

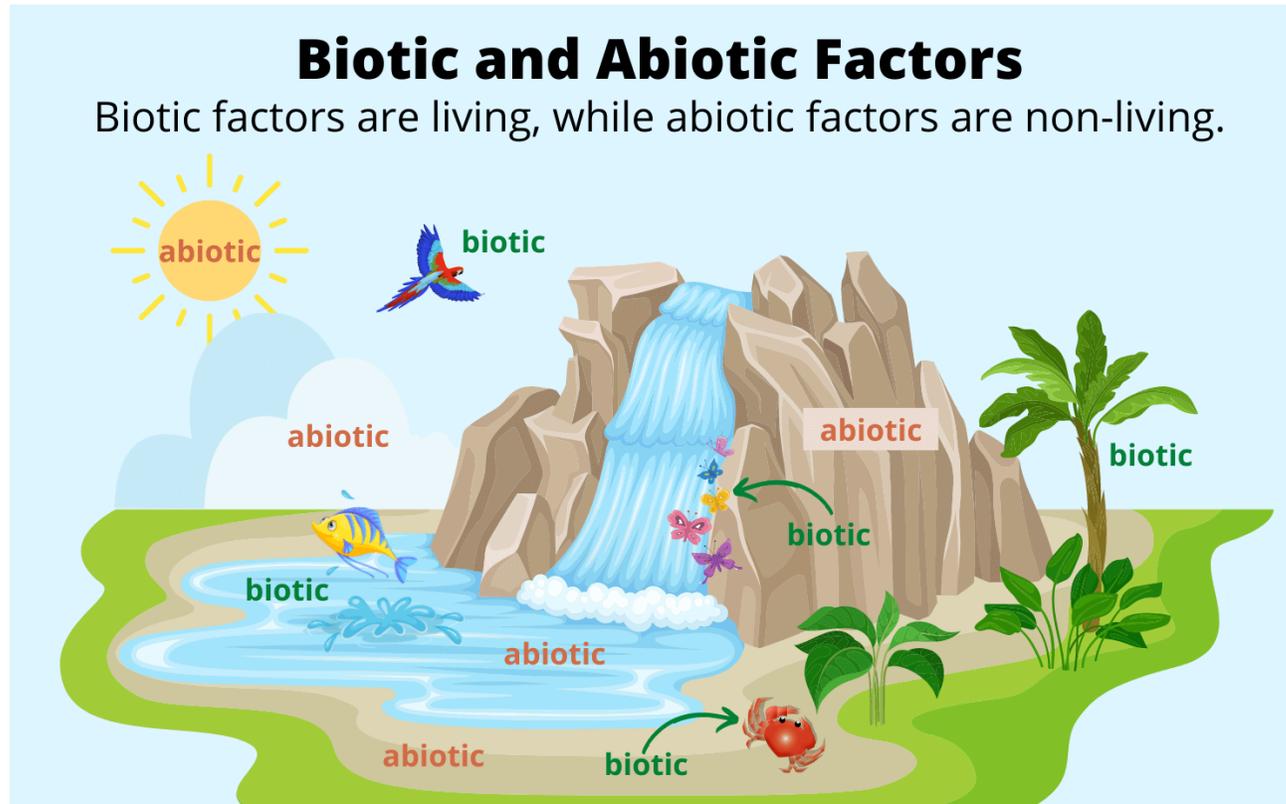


Environment



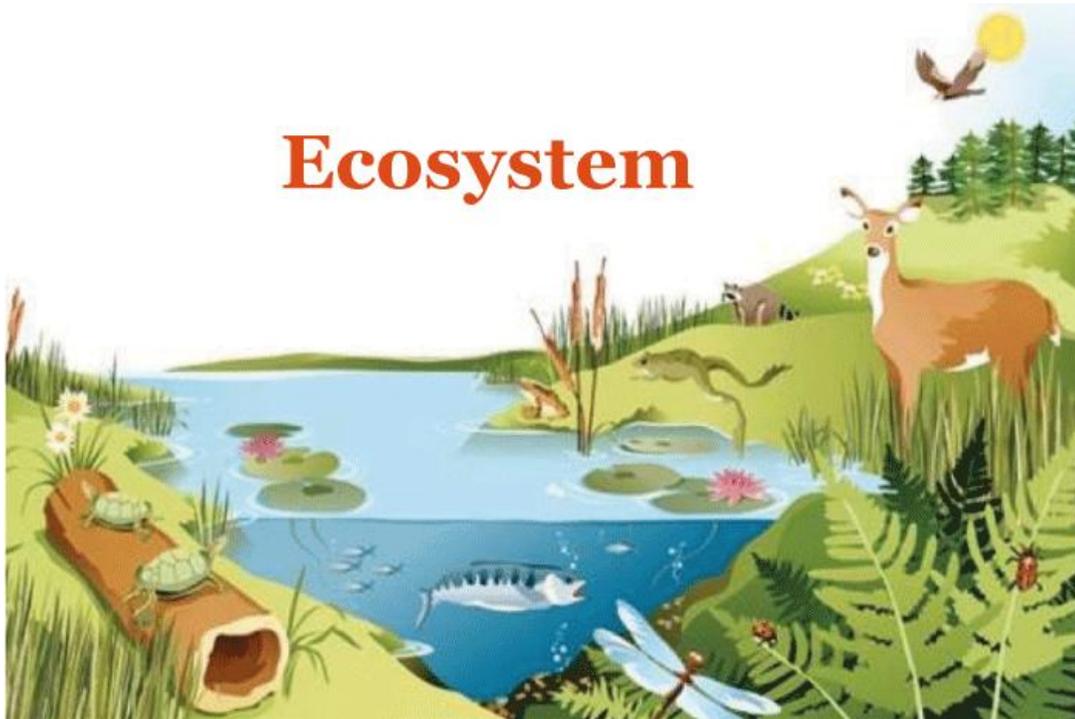
Definition of Environment

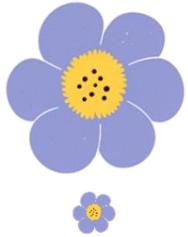
Combination of Biotic + Abiotic Components = Determine the favourable conditions for the survival of living beings.



