UNIT 1- ENVIRONMENT, ECOLOGY AND BIODIVERSITY

Environment:

Natural surroundings in which you live or exist, considered in relation to their physical characteristics or weather conditions.

The environment is indeed an inter-dependent complex of many factors including the biotic (biological components), abiotic (physical components), and the socio-cultural aspect of the population and flora and fauna of the living component.

The environment can be defined as a sum total of all the living and non-living elements and their effects which influence human life. While all living or biotic elements are animals, plants, forests, fisheries, and birds, etc. The non-living or abiotic elements include water, land, sunlight, rocks, and air, etc.

Environmental studies

Environmental studies are a group of multiple and inter-disciplinary studies, studying the relations of humans and the environment, and the impact of humans on nature.
It is a part of the broader field of environmental education, which integrates the basics of Biology, Chemistry, Physics, Mathematics, Geology, Statistics, Sociology, History, etc.

Scope of Environmental studies

Environmental studies discipline has multiple and multilevel scopes. This study is important and necessary not only for children but also for everyone. The scopes are summarized as follows:

1. The study creates awareness among the people to know about various renewable and nonrenewable resources of the region. The endowment or potential, patterns of utilization and the balance of various resources available for future use in the state of a country are analyzed in the study.
2. It provides the knowledge about ecological systems and cause and effect relationships.
3. It provides necessary information about biodiversity richness and the potential dangers to the species of plants, animals and microorganisms in the environment.
4. The study enables one to understand the causes and consequences due to natural and main induced disasters (flood, earthquake, landslide, cyclones etc.,) and pollutions and measures to minimize the effects.
5. It enables one to evaluate alternative responses to environmental issues before deciding an alternative course of action.
6. The study enables environmentally literate citizens (by knowing the environmental acts, rights, rules, legislations, etc.) to make appropriate judgments and decisions for the protection and improvement of the earth.

7. The study exposes the problems of over population, health, hygiene, etc. and the role of arts, science and technology in eliminating/ minimizing the evils from the society.
8. The study tries to identify and develop appropriate and indigenous eco-friendly skills and technologies to various environmental issues.
9. It teaches the citizens the need for sustainable utilization of resources as these resources are inherited from our ancestors to the younger generating without deteriorating their quality.
10. The study enables theoretical knowledge into practice and the multiple uses of environment.

Importance of Environmental studies

1. World population is increasing at an alarming rate especially in developing countries.
2. The natural resources endowment in the earth is limited.
3. The methods and techniques of exploiting natural resources are advanced.
4. The resources are over-exploited and there is no foresight of leaving the resources to the future generations.
5. The unplanned exploitation of natural resources lead to pollution of all types and at all levels.
6. The pollution and degraded environment seriously affect the health of all living things on earth , including man.
7. The people should take a combined responsibility for the deteriorating environment and begin to take appropriate actions to space the earth.
8. Education and training are needed to save the biodiversity and species extinction.
9. The urban area, coupled with industries, is major sources of pollution.
10. The number and area extinct under protected area should be increased so that the wild life is protected at least in these sites.
11. The study enables the people to understand the complexities of the environment and need for the people to adapt appropriate activities and pursue sustainable development, which are harmonious with the environment.
12. The study motivates students to get involved in community action, and to participate in various environmental and management projects.
13. It is a high time to reorient educational systems and curricula towards these needs.
14. Environmental studies take a multidisciplinary approach to the study of human interactions with the natural environment. It integrates different approaches of the humanities, social sciences, biological sciences and physical sciences and applies these approaches to investigate environmental concerns.
15. Environmental study is a key instrument for bringing about the changes in the knowledge, values, behaviors and lifestyles required to achieve sustainability and stability within and among countries.

Ecosystem

An ecosystem is a community of living organisms in conjunction with the nonliving components of their environment, interacting as a system.

Community or group of living organisms that live in and interact with each other in a specific environment.

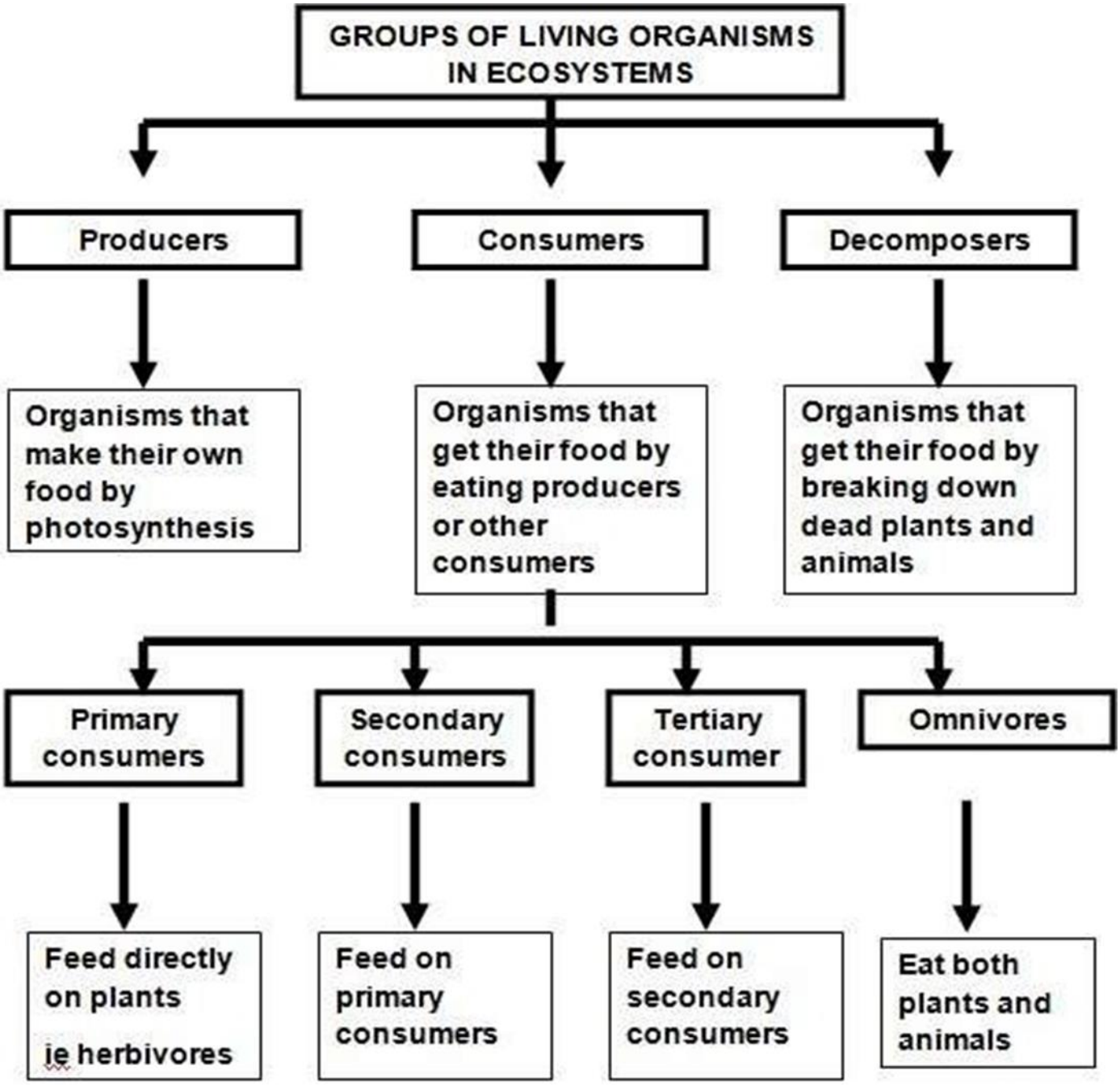
The term ecosystem was coined in 1935 by the Oxford ecologist Arthur Tansley to encompass the interactions among biotic and abiotic components of the environment at a given site. The living and non-living components of an ecosystem are known as biotic and abiotic components, respectively.

