inorganic aspects – C, N, CO_2 , H_2O.
2) Organic compounds – Protein, Carbohydrates, Lipids – link abiotic to biotic aspects.
3) Climatic regimes – Temperature, Moisture, Light & Topography.
4) Producers – Plants.
5) Macro consumers – Phagotrophs – Large animals.
6) Micro consumers – Saprotrophs, absorbers – fungi.

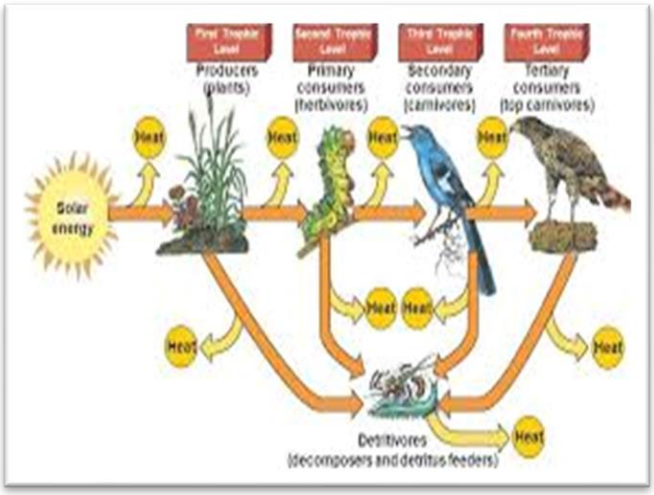
Functional aspects:

1) Energy cycles.
2) Food chains.
3) Diversity-interlinkages between organisms.
4) Nutrient cycles-biogeochemical cycles.
5) Evolution.



3.3 PRODUCERS, CONSUMERS AND DECOMPOSERS

Every living organism is in some way dependent on other organisms. Plants are food for herbivorous animals which are in turn food for carnivorous animals. Thus there are different tropic levels in the ecosystem. Some organisms such as fungi live only on dead material and inorganic matter.



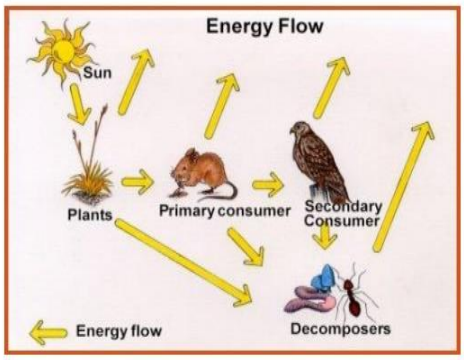
Plants are the ‘producers’ in producers the ecosystem as they manufacture their food by using energy from the sun. In the forest these form communities of plant life. In the sea these include tiny algal forms to large seaweed. The herbivorous animals herbivorous animals are primary consumers as they live on the producers. In a forest, these are the insects, amphibia, reptiles, birds and mammals. The herbivorous animals include for example hare, deer and elephants that live on plant life. They graze on grass or feed on the foliage from trees. In grasslands, there are herbivores such as the blackbuck that feed on grass. In the semiarid areas, there are species such as the chinkara or Indian gazelle. In the sea, there are small fish that live on algae and other plants.

At a higher tropic level, there are carnivorous animals, or animals secondary consumers, which live on herbivorous animals. In our forests, the carnivorous animals are tigers, leopards, jackals, foxes and small wild cats. In the sea, carnivorous fish live on other fish and marine animals. Animals that live in the sea range in size from microscopic forms to giant mammals such as the whale.

Decomposers or detrivores Decomposers or detrivores are a group of organisms consisting of small animals like worms, insects, bacteria and fungi, which break down dead organic material into smaller particles and finally into simpler substances that are used by plants as nutrition. Decomposition thus is a vital function in nature, as without this, all the nutrients would be tied up in dead matter and no new life could be produced Most ecosystems are highly complex and consist of an extremely large number of individuals of a wide variety of species. In the species-rich tropical ecosystems (such as in our country), only a few species are very common, while most species have relatively few individuals. Some species of plants and animals are extremely rare and may occur only at a few locations. These are said to be ‘endemic’ to these areas.

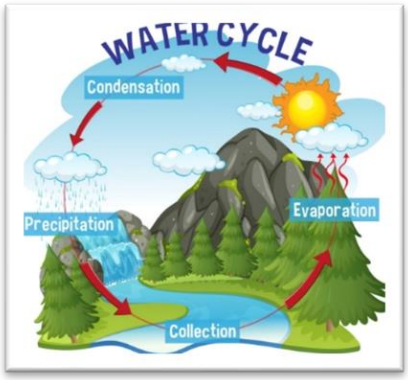
When human activities alter the balance in these ecosystems, the “perturbation” leads to the disappearance of these uncommon species. When this happens to an endemic species that is not widely distributed, it becomes extinct for all time.

3.4 ENERGY FLOW IN THE ECOSYSTEM



Every ecosystem has numerous interconnected mechanisms that affect human life. These are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle. While 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 in some way related to the growth and regeneration of its plant and animal species. These linked processes can be depicted as the various cycles. These processes depend on energy from sunlight. During photosynthesis carbon dioxide is taken up by plants and oxygen is released. Animals depend on this oxygen for their respiration. The water cycle depends on the rainfall, which is necessary for plants and animals to live. The energy cycle recycles nutrients into the soil on which plant life grows. Our own lives are closely linked to the proper functioning of these cycles of life. If human activities go on altering them, humanity cannot survive on our earth