Relation between Environment and Ecology

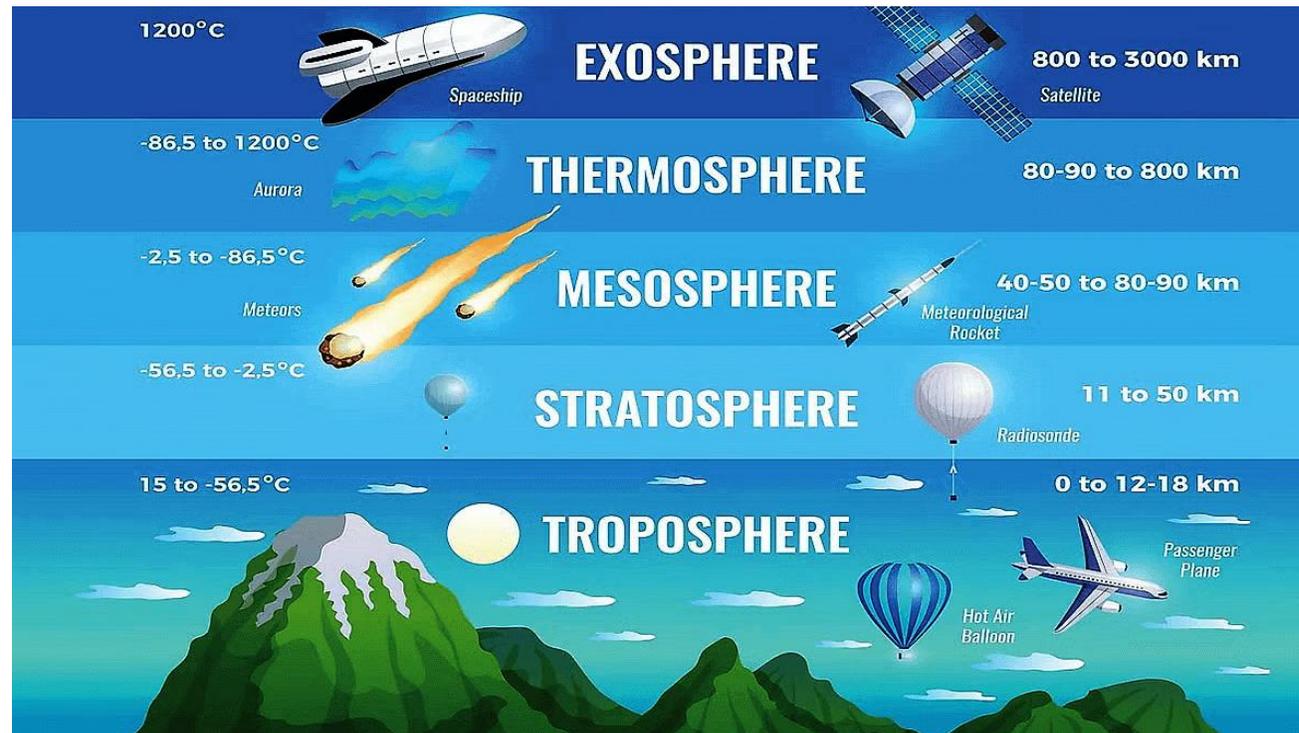
- ❑ **Balance of Biotic & Abiotic Components = Environment**
- ❑ **Relationship between Biotic & Abiotic Components = Ecology**