Smith (1966) has summarized common characteristics of most of the ecosystems as follows:

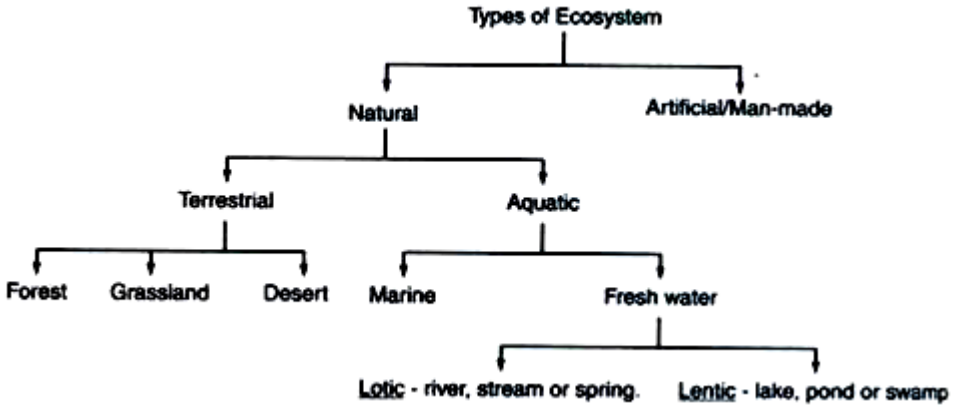
1. The ecosystem is a major structural and functional unit of ecology.
2. The structure of an ecosystem is related to its species diversity in the sense that complex ecosystem have high species diversity.
3. The function of ecosystem is related to energy flow and material cycles within and outside the system.
4. The relative amount of energy needed to maintain an ecosystem depends on its structure. Complex ecosystems needed less energy to maintain themselves.
5. Young ecosystems develop and change from less complex to more complex ecosystems, through the process called succession.
6. Each ecosystem has its own energy budget, which cannot be exceeded.
7. Adaptation to local environmental conditions is the important feature of the biotic components of an ecosystem, failing which they might perish.
8. The function of every ecosystem involves a series of cycles, e.g., water cycle, nitrogen cycle, oxygen cycle, etc. these cycles are driven by energy. A continuation or existence of ecosystem demands exchange of materials/nutrients to and from the different components.

The two main processes that ecosystem scientists study are Energy transformations and biogeochemical cycling.

ABIOTIC COMPONENTS	BIOTIC COMPONENTS
Sunlight	Primary producers
Temperature	Herbivores
Precipitation	Carnivores
Water or moisture	Omnivores
Soil or water chemistry (e.g., P, NO_3, NH_4)	Detritivores
etc.	etc.


GROUPS OF LIVING ORGANISMS IN ECOSYSTEMS
Producers
Consumers
Decomposers
Organisms that make their own food by photosynthesis
Organisms that get their food by eating producers or other consumers
Organisms that get their food by breaking down dead plants and animals
Primary consumers
Secondary consumers
Tertiary consumer
Omnivores
Feed directly on plants
ie herbivores
Feed on primary consumers
Feed on secondary consumers
Eat both plants and animals

COMPONENTS OF ECOSYSTEM



(a) Natural Ecosystems:

These ecosystems are capable of operating and maintaining themselves without any major interference by man.

A classification based on their habitat can further be made:

1. Terrestrial ecosystems: forest, grassland and desert.

2. Aquatic ecosystems: fresh water ecosystem, viz. pond, lake, river and marine ecosystems, viz.ocean, sea or estuary.

(b) Artificial Ecosystem:

These are maintained by man. These are manipulated by man for different purposes, e.g., croplands, artificial lakes and reservoirs, townships and cities.

Basic Structure of an Ecosystem:

Every ecosystem has a non-living (abiotic) and living (biotic) components.

Abiotic Components:

Basic inorganic compounds of an organism, habitat or an area like carbon dioxide, water, nitrogen, calcium, phosphorus, etc. that are involved in the material cycles are collectively called as abiotic component. The amount of these inorganic substances present at any given time, in an ecosystem is called as the standing state or standing quality of an ecosystem.

Whereas, organic components e.g., proteins, amino acids, carbohydrates and lipids that are synthesized by the biotic counterpart of an ecosystem make the biochemical structure of the ecosystem. The physical environment, viz. climatic and weather conditions are also included in the abiotic structure of the ecosystem.

Biotic Components:

From the trophic (nutritional) point of view, an ecosystem has autotrophic (self-nourishing) and a heterotrophic (other nourishing) components:

Autotrophic component (Producers):

This component is mainly constituted by the green plants, algae and all photosynthetic organisms. Chemosynthetic bacteria, photosynthetic bacteria, algae, grasses, mosses, shrubs, herbs and trees manufacture food from simple inorganic substances by fixing energy and are therefore called as producers.

(b) Heterotrophic component (Consumers):

The members of this component cannot make their own food. They consume the matter built by the producers and are therefore called as consumers. They may be herbivores, carnivores or omnivores. Herbivores are called as primary consumers whereas carnivores and omnivores are called as secondary consumers. Collectively we can call them as macro-consumers.

Decomposers:

Heterotrophic organisms chiefly bacteria and fungi that breakdown the complex compounds of dead protoplasm, absorb some of the products and release simple substances usable by the producers are called as decomposers or reducers. Collectively we call them as micro consumers.

Types of 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.

Structure (components) and function of forest ecosystem

I. Abiotic components:

The abiotic components are physical (inorganic and organic substances) components found in soil and atmosphere. (E.g. Temperature, light, rain fall)

II. Biotic components:
    1. Producers: The plants absorb sunlight and produce food through photosynthesis.(e.g. Trees, shrubs and ground vegetation)
    2. Consumers:
        a) Primary consumers: They directly depend on the plants for their food.(e.g.. Ants, flies, insects, mice, deer)
        b) Secondary consumers: They directly depend on the herbivores for their food. (e.g. Snakes, birds, fox)
        c) Tertiary consumers: They depend on the primary carnivores for their food.(e.g. .Tiger, lion)
    3. Decomposers: Rate of decomposition in tropical and subtropical forests is more rapid than in the temperate forests. (e.g. Bacteria and fungi).

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.