3.4.1 The Water Cycle



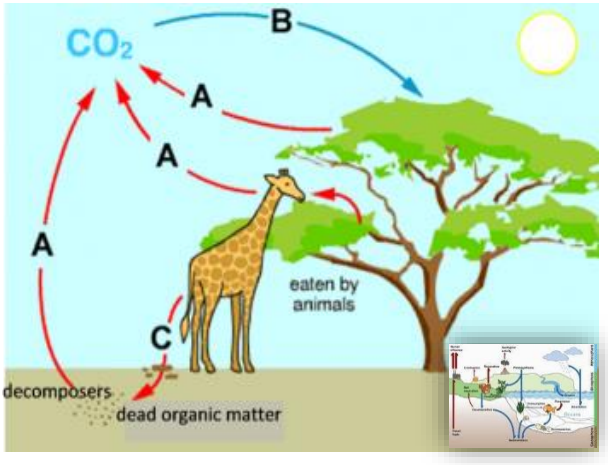
Water, air, and food are the most important natural resources to people. Humans can live only a few minutes without oxygen, less than a week without water, and about a month without food. Water also is essential for our oxygen and food supply. Plants breakdown water and use it to create oxygen during the process of photosynthesis.

The **water** (or hydrologic) **cycle** shows the movement of water through different reservoirs, which include oceans, atmosphere, glaciers, groundwater, lakes, rivers, and biosphere. Solar energy and gravity drive the motion of water in the water cycle. Simply put, the water cycle involves water moving from oceans, rivers, and lakes to the atmosphere by evaporation, forming clouds. From clouds, it falls as precipitation (rain and snow) on both water and land. The water on land can either return to the ocean by surface runoff, rivers, glaciers, and subsurface groundwater flow, or return to the atmosphere by evaporation or **transpiration** (loss of water by plants to the atmosphere).

An important part of the water cycle is how water varies in salinity, which is the abundance of dissolved ions in water. The saltwater in the oceans is highly saline, with about 35,000 mg of dissolved ions per liter of seawater. **Evaporation** (where water changes from liquid to gas at ambient temperatures) is a distillation process that produces nearly pure water with almost no dissolved ions. As water vaporizes, it leaves the dissolved ions in the original liquid phase. Eventually, **condensation** (where water changes from gas to liquid) forms clouds and sometimes precipitation (rain and snow). After rainwater falls onto land, it dissolves minerals in rock and soil, which increases its salinity. Most lakes,

rivers, and near-surface groundwater have a relatively low salinity and are called freshwater. The next several sections discuss important parts of the water cycle relative to fresh water resources.

3.4.2 The Carbon cycle



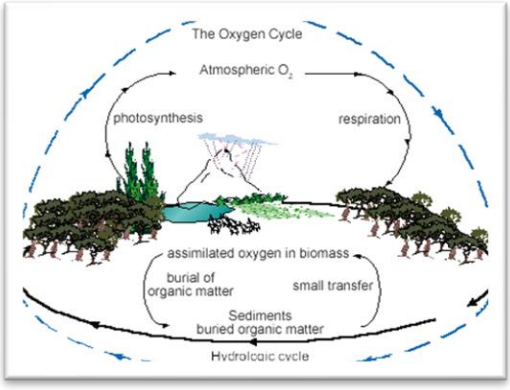
- **carbon cycle**: The physical cycle of carbon through the Earth's biosphere, geosphere, hydrosphere and atmosphere that includes such processes as photosynthesis, decomposition, respiration and carbonification.

The carbon cycle describes the flow of carbon between the biosphere, the geosphere, and the atmosphere, and is essential to maintaining life on earth.

Atmospheric Carbon Dioxide: Carbon in the earth's atmosphere exists in two main forms: carbon dioxide and methane. Carbon dioxide leaves the atmosphere through photosynthesis, thus entering the terrestrial and marine biospheres. Carbon dioxide also dissolves directly from the atmosphere into bodies of water (oceans, lakes, etc.), as well as dissolving in precipitation as raindrops fall through the atmosphere. When dissolved in water, carbon dioxide reacts with water molecules and forms carbonic acid, which contributes to ocean acidity. Human activity over the past two centuries has significantly increased the amount of carbon in the atmosphere, mainly in the form of carbon dioxide, both by modifying ecosystems ability to extract carbon dioxide from the atmosphere and by emitting it directly, e.g. by burning fossil fuels and manufacturing concrete.

Herbivorous animals feed on plant material, which is used by them for energy and for their growth. Both plants and animals release carbon dioxide during respiration. They also return fixed carbon to the soil in the waste they excrete. When plants and animals die they return their carbon to the soil. These processes complete the carbon cycle.

3.4.3 The Oxygen Cycle



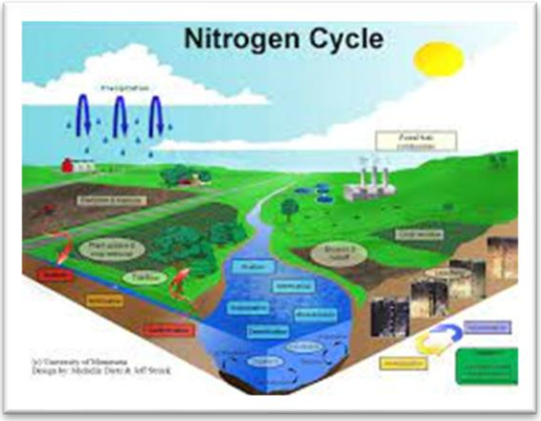
The oxygen cycle is the cycle that helps move oxygen through the three main regions of the Earth, the Atmosphere, the Biosphere, and the Lithosphere. The Atmosphere is of course the region of gases that lies above the Earth's surface and it is one of the largest reservoirs of free oxygen on earth. The Biosphere is the sum of all the Earth's ecosystems. This also has some free oxygen produced from photosynthesis and other life processes. The largest reservoir of oxygen is the lithosphere.

