Govt. Degree College Kilam
Department of Environmental Science
Study Material for BG 1st and 2nd Semester (CBCS)

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Credit I: Understanding Environment

1.1 Environment: Concept and importance.

1.2 Components of Environment: Physical, Biological and Social.

1.3 Ecosystem Definition, Structure and Function

1.3.1 Producers, consumers and decomposers

1.3.2 Food chains, food webs and ecological pyramids

1.3.3 Energy flow in an ecosystem

1.4 Ecosystem services: Ecological, economical, social, aesthetic and Informational value.

Environment: The term Environment can be broadly defined as one's surroundings. To be more specific we can say that it is the physical and biological habitat that surrounds us, which can be felt (seen, heard, touched, smelled and tasted). Literary environment means the surrounding external conditions influencing development or growth of people, animal or plants; living or working conditions etc. The word 'Environment' is derived from the French word 'Environ' or 'Environner' which means to encircle or to surround. The earth is the only planet known to support life as we know it. It supplies us with all the resources, the materials we use and the food we eat or drink.

Definitions: Environment refers to "the sum total of conditions which surround man at a given point in space and time" "Environment is the collection of all conditions influences and objects that affect the development of living beings".

Douglas and Holland: 'The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and growth, development and maturity of living organisms.'

In order to prevent environmental degradation, it is important to make everyone environmentally educated. Environmental science is not dependent on only one discipline but it includes several disciplines like chemistry, biology, Physics, law, Health, Agriculture, Economics, Education, Sociology etc. that is why it is called that environmental science has a multidisciplinary nature.

Importance: Environment is essential in every aspect of life. All the living beings are depending upon the environment. All the components like air, water, soil, food etc. required for survival of living organisms are obtained from environment. The importance of environment and its link to development and the quality of human life were first addressed on a global level at the Stockholm Conference on Human Environment in 1972.
In the industrialized era that we live today, every component that we intake - be it, air, water or food are contaminated by industrial activities. There is no zero pollution. To minimize this problem, knowledge of environmental studies is essential. An in-depth study of environmental studies will help us in the following ways:

(i) Environment comprising of air, water, land, plants, animals and microorganisms are mandatory for life.

(ii) Abiotic component is necessary for existence of life.

(iii) Biotic component is necessary for survival of life.

(iv) Water is important to all animals in order to regulate temperature, and is important to plants for nutrition.

(v) All life forms need air to live.

(vi) Air provides Oxygen to animals and CO2 to plants.

(vii) The most important thing to make house is residential space, and for residential space, we need land area.

(viii) Soil, water and air are the necessary nutrient provider for the living beings.

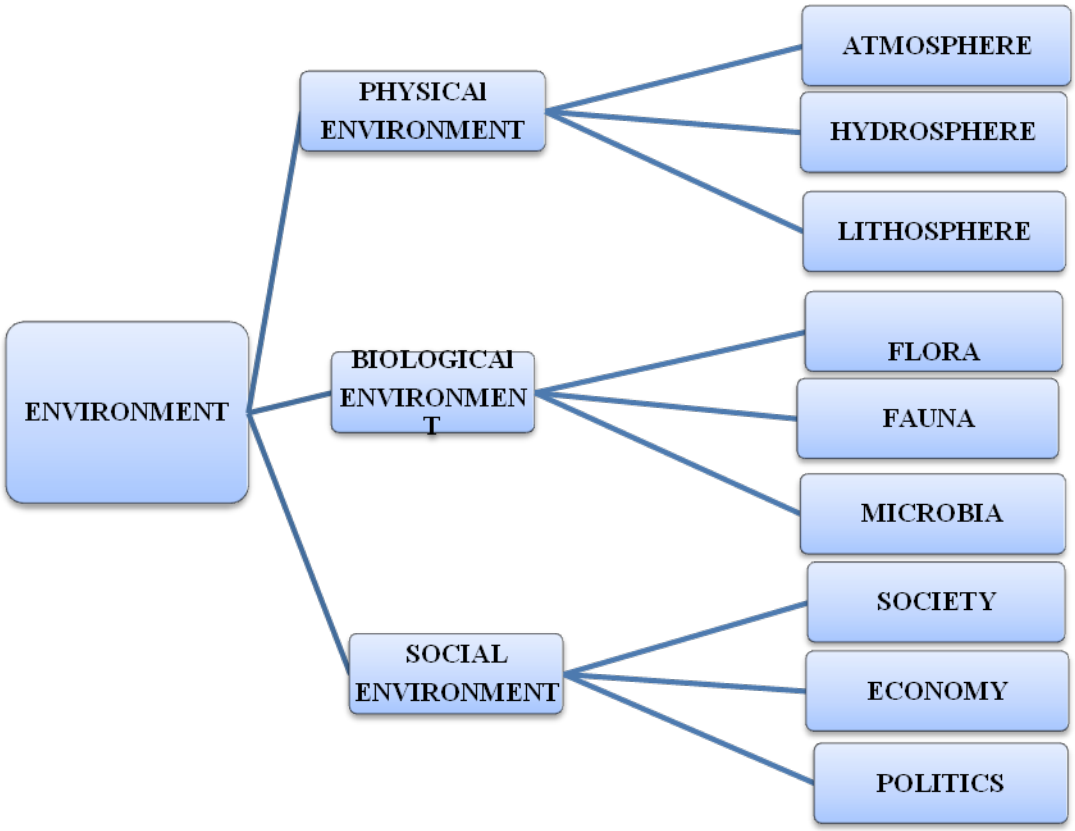
(ix) The abiotic environment also controls the climatic and weather factors.