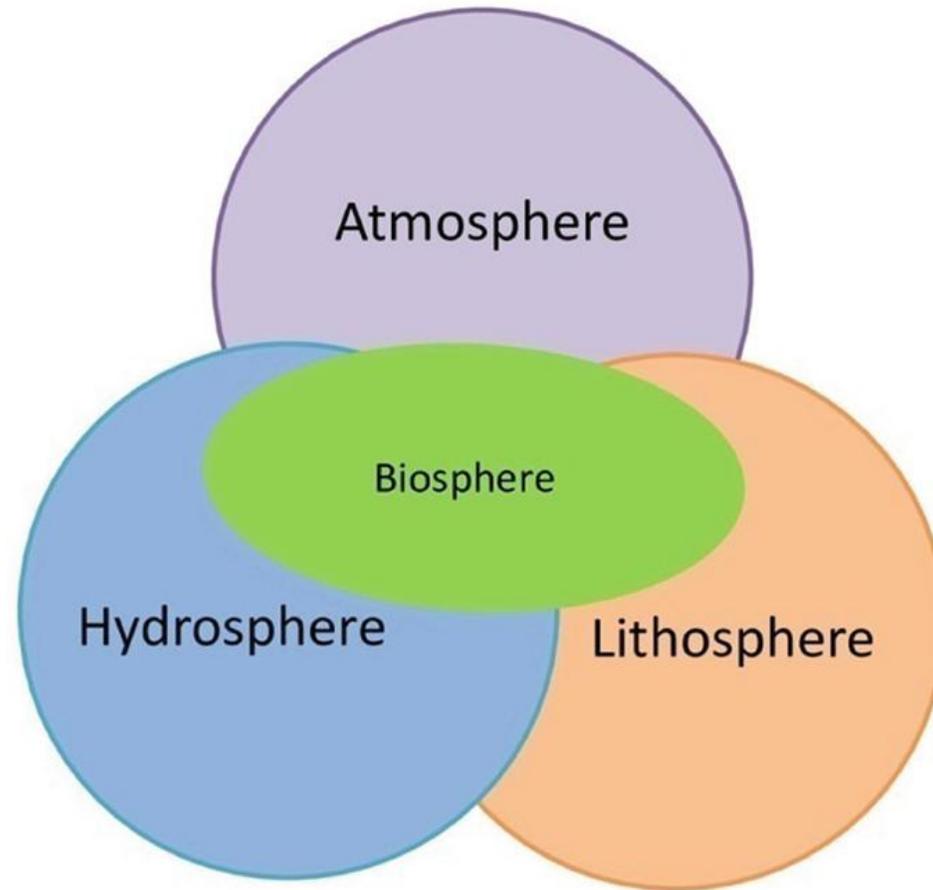
Environment and Atmosphere

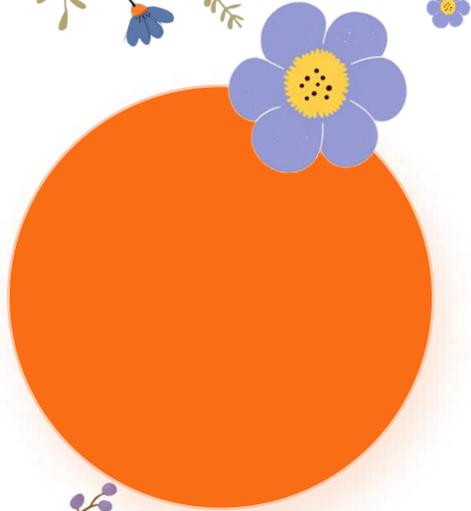
- ❑ Atmosphere- Layer of gases around the Earth that is held by gravity.
- ❑ ENVELOPE OF GASES AROUND THE EARTH)





Components of Environment





Environmental Pollution





Environmental Pollution



- The process by which certain substances are introduced into the environment that negatively affect the health of living beings is called Environmental Pollution.
- The substances responsible for pollution are called Pollutants.



□ Air Pollution

The unintended introduction of pollutants into the air, which adversely affects the health of life – is called Air Pollution.

🔍 Major Air Pollutants (8 gases included in AQI):

- PM 2.5
- PM 10
- Ozone (O₃)
- Nitrogen Dioxide (NO₂)
- Sulphur Dioxide (SO₂)
- Ammonia
- Lead
- Carbon Monoxide

Major Solutions for Air Pollution:

- Promotion of Electric Vehicles
- Use of Public Transport
- Afforestation
- Stubble Management
- Pollution Control Equipment in Industries
- Public Awareness
- Promotion of Renewable Energy Sources





Government Initiatives for Air Pollution Control:

- Air (Prevention and Control of Pollution) Act, 1981
- National Clean Air Program (NCAP), 2019
- FAME Scheme – for Electric Vehicles
- NAMP – Air Quality Monitoring Scheme
- Bharat Stage Fuel Standards

Fuel Standard

- ❑ Fuel standards are called Bharat Stage (BS).
- ❑ The standards are framed by the Central Pollution Control Board.
- ❑ BS controls the emission of pollutants from vehicles running on fossil fuels.
- ❑ The first emission standard in India was framed for petrol vehicles in 1991 and for diesel vehicles in 1992.
- ❑ Since 2000, all vehicles in India are required to meet Euro-1 or India 2000 standards.
- ❑ NCR vehicles were required to meet Euro-2 or BS-2 norms.
- ❑ In 2003, the Mashelkar Committee (chaired by Raghunath Anant Mashelkar) drafted India's emission standards.
- ❑ From 2020, BS-6 is implemented across India, skipping BS-5 directly.



National Clean Air Program (NCAP) – Started in 2019:

- ❑ To reduce PM levels by 20-30% in 102 polluted cities by 2024.
- ❑ Later, the target was revised to reduce PM-10 levels by 40% compared to 2017 levels by 2026.
- ❑ Measures – Monitoring, Public Awareness, Transport Improvement, Greening.