Most of this oxygen is not on its own or free moving but part of chemical compounds such as silicates and oxides. The atmosphere is actually the smallest source of oxygen on Earth comprising only 0.35% of the Earth's total oxygen. The smallest comes from biospheres. The largest is as mentioned before in the Earth's crust. The Oxygen cycle is how oxygen is fixed for freed in each of these major regions.

In the atmosphere Oxygen is freed by the process called photolysis. This is when high energy sunlight breaks apart oxygen bearing molecules to produce free oxygen. One of the most well known photolysis it the ozone cycle. O2 oxygen molecule is broken down to atomic oxygen by the ultra violet radiation of sunlight. This free oxygen then recombines with existing O2 molecules to make O3 or ozone. This cycle is important because it helps to shield the Earth from the majority of harmful ultra violet radiation turning it to harmless heat before it reaches the Earth's surface.

In the biosphere the main cycles are respiration and photosynthesis. Respiration is when animals and humans breathe consuming oxygen to be used in metabolic process and exhaling carbon dioxide. Photosynthesis is the reverse of this process and is mainly done by plants.

3.4.4 The Nitrogen Cycle



Carnivorous animals feed on herbivorous animals that live on plants. When animals defecate, this waste material is broken down by worms and insects mostly beetles and ants. These small 'soil animals' break the waste material into smaller bits on which microscopic bacteria and fungi can act. This material is thus broken down further into nutrients that plants can absorb and use for their growth. Thus, nutrients are recycled back from animals to plants. Similarly, the bodies of dead animals are also broken down into nutrients that are used by the plants for their growth. Thus, the nitrogen cycle on which life is dependent is completed. Nitrogen fixing bacteria and fungi in soil gives this important element to plants, which absorb it as nitrates. The nitrates are a part of the plant's metabolism, which help in forming new plant proteins. This is used by animals that feed on the plants. The nitrogen is then transferred to carnivorous animals when they feed on the herbivores. Thus, our own lives are closely interlinked to soil animals, fungi and even bacteria in the soil. When we think of food webs, we usually think of the large mammals and other large forms of life. But we need to understand that it is the unseen small animals, plants and microscopic forms of life that are of great value for the functioning of the ecosystem.

3.4.5 The Energy Cycle

The energy cycle is based on the flow of energy through the ecosystem. Energy from sunlight is converted by plants themselves into growing new plant material which includes leaves, flowers, fruit, branches, trunks and roots of plants.

Since plants can grow by converting the sun's energy directly into their tissues, they are known as producers in producers the ecosystem. The plants are used by herbivorous animals as herbivorous animals food, which gives them energy. A large part of this energy is used up for day to day functions of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood flow and body temperature. Energy is also used for activities such as looking for food, finding shelter, breeding and bringing up young ones. The carnivores in carnivores turn depend on herbivorous animals on which they feed. Thus the different plant and animal species are linked to one another through food chains. food chains Each food chain has three or four links. However as each plant or animal can be linked to several other plants or animals through many different linkages, these inter-linked chains can be depicted as a complex food web. food web This is thus called the 'web of life' that shows that there are thousands of interrelationships in nature. The energy in the ecosystem can be depicted in the form of a food pyramid food pyramid or food pyramid energy pyramid. The food energy pyramid has a large base of plants called '- producers'. The pyramid has a narrower middle section that depicts the number and biomass of herbivorous animals, herbivorous animals which are called 'first order consumers'. first order consumers The apex depicts the small biomass of carnivorous animals called 'second order second order consumers'. Man is one of the animals at the apex of the pyramid. Thus to support mankind, there must be a large base of herbivorous animals and an even greater quantity of plant material.

When plants and animals die, this material is returned to the soil after being broken down into simpler substances by decomposers such as insects, worms, bacteria and fungi so that plants can absorb the nutrients through their roots. Animals excrete waste products after digesting food, which goes back to the soil. This links the energy cycle to the Nitrogen cycle.

3.4.6 Integration of cycles in Nature

These cycles are a part of global life processes. These biogeochcemical cycles have specific features in each of the ecosystems. These cycles are however linked to those of adjacent ecosystems. Their characteristics are specific to the plant and animal communities in the region. This is related to the geographical features of the area, the climate and the chemical composition of the soil. Together the cycles are responsible for maintaining life on earth. If mankind disturbs these cycles beyond the limits that nature can sustain, they will eventually break down and lead to a degraded earth on which man will not be able to survive.

3.5 ECOLOGICAL SUCCESSION

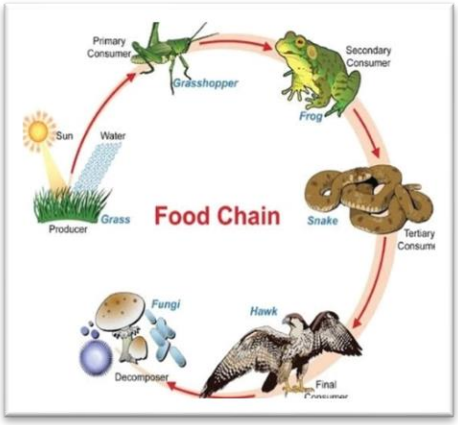
Ecological succession is a process through which ecosystems tend to change over a period of time. Succession can be related to seasonal environmental changes, which create changes in the community of plants and animals living in the ecosystem. Other successional events may take much longer periods of time extending to several decades. If a forest is cleared, it is initially colonized by a certain group of species of plants and animals, which gradually change through an orderly process of community development. One can predict that an opened up area will gradually be converted into a grassland, a

shrubland and finally a woodland and a forest if permitted to do so without human interference. There is a tendency for succession to produce a more or less stable state at the end of the successional stages. Developmental stages in the ecosystem thus consist of a pioneer stage, a series of changes known as serel stages, and finally a climax stage. The successive stages are related to the way in which energy flows through the biological system. The most frequent example of successional changes occur in a pond ecosystem where it fluctuates from a dry terrestrial habitat to the early colonisation stage by small aquatic species after the monsoon, which gradually passes through to a mature aquatic ecosystem, and then reverts back to its dry stage in summer where its aquatic life remains dormant.