Structure (components) and function of grassland ecosystem

I. Abiotic components: These abiotic components are supplied by CO_2 (Nutrients C,H,O,N,P,S,etc.)
II. Biotic components:
    1. Producers: They produce food.(Grasses, forbs and shrubs)
    2. Consumers:

a) Primary consumers: They depend on grasses for their food.(Cows, buffaloes, deer, sheep, etc.,)
b) Secondary consumers: They feed on herbivores.(Snakes, lizards, birds, jackals, fox, etc.,)
c) Tertiary consumers: They feed on secondary consumers.(Hawks, eagles, etc.,)

3. Decomposers: Fungi and bacteria (decompose the dead organic matter.

Desert Ecosystem

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

Structure and functions of the desert ecosystems:

I. Abiotic components: Temperature water, sunlight, rainfall, etc. The temperature is very high and low rain fall & low nutrient cycling.

II Biotic components:

1. Producers: Shrubs, bushes , In deserts mostly Succulent (e.g., cacti) plants are found available. They have water inside them to stay alive.

2. Consumers: Squirrels, mice, rabbits, reptiles. These animals dig holes in the ground to live in. Most of the animals can extract water from the seeds they eat.

3. Decomposers: Fungi and bacteria, Desert has poor vegetation with a very low amount of dead organic matter.

Aquatic Ecosystem

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.

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.

Structure (components) and function of aquatic ecosystem

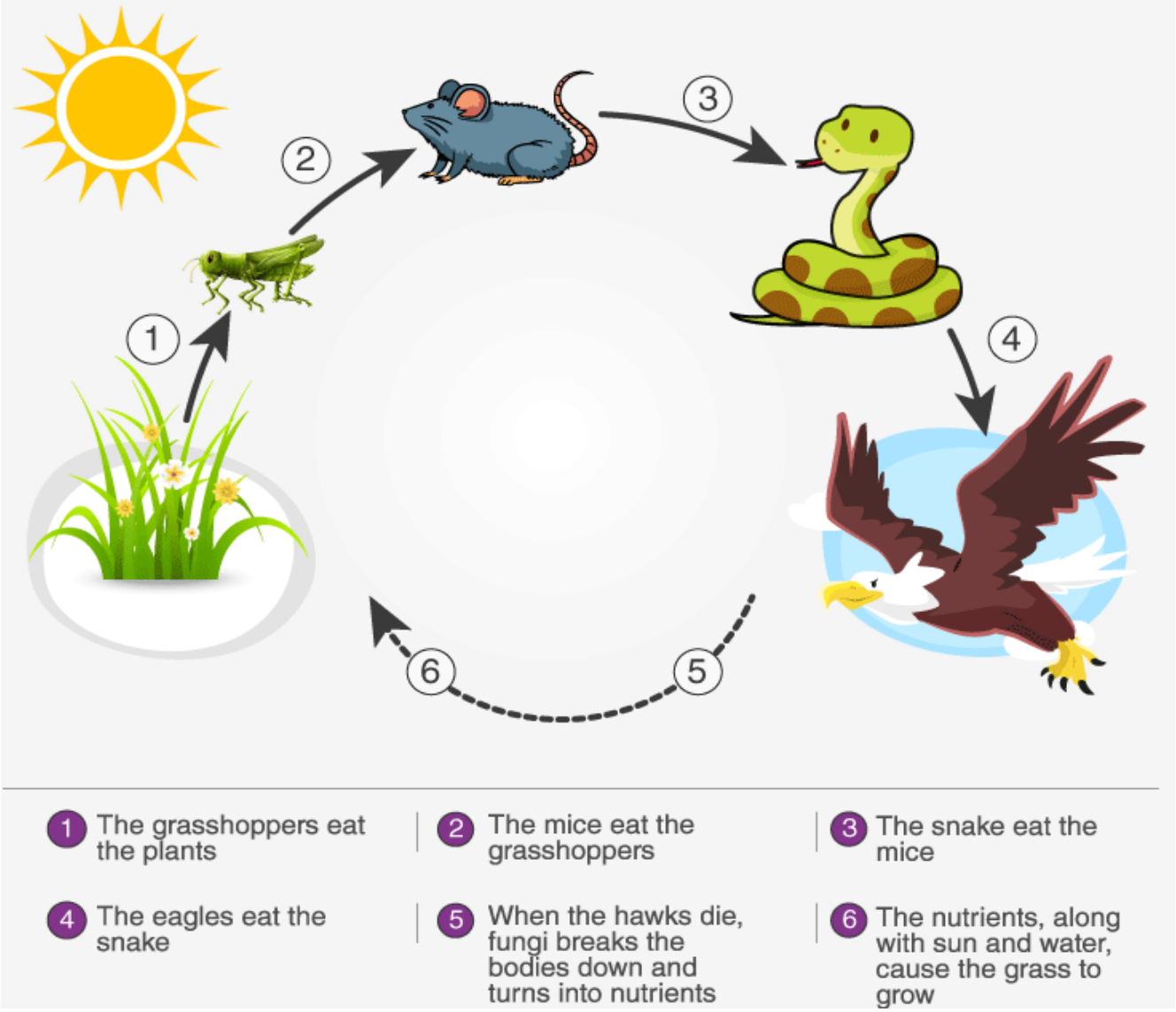
I. Abiotic components: Temperature, light proteins, O2

II. Biotic components:

1. Producers: They are green plants, may be submerged, free floating and amphibious plants. phytoplanktons, algae and flagellates
2. Consumers:
    a) Primary Consumers (Zooplanktons) Cilictes, protozoans, etc., - They feed on phytoplankton
    b) Secondary consumers (carnivores)Insects and small fishes. – They feed on zooplankton.
    c) Tertiary consumers: Large fishes like game fish - They feed on smaller fish.
3. Decomposers: Bacteria, fungi and actinomycetes.- They decompose the dead plants and animals

Important Ecological Concepts

1. Food Chain



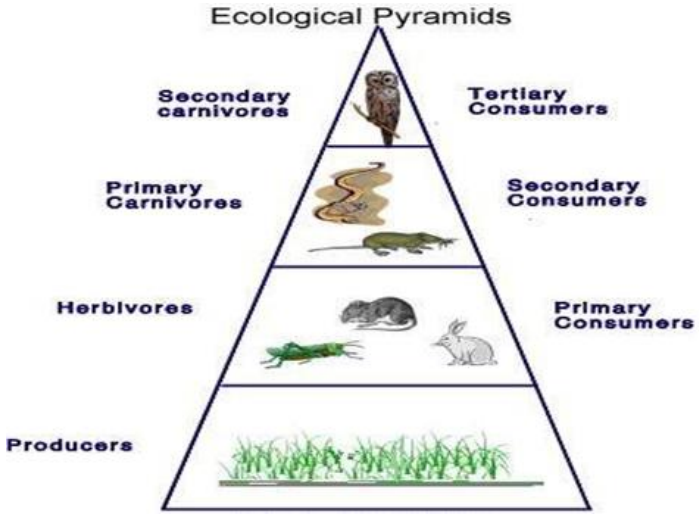
- The sun is the ultimate source of energy on earth. It provides the energy required for all plant life. The plants utilize this energy for the process of photosynthesis, which is used to synthesize their food.

- During this biological process, light energy is converted into chemical energy and is passed on through successive levels. The flow of energy from a producer, to a consumer and eventually, to an apex predator or a detritivore is called the food chain.