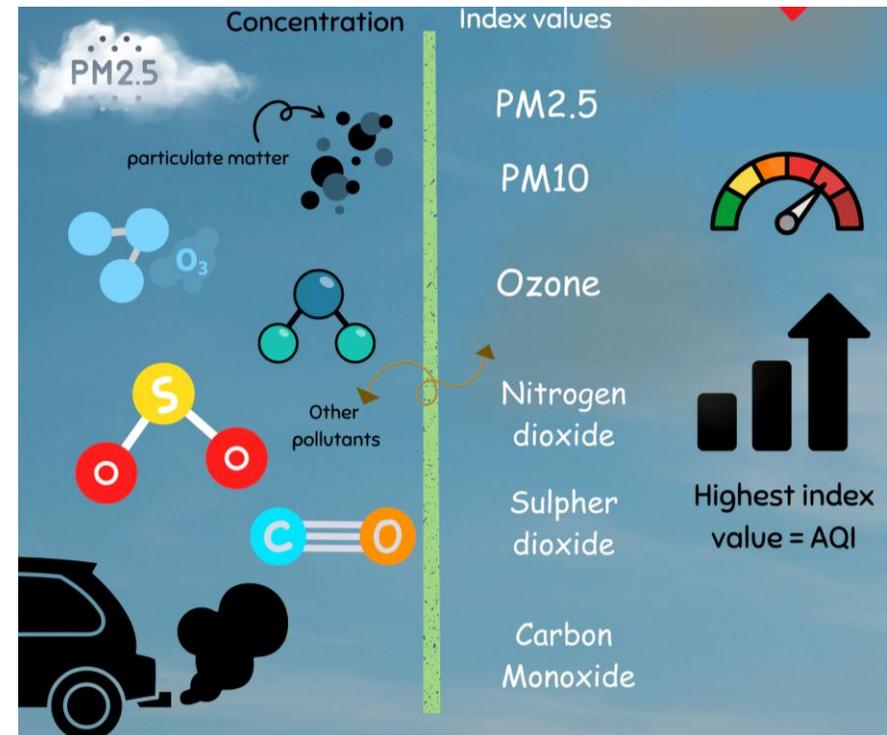


❑ National Air Quality Index (AQI):

❑ AQI helps the public understand how safe or harmful the air condition is for their health. Launched in 2014 by the Central Pollution Control Board (CPCB).

❑ Eight major components of AQI:

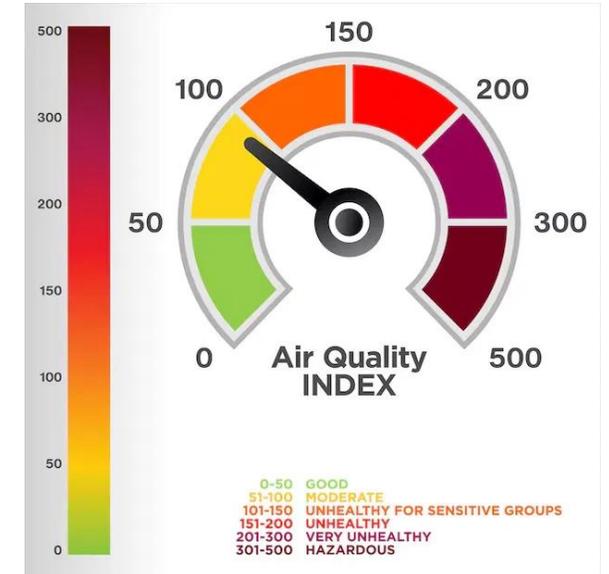
- ❑ PM-10
- ❑ PM-2.5
- ❑ O₃ (Ozone)
- ❑ NO₂ (Nitrogen Dioxide)
- ❑ SO₂ (Sulfur Dioxide)
- ❑ CO (Carbon Monoxide)
- ❑ NH₃ (Ammonia)
- ❑ Pb (Lead)



❑ AQI Categories and Color Indicators:

CENTRAL POLLUTION CONTROL BOARD'S AIR QUALITY STANDARDS

AIR QUALITY INDEX (AQI)	CATEGORY
0-50	Good
51-100	Satisfactory
101-200	Moderate
201-300	Poor
301-400	Very Poor
401-500	Severe



Environmental Impact Assessment (EIA):

- ❑ Determining the potential negative impact of any development project on the environment before its initiation is called Environmental Impact Assessment (EIA).
- ❑ Started in India in 1978.
- ❑ Under EIA, an Environmental Clearance Certificate must be obtained from the Central Pollution Control Board before starting 30 types of projects.
- ❑ These projects are related to metal industries, plants, mining, thermal power plants, river valley projects, nuclear power plant projects, and coastal infrastructure development.