3.6 FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

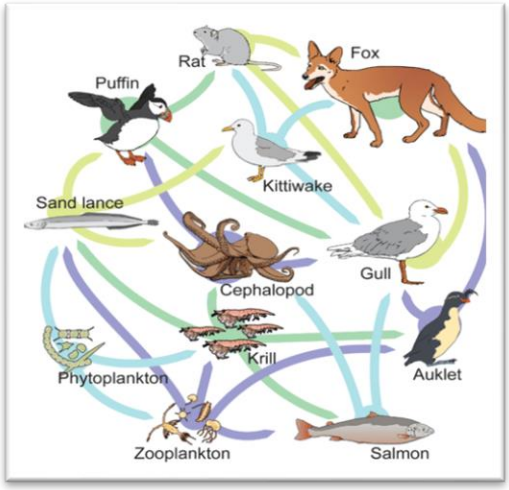
The transfer of energy from the source in plants through a series of organisms by eating and being eaten constitutes food chains.

3.6.1 The food chains



The most obvious aspect of nature is that energy must pass from one living organism to another. When herbivorous animals feed on plants, energy is transferred from plants to animals. In an ecosystem, some of the animals feed on other living organisms, while some feed on dead organic matter. The latter form the ‘detritus’ food chain. At each linkage in the chain, a major part of the energy from the food is lost for daily activities. Each chain usually has only four to five such links. However a single species may be linked to a large number of species. When observing a single food chain, you can see the path in which energy and nutrients get passed along through a specific community. Since a food chain is much more simplistic than a food web, it can be used to predict the response of an ecosystem due to changes in population of a single species. Trophic cascades are one way in which a food chain can be used to predict changes in an ecosystem. A trophic cascade occurs when one species has a change in population size, resulting in changes in populations of other species within the food chain.

3.6.2 The food webs

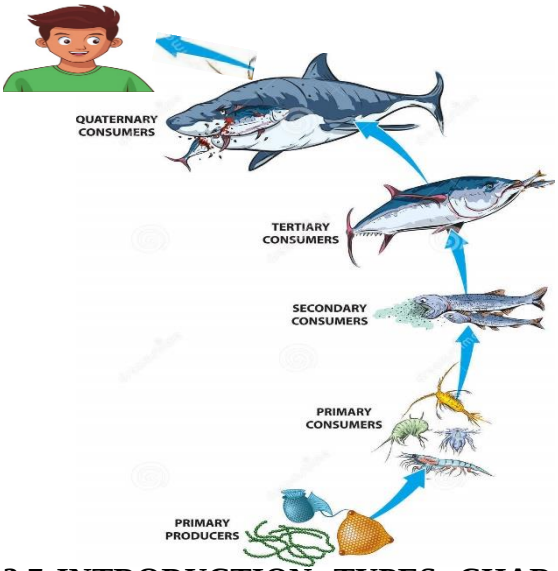


A **food web** represents multiple pathways through which energy and matter flow through an ecosystem. It includes many intersecting food chains. It demonstrates that most organisms eat, and are eaten, by more than one species.

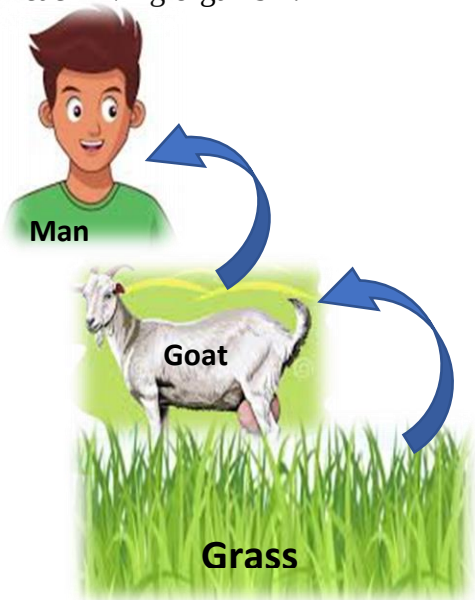
In an ecosystem there are a very large number of interlinked chains. This forms a food web. If the linkages in the chains that make up the web of life are disrupted due to human activities that lead to the loss or extinction of species, the web breaks down.

3.6.3 The ecological pyramids

In an ecosystem, green plants – the producers, utilize energy directly from sunlight and convert it into matter. A large number of these organisms form the most basic, or first 'trophic level' of the food pyramid. The herbivorous animals that eat plants are at the second trophic level and are called primary consumers. The predators that feed on them form the third trophic level and are known as secondary consumers. Only a few animals form the third trophic level consisting of carnivores at the apex of the food pyramid. This is how energy is used by living creatures and flows through the ecosystem from its base to the apex. Much of the energy is used up in activities of each living organism.



Aquatic Food Pyramid



Terrestrial Food Pyramid

3.7 INTRODUCTION, TYPES, CHARACTERISTIC FEATURES, STRUCTURE AND FUNCTION

Types of Ecosystem

An ecosystem can be as small as an oasis in a desert, or as big as an ocean, spanning thousands of miles. There are two types of ecosystem:

- Terrestrial Ecosystem
- Aquatic Ecosystem

Terrestrial Ecosystems

Terrestrial ecosystems are exclusively land-based ecosystems.