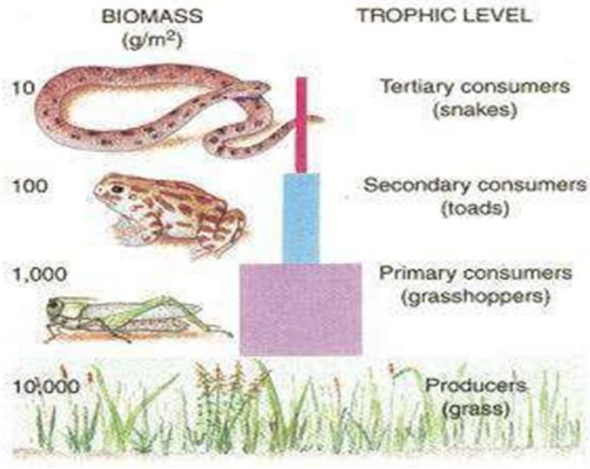
- Dead and decaying matter, along with organic debris, is broken down into its constituents by scavengers. The reducers then absorb these constituents. After gaining the energy, the reducers liberate molecules to the environment, which can be utilised again by the producers.

2. Ecological Pyramids

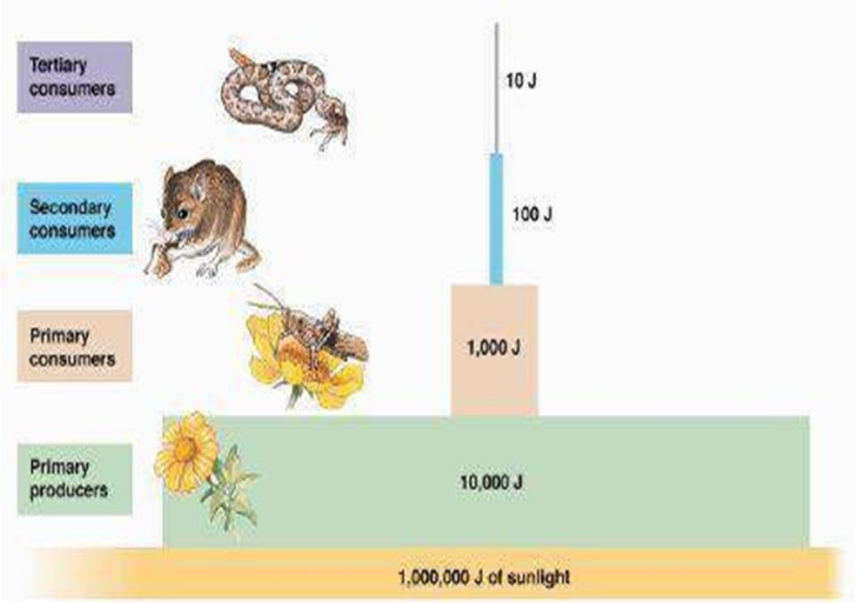
- An ecological pyramid is the graphical representation of the number, energy, and biomass of the successive trophic levels of an ecosystem. Charles Elton was the first ecologist to describe the ecological pyramid and its principals in 1927.
- The biomass, number, and energy of organisms ranging from the producer level to the consumer level are represented in the form of a pyramid; hence, it is known as the ecological pyramid.
- The base of the ecological pyramid comprises the producers, followed by primary and secondary consumers. The tertiary consumers hold the apex. In some food chains, the quaternary consumers are at the very apex of the food chain.
- The producers generally outnumber the primary consumers and similarly, the primary consumers outnumber the secondary consumers. And lastly, apex predators also follow the same trend as the other consumers; wherein, their numbers are considerably lower than the secondary consumers.
- For example, Grasshoppers feed on crops such as cotton and wheat, which are plentiful. These grasshoppers are then preyed upon by common mice, which are comparatively less in number. The mice are preyed upon by snakes such as cobras. Snakes are ultimately preyed on by apex predators such as the brown snake eagle.



Pyramid of Number



Pyramid of Biomass



Pyramid of Energy

Pyramid of Number

- It depicts the number of individual organisms at different tropic levels of food chain.
- The animals at the lower end (base of pyramid) of the chain are the most abundant. Successive links of carnivores decrease rapidly in number until there are very few carnivores at the top.
- The pyramid of number ignores the biomass of organisms and it also does not indicate the energy transferred or the use of energy by the groups involved. The lake ecosystem provides a typical example for pyramid of number.

Pyramid of Biomass

- The biomass of the members of the food chain present at any one time forms the pyramid of the biomass.
- Pyramid of biomass indicates decrease of biomass in each tropical level from base to apex. For example, the total biomass of the producers ingested by herbivores is more than the total biomass of the herbivores in an ecosystem. Likewise, the total biomass of the primary carnivores (or secondary consumer) will be less man the herbivores and so on.

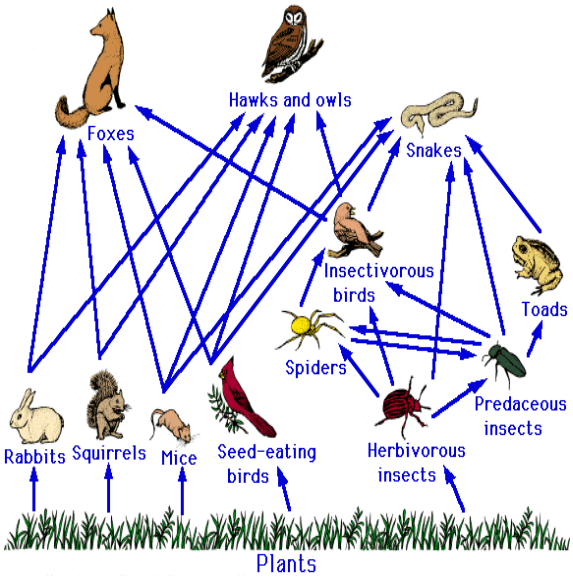
Pyramid of Energy

- When production is considered in terms of energy, the pyramid indicates not only the amount of energy but also flow at each level the actual role the various organisms play in the transfer of energy.

3. Food Web

Food web is a network of interconnected food chains. It comprises all the food chains within a single ecosystem. It helps in understanding that plants lay the foundation of all the food chains. In a marine environment, phytoplankton forms the primary producer.

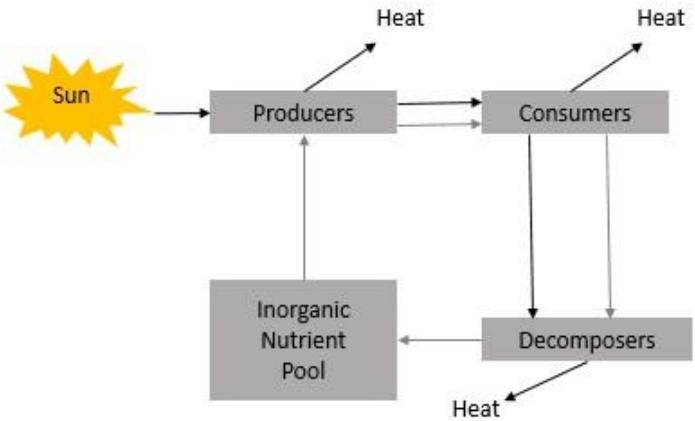
Food webs are more realistic representation of consumption relationships in ecosystems