(x) Soil provides food for all the living beings as plats grow in it. It also provides different types of minerals to plants which are very necessary for growth.

(xi) Water is one of the most necessary things for living organisms. It constitutes about 60-70 % mass of every living organism

(xii) Living beings are highly dependent to each other. For example humans are highly depend upon plants and trees for food and oxygen, and plants and trees are also depend upon humans and animals because of CO_2.

Components of Environment: Environment is constituted by the interacting systems of physical, biological and social elements inter-related in various ways, individually as well as collectively. The classification of the environment can be best described from the following figure:



Components of Environment

These elements may be explained as under:

- **The Physical component:** External physical factors like Air, Water, and Land etc. This is also called the Abiotic Environment. The meaning of 'a-biotic' or 'physical' is non living. So we can say that physical or a-biotic environment is the environment which includes non living or physical things. The physical or a-biotic environment also includes the climatic factors such as sunbeams, rainwater, precipitation, moisture, pressure and wind speed.

- **Biological Component:** All living organisms around us viz. plants, animals, and microorganisms. This is also called the Biotic Environment**.** The biological environment as the name indicates refers to the various floras (plants), fauna (animals) and microbes (micro organisms) that are found in our surroundings.
- **Social or Cultural Component:** The social or cultural environment means the environment which is created by the man through his different social and cultural

activities and thinking. The historical, cultural, political, moral, economic aspects of human life constitute the social or cultural environment.

Concept of Ecosystem: A biotic community cannot live in isolation. It lives and flourishes in an environment which supplies and fulfills its material and energy requirements and provides other living conditions. The biotic community and its physical environment in which matter (chemical elements) cycle and energy flows is called the 'ecosystem'. The term ecosystem was coined by British ecologist A.G Tansely in 1935.Ecosystem has been defined as the basic functional unit of ecology. An ecosystem is any spatial or organizational unit which includes a community of living organisms and non living substances of environment interacting to produce and exchange materials between the living and nonliving parts. It may be as small as a water drop or as large as the entire earth.

According to A.G Tansley an ecosystem results from the interaction of all the living and non living factors of any particular environment. 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.

Structure and Function of ecosystem: From the structural point of view all ecosystems consist of following two basic components:

a) **Abiotic components:** It represents the non-living or physical environment of an ecosystem which has a strong influence on the life of living organisms. The physical and chemical components of an ecosystem constitute its abiotic component as under.

- **Physical factors:** These factors include soils, temperature, wind, sunlight, water, currents, humidity etc. these are very important and have strong influence on the ecosystem.
- **Chemical factors:** These constitute inorganic and organic substances. The inorganic substances include Carbon, Hydrogen, Nitrogen, Potassium Phosphorus, and Sulphur etc these are involved in nutrient cycling and are present in an ecosystem at any given time. The organic substances include carbohydrates, lipids, and proteins and are present in the biomass or in the environment.

b) **Biotic component:** The live component of an ecosystem comprises plants, animals, and microorganisms (Bacteria and Fungi). They carry out different functions and based on their role they are classified into three main groups. They are:

i. **Producers** are mainly green plants having chlorophyll. They produce carbohydrates by photosynthesis process. In effect the plants convert solar energy into chemical energy using water and carbon dioxide. These are called Autotrophs (self feeder) since they produce their own food. Part of the food produced by the autotrophs is utilized for their own consumption for survival and growth while the remaining is stored in the plant parts for future consumption. This becomes the food for other biotic components in the environment.