Terrestrial ecosystems Terrestrial ecosystems in Terrestrial ecosystems their natural state are found in different types of forests, grasslands, semiarid areas, deserts and sea coasts. Where the land is intensively used, these have been gradually modified over several thousand years into agricultural and pastoral regions. In the recent past they have been rapidly converted into intensively irrigated agricultural ecosystems or into urban and industrial centers.

"Though this has increased production of food and pro- has increased production of food and provides the raw material for 'consumer' goods that we use, the overuse and misuse of land and natural ecosystems has led to a serious degradation of our environment. degradation of our environment."

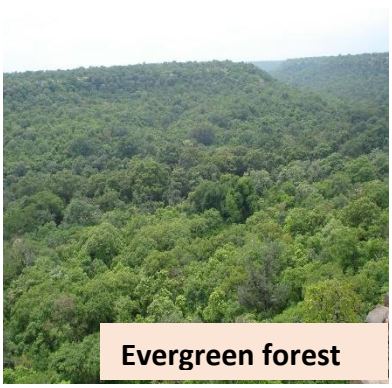
When our human population was small, most ecosystems could supply all our needs. Resources were thus used 'sustainably'. sustainably'. As industrial 'development' led to a very great increase in consumption of resources, the short term economic gains for people became an indicator of progress, rather than long term ecological benefits. This has resulted in an 'unsustainable of natural resources. Forests thus disappear, rivers run dry, deserts begin to spread, and air, water and soil become increasingly polluted as by-products of development. Human well being itself is then seriously affected.

There are different types of terrestrial ecosystems distributed around various geological zones. They are as follows:

1. Forest Ecosystems
2. Grassland Ecosystems
3. Tundra Ecosystems
4. Desert Ecosystem

Forest Ecosystem

A forest ecosystem consists of several plants, animals and microorganisms that live in coordination with the abiotic factors of the environment. Forests help in maintaining the temperature of the earth and are the major carbon sink.



Forest types in India: The forest type depends upon the abiotic factors such as climate and soil characteristics of a region. Forests in India can be broadly divided into Coniferous forests and Broadleaved forests.

They can also be classified according to the nature of their tree species – evergreen, deciduous, xerophytic or thorn trees, mangroves, etc. They can also be classified according to the most abundant species of trees such as Sal or Teak forests.

Coniferous forests grow in the Himalayan mountain region, where the temperatures are low. These forests have tall stately trees with needlelike leaves and downward sloping branches so that the snow can slip off the branches. They have cones instead of seeds and are called gymnosperms.

Broadleaved forests have several types, such as evergreen forests, deciduous forests, thorn forests, and mangrove forests. Broadleaved forests have large leaves of various shapes.

Evergreen forests grow in the high rainfall areas of the Western Ghats, North Eastern India and the Andaman and Nicobar Islands. These forests grow in areas where the monsoon lasts for several months. Some even get two monsoons, such as in Southern India.

Evergreen plants shed a few of their leaves throughout the year. There is no dry leafless phase as in a deciduous forest. An evergreen forest thus looks green throughout the year. The trees overlap with each other to form a continuous canopy. Thus, very little light penetrates down to the forest floor. Only a few shade loving plants can grow in the ground layer in areas where some light filters down from the closed canopy. The forest is rich in orchids and ferns. The barks of the trees are covered in moss. The forest abounds in animal life and is most rich in insect life.

Deciduous forests are found in regions with a moderate amount of seasonal rainfall that lasts for only a few months. Most of the forests in which Teak trees grow are of this type.

The deciduous trees shed their leaves during the winter and hot summer months. In March or April they regain their fresh leaves just before the monsoon, when they grow vigorously in response to the rains. Thus, there are periods of leaf fall and canopy regrowth. The forest frequently has a thick undergrowth as light can penetrate easily onto the forest floor.

Thorn forests are found in the semi-arid regions of India. The trees, which are sparsely distributed, are surrounded by open grassy areas. Thorny plants are called xerophytic species and are able to conserve water. Some of these trees have small leaves, while other species have thick, waxy leaves to reduce water losses during transpiration. Thorn forest trees have long or fibrous roots to reach water at great depths. Many of these plants have thorns, which reduce water loss and protect them from herbivores.

Mangrove forests grow along the coast especially in the river deltas. These plants are able to grow in a mix of saline and fresh water. They grow luxuriantly in muddy areas covered with silt that the rivers have brought down. The mangrove trees have breathing roots that emerge from the mudbanks.

Forest utilisation*:* Natural forests provide local people with a variety of products if the forest is used carefully. Over-exploitation for fuel wood or timber, and conversion to monoculture plantations for timber or other products, impoverishes local people as the economic benefit goes to people who live elsewhere. The entire resource base on which local people have traditionally survived for generations, is rapidly destroyed. Eventually the forest is completely degraded. Natural forest ecosystems play an important role in controlling local climate and water regimes. It is well-known that under the canopy of a natural forest, it is cooler than outside the forest During the monsoon, the forest retains moisture and slowly releases it through perennial streams during the rest of the year. Plantations fail to perform this function adequately. The loss of forest cover in the catchments of a river thus leads to irreversible changes such as excessive soil erosion, large run-off of surface water during monsoons leading to flash floods, and a shortage of water once the monsoons are over.

Forest products that are collected by Forest products people include food such as fruit, roots, herbs and medicinal plants. People depend on fuelwood to cook food, collect fodder for domestic animals, cut building material for housing, collect medicinal plants that have been known for generations for several ailments and use a variety of non timer forest products such as fiber, cane, gum, to make household articles. Wood from different species of trees have special uses. For instance a soft wood is used for the yok of a bullock cart while a very hard wood is used for its axil. These forest products are of great economic value as they are collected, sold and marketed. Forest dwellers and agricultural people use these goods directly. Other people get them indirectly from the market. Traditional types of agriculture needs forest material such as branches and leaves, which are burnt to form wood ash which acts as a fertiliser for crops such as rice. Urban people use these forest resources indirectly as all their food and other goods come from agricultural areas that are dependent on the neighbouring forests.