Significance of food chains and food webs

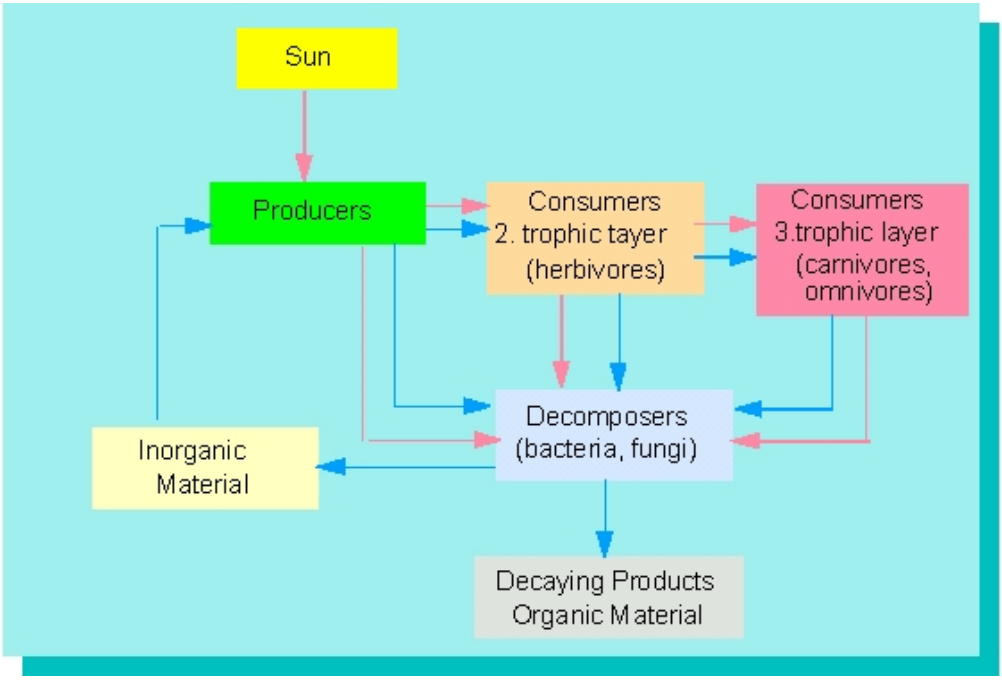
- Energy flow and nutrient cycling takes place through them.
- They maintain and regulate the population size of different tropic levels, and thus help in maintaining ecological balance.

Energy flow in an Ecosystem



- Energy moves life. The cycle of energy is based on the flow of energy through different trophic levels in an ecosystem. Our ecosystem is maintained by the cycling energy and nutrients obtained from different external sources. At the first trophic level, primary producers use solar energy to produce organic material through photosynthesis.
- The herbivores at the second trophic level, use the plants as food which gives them energy. A large part of this energy is used up for the metabolic functions of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood circulation and body temperature.
- The carnivores at the next trophic level, feed on the herbivores and derive energy for their sustenance and growth. If large predators are present, they represent still higher trophic level and they feed on carnivores to get energy. Thus, the different plants and animal species are linked to one another through food chains.
- Decomposers which include bacteria, fungi, molds, worms, and insects break down wastes and dead organisms, and return the nutrients to the soil, which is then taken up by the producers. Energy is not recycled during decomposition, but it is released.
- The flow of energy from producer level to top consumer level is called energy flow.
- The flow of energy in an ecosystem is unidirectional. It flows from producer level to consumer level.
- The process of energy flow involves transfer of energy from autotrophs to various components of heterotrophs and help in maintaining bio diversity.
- The main source of energy in the ecosystem is sunlight. About 80% of energy is lost during flow of energy from one tropic level to the next one.

Material flow in an Ecosystem



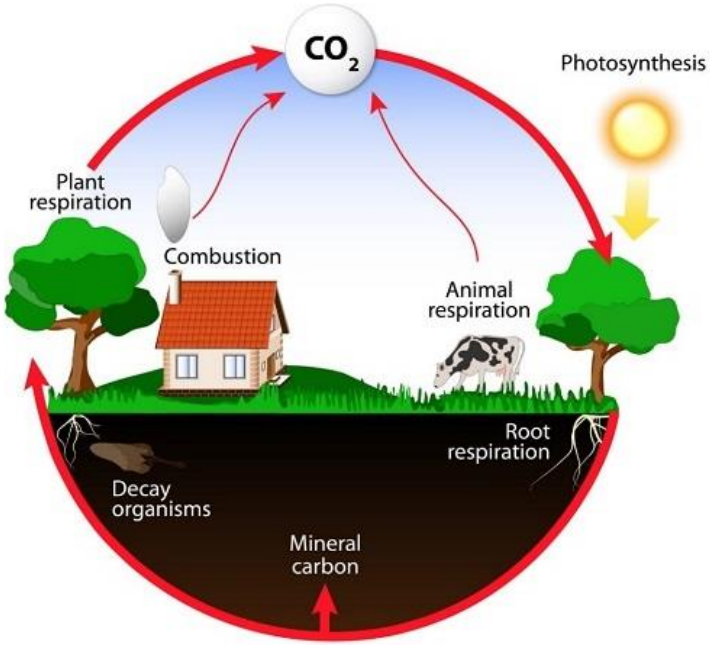
- All elements in the earth are recycled time and again. The major elements such as oxygen, carbon, nitrogen, phosphorous, and sulphur are essential ingredients that make up organisms.
- Biogeochemical cycles refer to the flow of such chemical elements and compounds between organisms and the physical environment. Chemicals taken in by organisms are passed through the food chain and come back to the soil, air, and water through mechanisms such as respiration, excretion, and decomposition.
- As an element moves through this cycle, it often forms compounds with other elements as a result of metabolic processes in living tissues and of natural reactions in the atmosphere, hydrosphere, or lithosphere.
- Such cyclic exchange of material between the living organisms and their non-living environment is called Biogeochemical Cycle.

Following are some important biogeochemical cycles −

- Carbon Cycle
- Nitrogen Cycle
- Water Cycle

Carbon Cycle

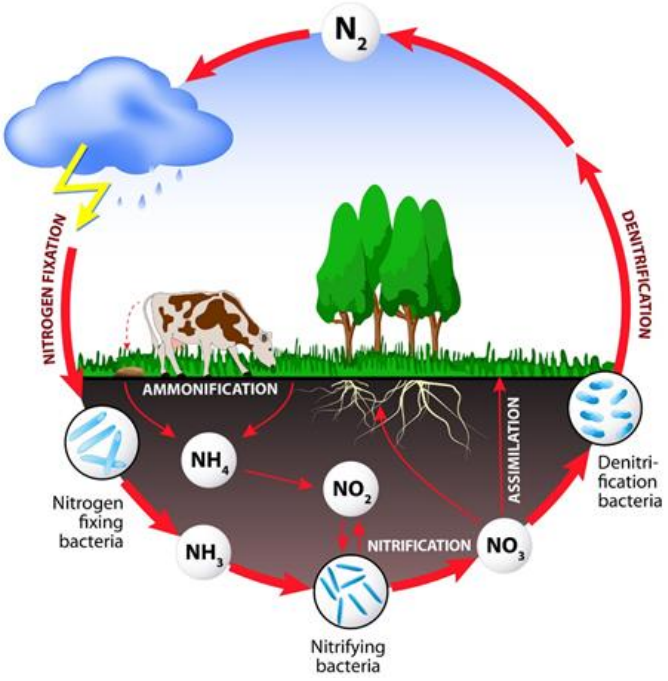
Carbon enters into the living world in the form of carbon dioxide through the process of photosynthesis as carbohydrates. These organic compounds (food) are then passed from the producers to the consumers (herbivores & carnivores). This carbon is finally returned to the surrounding medium by the process of respiration or decomposition of plants and animals by the decomposers. Carbon is also recycled during the burning of fossil fuels.