ii. **Consumers:** Consumers are living things, which do not have chlorophyll, and hence they are unable to produce their own food. They rely on the producers for their food

requirements. Consumers are called Heterotrophs. Consumers are classified into four categories. They are

a. **Primary Consumers or Herbivores:** They are also called first order consumers. They eat the producers or plants. Examples are cattle like cow and goat, deer, rabbit etc.
b. **Secondary Consumers or Primary Carnivores:** They are also called second order consumers. They eat herbivores Examples are snakes, cats foxes etc.
c. **Tertiary Consumers:** They are also called third order consumers. They feed on secondary consumers. They are large Carnivores. Example is Wolf.
d. **Quaternary Consumers:** They are also called fourth order consumers. They feed on secondary consumers. They are very large Carnivores and feed on tertiary consumers and are not consumed by other animals. Examples are lions and tigers.

iii. **Decomposers** called, as Sapotrophs are mainly microorganisms like Bacteria and Fungi. The dead organic materials of producers and consumers are their food. They break down the organic matter into simple compounds during their metabolic process. These simple compounds are nutrients, which are absorbed by the producers thus completing a cyclic exchange matter between the biotic and abiotic components of the ecosystem.

Functions of ecosystem: Ecosystem function is the technical term used in the framework to define the biological, geochemical and physical processes and components that take place or occur within an ecosystem. or more simply put, ecosystem functions relate to the structural components of an ecosystem (e.g. vegetation, water, soil, atmosphere and biota) and how they interact with each other, within ecosystems and across ecosystems. Sometimes, ecosystem functions are called ecological processes. Some of the major functions of an ecosystem are discussed below:

Food Chain: A food chain is the sequence of who eats whom in an ecosystem. The transfer of food energy from the source i.e plants (producers) through a series of organisms (herbivores to carnivores to decomposers) with separated stages of eating and being eaten is known as the food chain. A food chain is a sequence of feeding relationships between organisms living within the same community. The examples of food chains are as follows:

Grass	**Insects**	**Frog**	**Birds**
(producer)	**(Herbivore)**	**(carnivore)**	**(top carnivore)**

Grass	**Deer**	**Lion**	
Plants	**Worms**	**Birds**	**Cat**

Food chains are of two types as follows:

1. **Grazing Food Chain:** This type of food chain starts from the green plants goes to grazing herbivore, and on the carnivores. Such types of food chains are directly dependent on an influx of solar radiation. Most of the ecosystems follow such type of food chains.

Grass Deer Lion

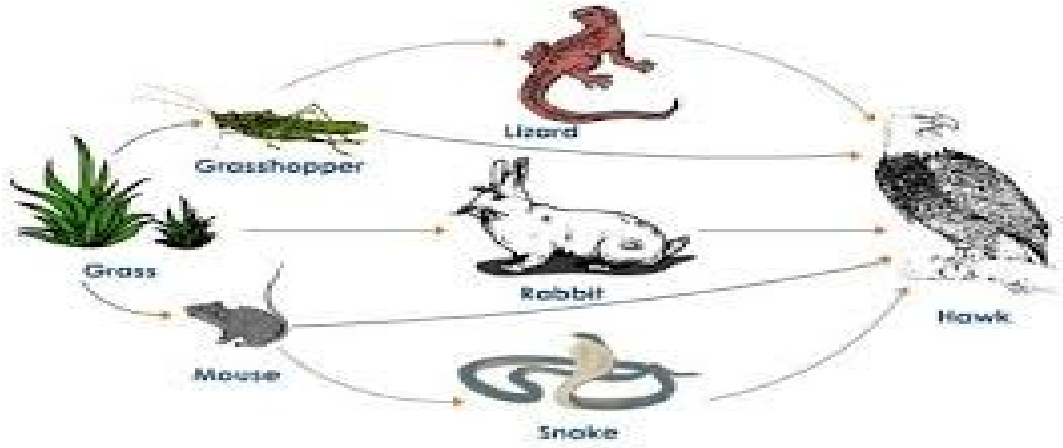
Grass Grass hopper Frog Snake Hawk

2. **Detritus Food Chain:** This type of food chain starts with dead organic matter goes to microorganisms and then to organisms feeding on Detritus and their predators. Such food chains are less dependent on solar energy.An example of the detritus food chain is seen in a mangrove (estuary) and forest ecosystem, examples are given below:

Dead plants Soil mites insects Lizards

Dead Plants Bacteria Protozoa

Food Web: In an ecosystem, there are a large number of interlinked food chains. Many of these food chains are interconnected by species which occur in more than one food chain. These interconnected food chains operating in an ecosystem which establish a network of relationships between various species, is called 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. In simple words a network of large number of food chains forms a food web. Food webs provide more than one alternatives of food to most of the organisms in an ecosystem and thus increase their chances of survival.