Forest services include the control of the flow services of water in streams and rivers. Forest cover reduces surface runoff of rainwater and allows ground water to be stored. Forests prevent erosion of soil. Once soil is lost by erosion, it can take thousands of years to reform. Forests regulate local temperature. It is cooler and more moist under the shade

of the trees in the forest. Most importantly, forests absorb carbon dioxide and release oxygen that we breathe. The wild relatives of our crop plants and fruit trees have special characteristics in their genes which are used to develop new crops and newer varieties of fruit. These newer varieties developed from wild relatives give greater yields of are more resistant to diseases. New industrial products are being produced from the wild plants of the forest. Many of our new medicines come from wild plants.

Direct uses of forest products: Fruits – mango, jamun, awla Roots – Dioscoria Medicine – Gloriosa, Foxglove Fuelwood – many species of trees and shrubs Small timber for building huts and houses Wood for farm implements Bamboo and cane for baskets Grass for grazing and stall feeding livestock

Indirect uses of forest products: Building material for construction and furniture for the urban sector Medicinal products collected and processed into drugs Gums and resins processed into a variety of products Raw material for industrial products and chemicals Paper from bamboo and softwoods.

What are the threats to the forest ecosystem?

As forests grow very slowly, we cannot use more resources than they can produce during a growing season. If timber is felled beyond a certain limit the forest cannot regenerate. The gaps in the forest change the habitat quality for its animals. The more sensitive species cannot survive under these changed conditions. Wood is illegally extracted from many forests leading to a highly disturbed ecosystem.

As the forest resources are exploited beyond what they can produce the forest canopy is opened up, the ecosystem is degraded, and its wildlife is seriously threatened. As the forest is fragmented into small patches its wild plant and animal species become extinct. These can never be brought back. Extinction is forever.

What if the forests disappear?

When forests are cut down tribal people who depend directly on them for food and fuelwood and other products find it very difficult to survive. Agricultural people do not get enough fuelwood, small timber, etc. for making houses and farm implements. Urban people who depend on food from agricultural areas, which in turn depend on neighbouring forest ecosystems have to pay a higher price for food as human population grows. Insects that live and breed in the forest such as bees, butterflies and moths decrease in abundance once forests are degraded. The rain that falls on deforested land flows directly into nearby rivers. Thus, water is not retained under the ground. People thus do not get a sufficient quantity of water throughout the year. The exposed soil is rapidly washed away during the rains once the protective forest cover is removed. Thus, agriculture is seriously affected in such areas. In deforested areas, the water in streams is brown in colour as soil is washed away while water in forested streams is crystal clear. Wild animals lose their habitat. This leads to extinction of our precious species. Residual forests must be protected from being destroyed any further if all the diverse species of plants and animals are to be kept for future generations.

How can forest ecosystems be conserved?

We can conserve forests only if we use its resources cautiously. This can be done by using alternate sources of energy instead of fuelwood. There is a need to grow more trees than are cut down from forests every year for timber. Afforestation needs to be done continuously from which fuelwood and timber can be judiciously used. The natural forests with all their diverse species must be protected as National Parks and Wildlife Sanctuaries where all the plants and animals can be preserved.

3.7.2 Grassland ecosystems

Grassland Ecosystem

In a grassland ecosystem, the vegetation is dominated by grasses and herbs. Temperate grasslands, savanna grasslands are some of the examples of grassland ecosystems. Grassland ecosystems are important mechanisms of ecological communities on Earth, and perform key functions in carbon (C) cycling, climate regulation, and the maintenance of biological diversity. However, since the middle of the 20th century, these ecosystems have been subjected to major environmental fluctuations because of climate change and strengthened human activities. These ongoing changes have affected grass growth and the functioning of constituent ecosystem. In this context, net primary productivity (NPP) is one key indicator that can be used to measure the ability of a grassland ecosystem to maintain a level of sustainable development, recorded via the net amount of C captured by land plants annually through photosynthesis. Variations in NPP are therefore indicative of relationships between vegetation growth and the surrounding environment; it is therefore critical to better understand the responses of grassland NPP to both climate change and human activities.

Grassland Types in India:

Grasslands form a diversity of ecosystems that are situated in different climatic conditions ranging from near desert conditions, to patches of ***shola grasslands*** that occur on hillslopes alongside the extremely moist evergreen forests in ***South India***. In the Himalayan mountains there are the high cold ***Himalayan pastures***. There are tracts ***of tall elephant grass*** in the low-lying ***Terai belt south of the Himalayan*** foothills. There are ***semi-arid grasslands*** in ***Western India***, parts of ***Central India,*** and in the ***Deccan Plateau.***

Himalayan pasture belt

Terai grasslands

Shola grasslands

How are grasslands used?

Grasslands are the grazing areas of many rural communities. Farmers who keep cattle or goats, as well as shepherds who keep sheep, are highly dependent on grasslands. Domestic animals are grazed in the 'common' land of the village. Fodder is collected and stored to feed cattle when there is no grass left for them to graze in sum mer. Grass is also used to thatch houses and farm sheds. The thorny bushes and branches of the few trees that are seen in grasslands are used as a major source of fuelwood. Overgrazing by huge herds of domestic livestock has degraded many grasslands. Grasslands have diverse species of insects that pollinate crops. There are also predators of these insects such as the small mammals like shrews, reptiles like lizards, birds of prey, and amphibia such as frogs and toads. All these carnivorous animals help to control insect pests in adjoining agricultural lands.