Nitrogen Cycle

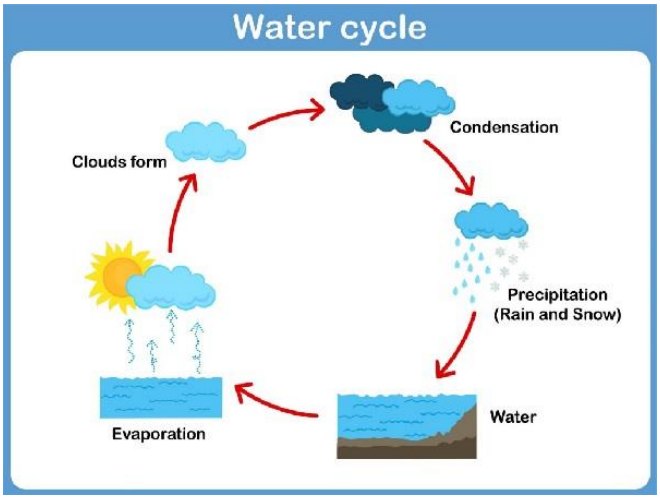
Nitrogen is present in the atmosphere in an elemental form and as such it cannot be utilized by living organisms. This elemental form of nitrogen is converted into combined state with elements such as H, C, O by certain bacteria, so that it can be readily used by the plants.

Nitrogen is being continuously expelled into the air by the action of microorganisms such as denitrifying bacteria and finally returned to the cycle through the action of lightening and electrification.



Water Cycle

The evaporation of water from ocean, rivers, lakes, and transpiring plants takes water in the form of vapors to the atmosphere. This vaporized water subsequently cools and condenses to form cloud and water. This cooled water vapor ultimately returns to the earth as rain and snow, completing the cycle.



Biodiversity

Biodiversity, a shortened form of Biological diversity, refers to the existence of number of different species of plants and animals in an environment.

"Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

Biodiversity is also defined as the existence of variability among living organisms on the earth, including the variability within and between species, and within and between ecosystems.

Species Diversity

Species diversity refers to the variety of different species of plants, animals, fungi, and organisms that are present in a region. It is estimated that there are above 30 million species on the earth. Species diversity is a part of diversity. Even within a small pond, we can notice a great variety of species. Species diversity differs from ecosystem to ecosystem. For example, in a tropical ecosystem more diversity is found than in temperate ecosystem. The most diverse group of species is invertebrates - animals without backbones.

At present, conservation scientists have been able to identify and categorize about 1.8 million species on earth. Many new species are being identified. Areas that are rich in species diversity are called ‘hotspots’ of diversity.

Genetic Diversity

Species Diversity

Genetic Diversity

It is the variation in genes that exists within a species. Genetic diversity corresponds to the variety of genes contained in plants, animals, fungi, and micro-organisms.

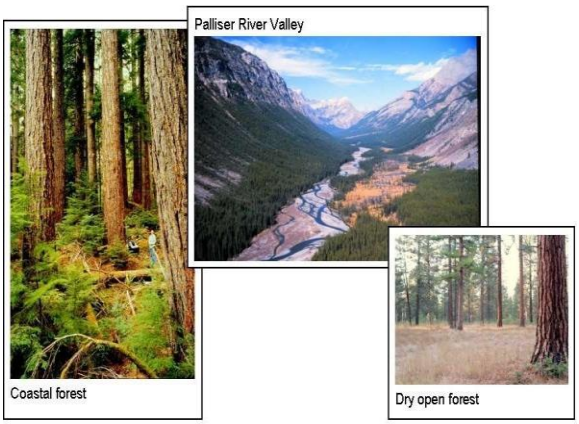
It occurs within a species as well as between species. For example, poodles, German shepherds and golden retrievers are all dogs, but they all are different in look, color, and abilities. Each human being is different from all others. This genetic variability is essential for a health breeding of a population of species.

The diversity in wild species make the ‘gene pool’ from which crops and domestic animals have been developed over thousands of years.

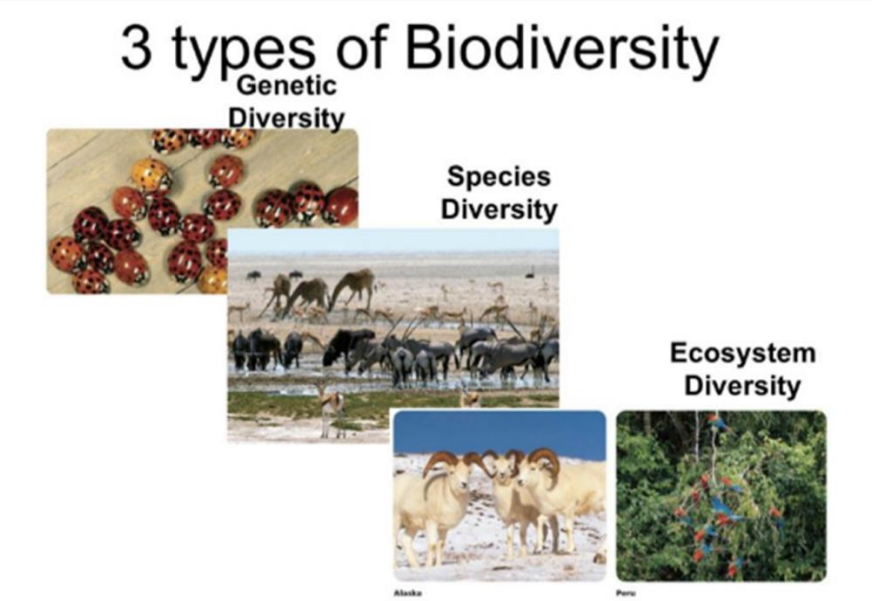
Ecosystem Diversity

It is the diversity of ecosystems, natural communities, and habitats. In other words, ecosystem diversity refers to the variety of ways that species interact with each other and their environment. Tropical or temperate forests, grasslands, hot and cold deserts, wetlands, rivers, mountains, and coral reefs are instances of ecosystem diversity.

Each ecosystem corresponds to a series of complex relationships between biotic (living) and abiotic (non-living) components.



Ecosystem Diversity



Significance of Biodiversity

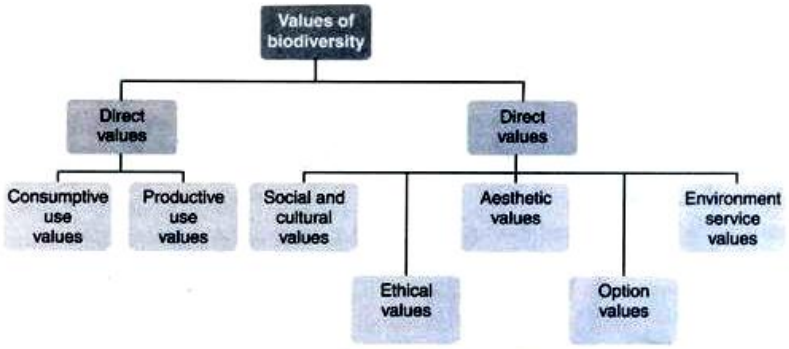
Environmental services from species and smooth running cycles of ecosystems are necessary at global, regional, and local levels.