Food Web in Grassland ecosystems

Energy flow in ecosystem: Energy flow, also called the calorific flow, refers to the flow of energy through a food chain. Energy is the capacity to do work. Solar energy is transformed into chemical energy by Chlorophyll bearing plants convert this energy from the sun into carbohydrates and sugars using carbon dioxide and water. This process is known as Photosynthesis. The generalized form of the photosynthetic reaction is

$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

Carbon dioxide + water → glucose + oxygen + water

Flow of energy in an ecosystem takes place through the food chain and it is this energy which keeps the ecosystem going. The flow of energy through various tropic levels in an ecosystem can be explained with the help of various energy flow models.

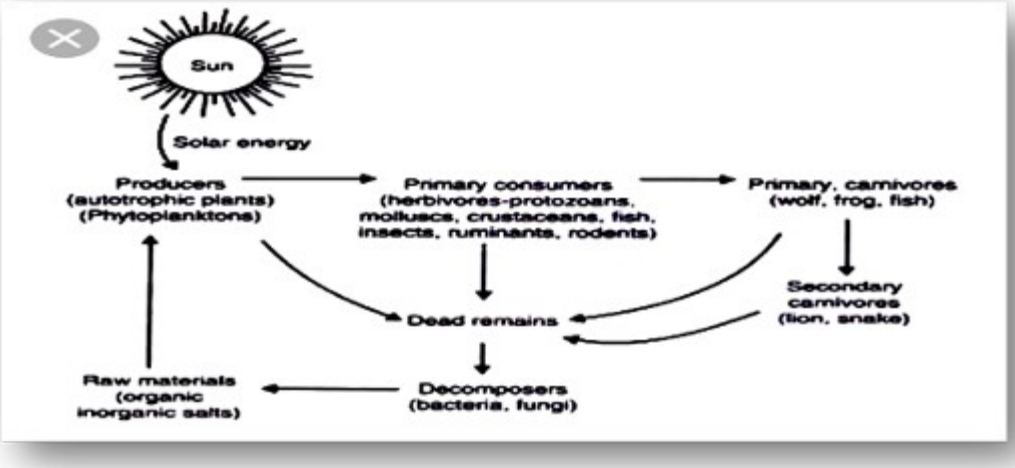
ii. Single channel energy flow model: The flow of energy takes place in a unidirectional manner through a single channel of green plants or producers to herbivores and carnivores. From this model two things are clear:

- There is unidirectional flow of energy. The energy captured by autographs does not revert back to solar input but passes to herbivores and carnivores. Due to one way flow of energy, the system would collapse if the primary source of energy (i.e., sun) were cut off.
- At each trophic level, there occurs progressive decrease in energy. This is accounted largely by the energy lost in metabolic reactions (respiration) coupled with unutilized energy.

ii. Double channel or Y shaped energy model. Y shaped energy flow model as pioneered by H.T.Odum in 1956. This model shows common boundary, light and heat flows as well as the import, export and storage of organic matter. Decomposers are placed in a separate box as a means of partially separating the grazing and detritus food chains. In terms of energy levels, decomposers are, in fact a mixed group. The significant part in Y shaped model is that the two food chains are not isolated from each other.

Y shaped energy flow model is more realistic and practical than single channel energy flow model because of the following points:

- It confirms the basic stratified structure of ecosystem.
- It separates the two chains i.e. grazing food chain and detritus food chain in both time and space.
- Micro consumers (e.g. bacteria, fungi) and the macro consumers (animals) differ greatly in size- metabolism relations in two models.