What are the threats to grassland ecosystems?

- Sustained global warming could turn current marginal grasslands into deserts as rainfall patterns change.
- Land once incompatible with row-crop agriculture, but which provided a living to ranching families and habitat for prairie wildlife, is being converted to row-crops.
- Development of urban areas is increasingly cutting into grassland habitat.
- Where only one crop is grown, pests and disease can spread easily, creating the need for potentially toxic pesticides.

Why are our grassland species vanishing?

Most people feel that it is only our forests and its wildlife that is disappearing. However, other natural ecosystems such as grasslands are disappearing even more rapidly. Many of the grassland species have disappeared from several parts of India in which they were found 50 or 60 years ago. The Cheetah is extinct in India. The Wolf is now highly threatened. Blackbuck and chinkara are poached for meat. Birds such as the beautiful Great Indian Bustards are vanishing. Unless grassland species are protected they will vanish from their shrinking habitat, as natural and undisturbed grasslands are left in very few locations. If these animals and birds are killed or their habitat is reduced further, their extinction will rapidly follow.

3.7.3 Desert ecosystem

Semi-arid plains

Desert Ecosystem

Deserts are found throughout the world. These are regions with very little rainfall. The days are hot and the nights are cold.

Desert and semi arid lands are highly specialised and sensitive ecosystems that are easily detroyed by human activities. The species of these dry areas can live only in this specialised habitat.

What is a desert or a semi-arid ecosystem?

Deserts and semi arid areas are located in West ern India and the Deccan Plateau. The climate in these vast tracts is extremely dry. There are also cold deserts such as in Ladakh, which are located in the high plateaus of the Himalayas. The most typical desert landscape that is seen in Rajasthan is in the Thar Desert. This has sand dunes. There are also areas covered with sparse grasses and a few shrubs, which grow if it rains. In most areas of the Thar the rainfall is scanty and sporadic. In an area it may rain only once every few years. In the adjoining semi arid tract the vegetation consists of a few shrubs and thorny trees such as kher and babul. The Great and Little Rann of Kutch are highly specialised arid ecosystems. In the summers they are similar to a desert landscape.

How can desert ecosystems be conserved?

There is an urgent need to protect residual patches of this ecosystem within National Parks and Wildlife Sanctuaries in desert and semi arid areas. The Indira Gandhi Canal in Rajasthan is destroying this important natural arid ecosystem, as it will convert the region into intensive agriculture. In Kutch, areas of the little Rann, which is the only home of the Wild Ass, will be destroyed by the spread of salt works. Development Projects alter the desert and arid landscape. There is a sharp reduction in the habitat available for its specialised species bringing them to the verge of extinction. We need a sustainable form of development that takes the special needs of the desert into account.

3.7.4 Aquatic ecosystems:

Aquatic ecosystems are ecosystems present in a body of water. These can be further divided into two types, namely:

1. Freshwater Ecosystem
2. Marine Ecosystem

Freshwater Ecosystem

The freshwater ecosystem is an aquatic ecosystem that includes lakes, ponds, rivers, streams and wetlands. These have no salt content in contrast with the marine ecosystem.

Wetlands are special ecosystems in which the water level fluctuates dramatically in different seasons. They have expanses of shallow water with aquatic vegetation, which forms an ideal habitat for fish, crustacea and water birds.

Marine Ecosystem

The marine ecosystem includes seas and oceans. These have a more substantial salt content and greater biodiversity in comparison to the freshwater ecosystem.

Marine ecosystems are highly saline, while brackish areas have less saline water such as in river deltas. Coral reefs are very rich in species and are found in only a few shallow tropical

seas. The richest coral reefs in India are around the Andaman and Nicobar islands and in the gulf of Kutch. Brackish water ecosystems in river deltas are covered by mangrove forests and are among the world's most productive ecosystems in terms of biomass production. The largest mangrove swamps are in the Sunderbans in the delta of the Ganges.

What are the threats to aquatic ecosystems?

Water pollution occurs from sewage and poorly managed solid waste in urban areas when it enters the aquatic ecosystem of lakes and rivers. Sewage leads to a process called eutrophication, which destroys life in the water as the oxygen content is severely reduced. Fish and crustacea cannot breathe and are killed. A foul odour is produced. Gradually the natural flora and fauna of the aquatic ecosystem is destroyed. In rural areas the excessive use of fertilisers causes an increase in nutrients, which leads to eutrophication. Pesticides used in adjacent fields pollute water and kills off its aquatic animals. Chemical pollution from industry kills a large number of life forms in adjacent aquatic ecosystems. Contamination by heavy metals and other toxic chemicals affects the health of people who live near these areas as they depend on this water.

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Exercise

1. Ecosystem is smallest unit of_____
   a) Ionosphere b) Lithosphere c) Biosphere d) Mesosphere

2. An ecosystem consist of_____
   a) Green plants and animals
   b) green plants and decomposers
   c) Producers and consumers
   d) green plants, animals, decomposers and abiotic environment

3. An ecosystem made up of_____
   a) biotic factors only b) abiotic factors only
   c) biotic and abiotic factors d) biotic and decaying matter only

4. The examples of natural ecosystem is _____
   a) cropland system b) forest c) garden d) all the above

5. The example of artificial ecosystem is _____
   a) cropland system b) forest c) grassland d) all the above

6. A food chain shows;
   a) one possible pathway for energy
   b) many possible pathways for energy
   c) the amount of energy available for producer
   d) the amount of energy available for consumer

7. Each step of food chain represents_____
   a) food web b) sere c) trophic level d) consumers

8. Trophic levels in ecosystem are formed by _____
   a) Herbivores b) carnivores
   c) predators d) organisms linked in a food chain