Biodiversity is essential for maintaining the water cycles, production of oxygen, reduction in carbon dioxide, protecting the soil, etc. It is also essential for preserving ecological processes, such as soil formation, circulation of and cleansing of air and water, global life support, fixing and recycling of nutrients, maintaining hydrological balance within ecosystems, maintaining rivers and streams throughout the year, etc.

Biodiversity has many values such as consumptive use value, productive use value, and social values, ethical and moral values.

A healthy biodiversity offers many valuable services as follows.

- The more a region is rich in terms of biodiversity, better is the regulation of the different cycles. For example, forests regulate the amount of carbon dioxide in the air by releasing oxygen as a by-product during photosynthesis, and control rainfall and soil erosion.
- Protects water resources from being depleted, contaminated, or polluted.
- Helps in soil formation and protection.
- Helps in nutrient storage and recycling.
- Helps check pollution.
- Contributes to climate stability.
- Helps an ecosystem in recovery from unpredictable events.
- Provides biological resources such as food, medicinal resources, and pharmaceutical drugs, wood products, ornamental plants, breeding stocks, etc.
- Provides recreation and tourism facilities.
- Helps in research, education, and monitoring.
- Preservation of biological resources is essential for the well-being and long-term survival of mankind.



Values of Biodiversity

The values can be divided as:

- **Direct values**

  Direct values, also known as use values and commodity values, are assigned to the products harvested by people. Direct values can be readily estimated by observing the activities of representative groups of people, by monitoring collection points for normal products and by examining the export/ import statistics. These values can be further sub-divided as:

  a) Consumptive use value
  It can be assigned to goods such as fuel wood and goods that are consumed locally and do not figure in national and international market

  b) Productive use value
  It is assigned to products that are derived from the wild and sold in commercial markets, both national as well as international markets.

- **Indirect values**

  Indirect values are assigned to benefits provided by biodiversity that do not involve harvesting or destroying the natural resource. Such benefits include ecological benefits such as soil formation, nutrient cycling, waste disposal, air and water purification, education, recreation, future options for human beings, etc. Indirect value can be further sub-divided as:

  a) Non-consumptive use value
  It is assigned to benefits such as soil formation/ protection, climate regulation, waste disposal, water and air purification, eco-tourism, medical research, etc

  b) Aesthetic, social and cultural value
  The diversity of life on Earth brings us many aesthetic and cultural benefits. It adds to the quality of life, providing some of the most beautiful and appealing aspects of our existence.

- Biodiversity is an important quality of landscape beauty. Many species of birds, large land mammals, sea animals and flowering plants are appreciated for their beauty.
- Millions of people enjoy hiking, camping, picnics, fishing, wildlife watching, and other recreational activities based on nature. These activities provide invigorating physical exercise and allow us to practice pioneer living skills.
- Contact with nature can also be psychologically and emotionally restorative. In many cultures, nature carries spiritual connotations, and a particular plant or animal species or landscape may

be inextricably linked to a sense of identity and meaning.

c) Option value

The option value of a species is its potential to provide our economic benefit to human society in the near future. For instance, there are several plant species which are edible and superior than those which are currently in use; e.g. Katemfe, a plant found in W. Africa, produces proteins that are 1,600 times sweeter than sucrose.

d) Existence value

It is assigned to protect wildlife. Since, for many people, the value of wildlife goes beyond the opportunity to photograph or even see a particular species. They argue that 'existence value', based on simply knowing that a species exist, is a sufficient reason to protect and preserve it. This right to exists was also stated in the U.N. General Assembly World Charter for Nature, 1982.

e) Ethical value

Moral justification for conservation of biodiversity is based on the belief that species have a moral right to exist, independent of our need for them. Consequently, the argument follows that in our role as the most intelligent species on Earth we have a responsibility to try as much as possible for the continuance of all forms of life.

Ethical values are deep rooted within human culture, a religion and society, but, those who look on cost benefit analysis, they overlook these ethical values. International boycotts of furs, teak and ivory are the good examples of moral justification.

Threats to biodiversity

- **Habitat loss and deforestation**

  The dramatic alteration of habitats directly threatens biodiversity. When such habitats are lost due to deforestation and other anthropogenic activities such as mining, the respective environments are unable to provide shelter, food, water, or breeding grounds for the living organisms. In other words, it leads to unhealthy and unbalanced ecosystems that result in the loss of biodiversity and extinction.

- **Climate change**

  The global climatic changes throughout the history of the plant have definitely modified life and ecosystems in the planet. As an outcome, crucial habitats have been destroyed and a number of species have gone extinct with a huge majority at the verge of extinction. It therefore means that if the global temperatures continue to change drastically, especially due to anthropogenic activities that accelerate the process, the threats to biodiversity will continue to expand as ecosystems and species will not be able to adapt.

Individuals, organizations and industries need to reduce their carbon footprints and they should equally participate in awareness creation. Cities and international governments can also charge for carbon emissions and enact policies that curtail activities which destroy the carbon sinks.

- **Overexploitation of resources**
  On the account of the ever rising human population, there has been a correlational increase in demand for manufactured products, essential goods and services. The high demands of these things have resulted in overfishing, overhunting, over-harvesting and excessive mineral resource extraction which has highly contributed to biodiversity loss. Mineral extraction, poaching, excessive logging and other forms of resource exploitation for profit has heightened the risks of species extinction. It has also altered natural habits therefore destroying food chains and interfering with the ecological balance.

- **Nutrient loading**
  As the agricultural sector continue to expand and serve towards attaining the world's food security, it has also more than doubled dependence on the use of fertilizers on a profitable scale. Accordingly, the use of fertilizers beyond limits has contributed to increased level of nitrogen and phosphorous nutrients in the natural ecosystems. As much as the nutrients exists naturally in all ecosystems, the manufacturing of artificial fertilizer with reactive nitrogen and phosphorus nutrients to increase crop productivity has altered the ecological balance over time thereby threatening the survival of ecosystems. Particularly, the survivals of species that flourish in phosphorous or nitrogen-poor environments are increasingly threatened. Furthermore, leaches and entry into water systems have resulted in increased eutrophication and the creation of anoxic (oxygen deficient) zones in marine habitats.

- **Environmental pollution**
  Pollution has continued to harm the biosphere by releasing and depositing toxic chemicals into the atmospheric, terrestrial and marine systems. With the high levels of pollution every year, it is gradually disrupting the Earth's ecosystems as the chemicals released potentially influences species' habits and ecosystems. Pollution has also depleted ozone levels, created dead zones in marine habitats due to toxicity and acid rains, altered species feeding and breading habits, and even caused the death of many species due to oil spills or the consumption of plastic and other toxic substances.

Sustainable Development

Sustainable development is the idea that human societies must live and meet their needs without compromising the ability of future generations to meet their own needs. The "official" definition of sustainable development was developed for the first time in the **Brundtland Report** in 1987.