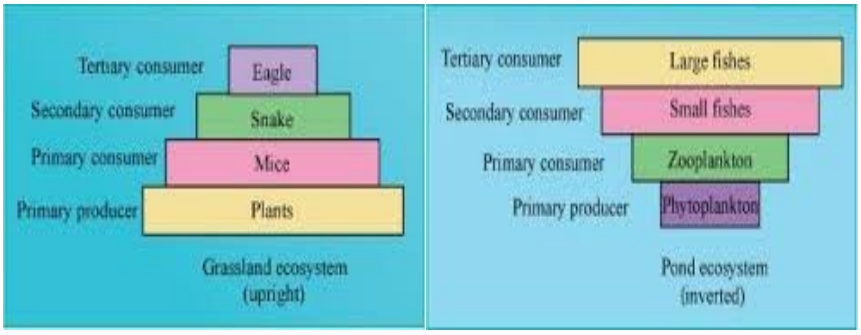
Thus, there is a continuous loss of energy(90%) within each trophic level from producer to consumer within an ecosystem and only 10% of energy passes on from one trophic level to another. This is accounted for largely by the energy dissipated as heat during metabolism of the organisms present in the food chain. It also indicates that shorter the food chain, greater would be the available food energy and with an increase in the length of the food chain, there is a corresponding increase in loss of energy.

Ecological pyramids: Ecological pyramids are diagrams that illustrate how ecologically important factors, such as energy, biomass, and population size, vary between trophic levels in an ecosystem. Graphic representation of trophic structure and function of an ecosystem, starting with producers at the base and successive trophic levels forming the apex is known as ecological pyramid. The concept of ecological pyramid was developed by Charles Elton in 1927 and after his name these pyramids are also called as Eltonian pyramids.

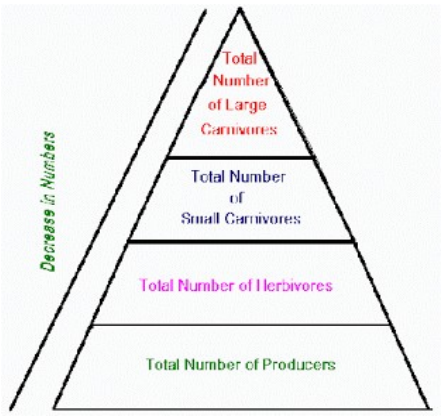
Based on the parameters selected to depict the trophic relationship, an ecological pyramid may be of the following types.

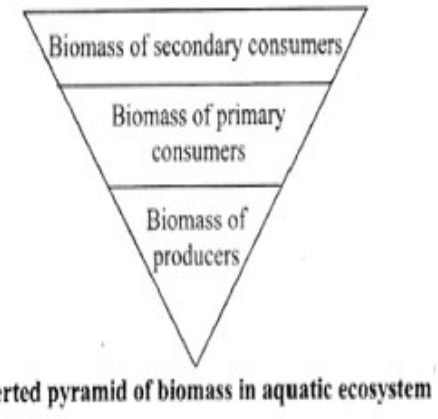
Pyramid of numbers: - They show the relationship between producers, herbivores and carnivores at successive trophic levels in terms of numbers.

In a forest or lake ecosystem, the pyramid is always in an upright position. However, in a parasitic food chain the shape of the pyramid is always inverted, the number of organisms gradually increases making the pyramid inverted in shape.



1. **Pyramid of biomass:** The pyramid of biomass is comparatively more realistic than pyramid of number. If the numbers of organisms at each trophic level are multiplied by their weight then what we obtain is the pyramid of biomass. When we plot the biomass (net dry weight) of producers, herbivores, carnivores and so on we have a pyramid of biomass. In a grassland or forest ecosystem, there is gradual decrease in biomass of organisms at successive levels from producers to consumers. These pyramids are in upright position.
   However, in a pond, producers are small organisms, so their biomass is also less. But the primary and secondary consumers are bigger, so their biomass is more. Therefore, the value of biomass shows gradual increase making it an inverted pyramid like that of parasitic food chain.

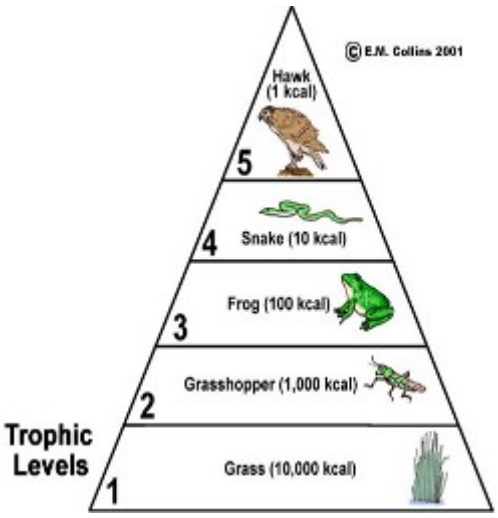




Inverted pyramid of biomass in aquatic ecosystem

Upright pyramid of biomass of forest ecosystem

2. **Pyramid of energy:** - When the production of a community is measured in terms of energy, we find that pyramid is formed starting from producers to tertiary consumers. It indicates that less energy is transferred from each tropic level than was put into it. There is always a gradual decrease in the energy content at successive trophic levels from the producers to consumers. Therefore, the pyramid attains the upright shape.