9. A trophic level refers to;_____
   a)Area in the tropics b) an organism's position in a food chain
   c) an organism's position in a food chain
   d) an organism's position in a biome

10. Identify the possible link "A" in the following food chain:

    Plant ⟶ Insect ⟶ frog ⟶ A ⟶ Eagle

    a) Cobra b) parrot c) rabbit d) wolf

11. A destritus food chain starts with ----------
    a) Producers b) herbivores c) decomposers d) carnivores

12. The network formed by interlinking food chains is called_____
    a) Food link b) food web c) ecosystem d) trophic system

13. An animal that eats only plants is _____
    a) Primary consumer b) secondary consumer
    c) tertiary consumer d) primary producer

14. The organisms which utilize plants and animals as food are called_____
    a) Herbivores b) carnivores c) omnivores d) saprophytes

15. Primary consumers in the detritus food chain are ---------_____
    a) Herbivores b) bacteria and fungi
    c)insect larva, nematodes d) all the above

16. Food chain in which microorganisms breakdown the food formed by primary producers is_____
    a) Parasitic food chain b) detritus food chain
    c)consumer food chain d) producer food chain

17. Nitrogen is absorbed by the plants in the form of
    a) Ammonium b) Nitrites c) Nitrates d) All

18. Conversion of ammonia to nitrite and then to nitrates is called
    a) Ammonification b) Denitrification
    c) Assimilation d) Nitrification

19. The largest reservoir of nitrogen on our planet is_____
    a) Ocean b) atmospher c) biosphere d) fossil fuels

20. Which of the following chemical formula represents the nitrogen in the atmosphere?
    a) NH_4 b) NO_3 c) NO_4 d) N_2

21. In an ecosystem the rate of production of organic matter during photosynthesis is termed as_____
    a) Net productivity b) net primary productivity
    c)gross primary productivity d) secondary productivity

22. The pyramid of terrestrial ecosystem is_____
    a) Irregular b) inverted c) upright d) all the above

23. The organisms which convert complex organic components of dead bodies into simple organic molecules are called_____
    a) Microorganisms b) decomposers c) transformers d) converters

24. Two examples of decomposers are:_____

a) Fungi and bacteria b) algae and marine animals
c) carnivores and herbivores d) ferns and mosses

25. First order consumers are _____
a) Carnivores b) herbivores c) decomposers d) omnivores

26. On the basis of nutrition, producers are
a) Heterotrophic b) parasitic c) autotrophic d) saprophytic

27. An example of a consumer in a pond ecosystem is _____
a) Water lily b) algae c) hydrilla d) frog

28. An example of a biotic factor in a pond ecosystem is_____
a) Temperature b) water c) fish d) sunlight

29. Which is the possible path of movement of nitrogen in nitrogen cycle?
a) Soil-animals-plants-air-soil
b) Air-animals-soil-plants-air
c) Soil-air plants-animals-soil
d) Air-soil-plants-animals-soil-air

30. Which process in the nitrogen cycle turns ammonium into nitrates?
a) Fixation b) nitrification c) assimilation d) ammonification

31. Combustion occurs in the_____
a) Water b) oxygen c) carbon d) nitrogen

32. Through which process do living organisms release carbon into the atmosphere?
a) Photosynthesis b) cellular respiration
c) transpiration d) combustion

33. Which cycle most likely includes sunlight, photosynthesis and respiration?
a) Water cycle b) carbon cycle c) oxygen cycle d) nitrogen cycle

34. The term eosystem was coined by_____
a) Odum b) Ernst Haeckel c) Tansley d) Reiter

35. Which of the following ecosystems has highest gross primary productivity?

a) grasslands b) coral reefs c) mangroves d) rainforest

36. The recycling of elements in an ecosystem is called
a) chemical cycle b) geological cycle
c) biogeochemical cycle d) geochemical cycle

37. The source of energy in an ecosystem is_____
    a) The composition of animals and plants by bacteria
    b) photosynthesis by plants
    c) fermentation by sugar
    d) sun light

38. How many parts are there in the forest ecosystem?
    a) One b) Two c) Three d) Four

39. On which factor forest type is mainly dependent?
    a) Abiotic b) Size of the forest
    c) Shape of trees d) Products from the trees

40. Where can we find coniferous forest in India?
    a) Deserts b) River deltas c) Grassland d) Himalayan

41. Which state in India has the maximum percentage of its area covered by forest?
    a) Arunachal Pradesh b) Madhya Pradesh
    c) Mizoram d) Nagaland

42. Where can we find thorn forest in India?
    a) Semi-arid regions b) Desert regions
    c) Himalayan regions d) Northeast regions

43. Trees in thorn forest are**:**
    a) Tall b) Dense c) Scattered d)none of these

44. According to the survey done by Ministry of Environment and Forest, the total forest cover in India is around:
    a) 33% b) 23% c) 21% d) 28%

45. Deciduous forests are found in regions which have:
    a) Heavy amount of seasonal rainfall for long term
    b) Moderate amount of seasonal rainfall that lasts for only a few months
    c) Barren land
    d) Less rain for less time

46. Where Evergreen forests grow in India?
    a) High rainfall areas of the Western Ghats, North Eastern India and the Andaman and Nicobar Islands.
    b) Southern parts of the country
    c) Northern part of the country
    d) b & c Both

47. Energy _____ in an Ecosystem.
a) is released b) is absorbed c) flows d) None of the above

48. A pond / lake is
a) A biome b) Unnatural ecosystem
c) An artificial ecosystem d) Community of plants and animals only

49. Primary consumers are
a) Green plants b) Herbivorous c) Carnivorous d) All the above

50. Secondary consumers are
a) Green plants b) Herbivorous c) Carnivorous d) All the above