Global objectives for sustainable development

1. Eradicate poverty in all its forms, everywhere.
2. Eradicate hunger, achieve food safety and improved diet and promote sustainable agriculture.
3. Ensure healthy lives and promote well-being for everyone of all ages.
4. Ensure inclusive and fair education of good quality and promote lifelong learning for everyone.
5. Achieve gender equality and strengthen the position of all women and girls.
6. Ensure access to and the sustainable management of water and sanitation for everyone.
7. Ensure access to affordable, reliable, sustainable and modern energy for everyone.
8. Promote continuous, inclusive and sustainable economic growth, full and productive employment, and decent work for everyone.
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and promote innovation.
10. Reduce inequalities within and between countries.
11. Make cities and settlements inclusive, safe, flexible and sustainable.
12. Ensure sustainable consumption and production patterns.
13. Take urgent action to combat climate change and its effects.
14. Preserve and make sustainable use of seas, lakes and marine resources for sustainable development.
15. Sustainable forestry, stop desertification, slow down and reverse soil degradation as well as halt the loss of biodiversity.
16. Promote peaceful and inclusive communities for sustainable development, provide access to justice for everyone and build effective, responsible and inclusive institutions at all levels.
17. Strengthen implementation tools and revitalise the Global Partnership for Sustainable Development.

1. Eradication of poverty across the world

These organizations primarily focus on the least developed and low-income countries where poverty is rife. They aim to eradicate poverty across the board by expanding social protection programs like school feeding, cash transfers, targeted food assistance, social insurance and labor market programs

such as skill training, old-age pensions, wage subsidies, unemployment insurance, disability pensions and so on.

2. Promotion of good health and well being

This sustainable development goal seeks to ensure good health and well-being for all at each stage of life. The goal takes into account all the main health priorities such as maternal and child health, reproductive health, environmental, communicable and non-communicable diseases, universal health coverage, and access to quality, safe, effective, and affordable vaccines and medicines.

It also advocates for enhanced health financing, increased research and development, strengthening the capacity of every country engaged in health risk prevention and management.

3. Provision of Quality Education for All

These bodies have realized that the level of child school dropout is at an all-time high. This gap must be closed to ensure sustainable future development even as international communities work to ensure quality and equity in the education sector.

In a nutshell, this goal seeks to ensure equitable and inclusive quality education and promotion of long-life learning opportunities.

4. Provision of Clean Water and Sanitation

Water and sanitation are on top of the chart regarding sustainable development. They are critical to the survival of humans and the planet. This goal aims to address aspects relating to sanitation, hygiene, drinking water and the quality and sustainability of water resources across the globe.

5. Building up Strong Infrastructure, Supporting Inclusive and Sustainable Industrialization and Incubating Innovation

This goal takes into account three aspects of sustainable development: industrialization, infrastructure, and innovation. Infrastructure is vital because it offers the basic framework necessary to smooth the running of enterprise and society at large.

Industrialization drives up economic development, yield job opportunities, hence, reducing levels of poverty. Innovation enhances the technological abilities of industrial sectors and triggers the development of innovative skills.

6. Enabling Access to Affordable and Clean Energy

Energy is the most critical resource to achieving most of the sustainable development goals. Energy plays a vital role in mitigating poverty through advancements in industrialization, education, water supply and health and fighting climate change.

This sustainable development goal focuses on developing and expanding renewable energy resources such as sun, wind, hydropower, liquid and solid biofuels, biogas and geothermal.

These renewable sources of energy don’t emit greenhouse gasses to the atmosphere and therefore are ideal for the environment and human health.

7. Achieving Gender Equality

In the past few decades, gender equality and women empowerment have been agendas for most governments for long-term sustainable development.

Access to education for girls has since improved, the percentage of child marriage has plummeted, and huge leaps have been taken in the domain of sexual and reproductive health and rights such as the dramatic reduction in maternal health.

Although there is still a long way to go to reach this milestone, organizations are using every ounce of their energy and throwing in resources to ensure the dream is realized.

There are other sustainable development goals set by these bodies including decent jobs and economic growth, sustainable cities and communities, conservation of sea, ocean and marine resources, combating climate change, sustainable consumption and production patterns and much more.

Applications of Sustainable Development.

1. Wind Energy

People have utilized the power of the wind for millennia, dating back to the first recorded windmill in Persia between 500 and 900 AD. Fast forward to the 21st century and, in many localities, energy generated by wind power has become either competitive with or less expensive than coal-generated electricity.
Wind turbines are a great solution for power generation due to their cost and the fact that they require a very small land footprint. Other land uses such as farming, conservation and recreation can happen simultaneously with wind power generation. As the price of wind power technology continues to drop and energy storage and transmission infrastructure improves, wind energy could significantly supplement or replace entire grid systems.

2. Solar Energy

From roof-top solar panels to massive solar farms that can attain the same generating capacity as a conventional power plant, it is clear that there is a renewable energy revolution happening in the world — and it is powered by the sun.
A solar farm can reduce 94% of the emissions that a coal power plant emits. It also eliminates noxious pollutants like sulphur nitrous oxides and mercury which are major contributors to the air pollution responsible for millions of premature deaths every year. Solar technology is getting cheaper and is now cost competitive or less costly than conventional power generation in many parts of the world.

According to the International Renewable Energy Agency, currently 220 million to 330 million tons of annual carbon dioxide are saved due to solar photovoltaic. With solar still making up less than 2% of the global energy mix, this shows the great potential for the growth of solar in the future.

3. Crop Rotation

Currently we produce the bulk of our food through industrial agriculture. A system which relies on large farms that monocrop and use enormous amounts of fertilizer and chemical pesticides. Industrial agriculture is immensely damaging to soils, water, air and the climate.

Crop rotation, in contrast, is defined as "the successive planting of different crops on the same land to improve soil fertility and help control insects and diseases." This way of farming is not a new practice, but rather a more ancient way of farming chemical-free, whilst maximizing the long-term growth potential of land.

An ongoing study at Iowa State University's Marsden Farm research centre has shown that complex crop rotation systems can outperform conventional monoculture in both yield and profitability. It is also a practice that produces a diverse range of foods, can be adapted to different local conditions, causes less erosion and stores more carbon in soils assisting with carbon sequestration.

4. Water efficient fixtures

Many countries in the world are becoming water stressed and we are beginning to understand that water is not as unlimited as we once believed. In most buildings around the world, essential water usage such as showering, washing hands and sewage conveyance is unavoidable.

However, the amount of water used for these essential services can be drastically reduced by more than 50% with the use of water-saving fittings and fixtures. Some examples of water-efficient fixtures include: low-flow taps and shower heads, dual flush toilets and toilet stops. These fixtures can be retrofitted easily and affordably into existing buildings or specified for new building projects.

5. Green Spaces

Green spaces such as parks, wetlands, lakes, forests or other eco systems are fundamental to sustainably developed urban areas. These areas are essential for cooling cities while trees produce oxygen and filter out air pollution. Well-designed green spaces also play a critical role in providing safer routes for those commuting by foot or bicycle and providing safer spaces for physical activity and recreation.

According to the World Health Organization, "recent estimates show that physical inactivity, linked to poor walkability and lack of access to recreational areas, accounts for 3.3% of global deaths." Thus having access to green spaces can improve health and well-being and even aid in the treatment of mental illness

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