Ecosystem services : The benefits obtained from ecosystems are called as ecosystem services. The benefits arising from the ecological functions of healthy ecosystems are provided by soil, water, air and land to the human beings and other living beings which include plants and animals. Thus all biotic (living) and Abiotic (non-living) components of the ecosystem are included in the list of ecosystem services.

Ecological Values: Healthy ecosystems are vital to life. They regulate many of the chemical and climatic systems that make available clean air and water and plentiful oxygen. Forests, for example, regulate the amount of carbon dioxide in the air, produce oxygen as a byproduct of photosynthesis (the process by which plants use sunlight to create energy), and control rainfall and soil erosion. These forests also provide humus to the soil through leaf litter and add nutrient strength to the soil. One of the strengths of our agriculture is the soil nutrients. These nutrients in the soil are being made available to the plants through biogeochemical cycles. These cycles are driven by soil microbes. A gram of fertile agricultural soil contains 2.5 billion bacteria, 4.0 lacs fungi, 50,000 algae and 30,000 protozoa. All these have their role to play in the soil and its fertility and they interact with each other. These micro organisms are also helpful in decreasing the toxicity of the soil which comes through the waste products. There is an array of other ecosystem services, a few are

- Water purification system through natural systems
- Role of bees in pollination
- Watershed management.
- Afforestation

Economic values: A large number of products are derived from air, water, and soil and are sold and bought in the market. These derived products have economic value in the market. The forest produce timber, gum, resins, oils, waxes, dyes and rubber which are sold and bought are of immense commercial value. The much of energy needs of the rural masses are still being met by forests. Well maintained trees and shrubs can increase property value by up to 14%. Trees

properly placed around buildings can reduce air conditioning needs by 30%. A mature tree more than 50 yrs removes almost 70 times more pollution than a newly planted tree. A healthy tree can have a value of up to $10,0000 for its unknown services. The shade and wind buffering provided by trees reduces annual heating and cooling costs by 2.1 billion dollars. One tree can absorb as much carbon in a year as a car produces while driving 26,000 miles. Over the course of its life, a single tree can absorb one ton of carbon dioxide.

Social values: An important place of honor has been given to the plants and animals in the galaxy of Hindu gods and their associates.There are animal gods like hanuman (Monkey), Ganapati (mice), Lord Vishnu sleeps on the snake, rides on theGaruda, while the god Ishwara and his sons Ganapathy and Subramanayam have the bull, mouse and the peacock astheir vahans (ride) and goddess Durga has selected the tiger as her animal to ride. The early Indus civilization showsthe use of animal symbols in their seals. Their mythology and literature are full of accounts of these animals.

Aesthetic values: The ornamental plants are still an attractive commodity or art of beauty in our drawing rooms, balconies, pavements,lawns and gardens etc. The unusual and interesting flora (Plants) and fauna (animals) still attracts lot of touristsespecially when combined with scenic landscapes. The wildlife gives recreation to people of all walks of life. Birdwatching is still a very popular pastime and profession among many people. The aesthetic value of the biodiversity alsogives us some sort of feeling the pride. The Kashmir Stag is pride of the people of the state. Similarly the nationalanimal tiger represents the country India.

Informational values: Information literally means getting knowledge about someone or something based on facts while as the value measures the worth or usefulness of something. In an ecosystem a set of biotic and abiotic factors work together with each other in an environment and they exchange energy with each other and there is cycling of nutrients etc. Informational value thus studies ecosystems with details on the information of the various biotic and abiotic factors about their ability to sustain. It also envisages to know the direct and indirect benefits of the ecosystems.

The ecosystems have value on the fact that it flourishes life on the earth. Besides it provides services to satisfy the needs of the human beings. The following points can be useful in understanding the informational value of an ecosystem and can be elaborated further.

- Role of forests in maintaining the environment and the value of oxygen provided by the forests.
- The source of earning and economic gains derived out of land or soil.
- The value of water when we have to purchase bottled water from the market.
- The value of oxygen present in the atmosphere and the value we pay in purchasing oxygen cylinder for the purpose of medical treatment.