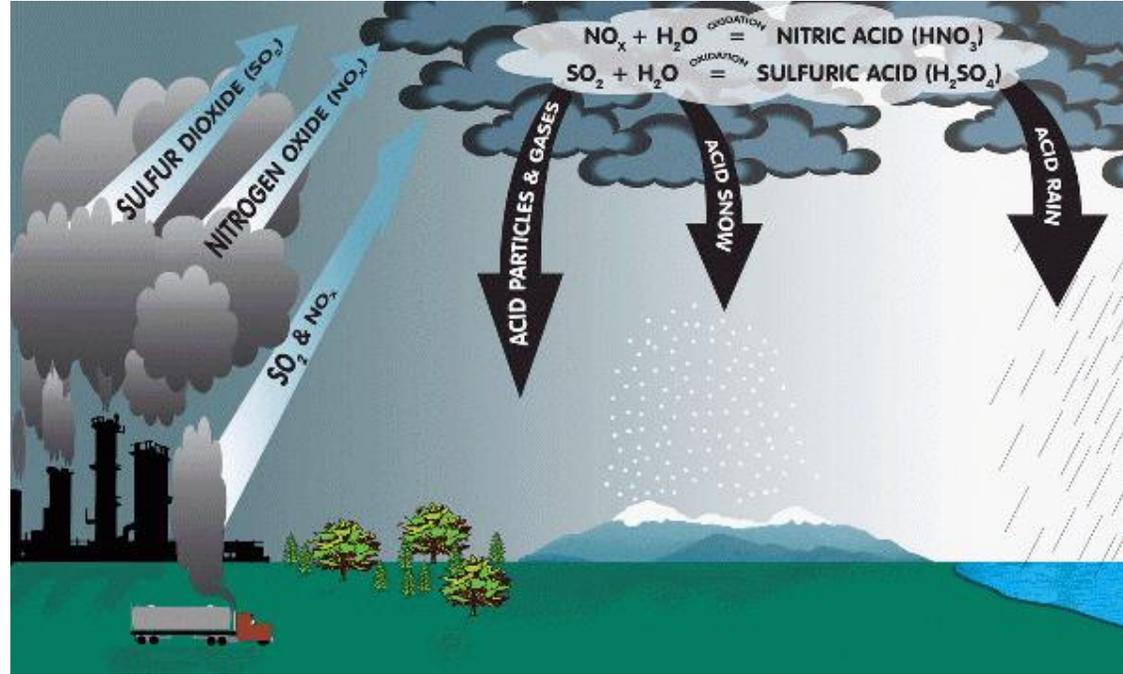




❑ Major Benefits of Environmental Impact Assessment (EIA):

- ❑ Identifies environmental damages from developmental projects in advance and attempts their resolution to maintain ecological balance.
- ❑ Establishes balance among economic, social, and environmental aspects ensuring sustainable development.
- ❑ Prevents over-exploitation of natural resources like water, air, land, minerals and promotes their efficient use.
- ❑ Evaluates impacts on health, livelihood, and cultural rights of people in affected areas and suggests suitable measures.
- ❑ Assesses potential risks like landslides, floods, droughts due to projects and suggests preventive measures.
- ❑ Helps the government make scientific decisions on whether to permit projects.
- ❑ Assists countries like India in fulfilling obligations under international environmental treaties and agreements (like Rio Declaration).

Acid Rain



Sulphur dioxide (SO_2) and
Nitrogen oxide (NO_x)

Reaction with water vapours

Form Sulphuric acid and Nitric
Acid

➤ Ozone layer and its depletion

- Provide protection from dangerous UV Rays.
- CFC is main factor to destroy Ozone layer.
- 4% depletion is recorded in stratosphere.
- World Ozone Day - 16 September



Source of CFCs

01

Air-condition, refrigerator, Aerosol spray

02

Emission of Chloro-fluoro Carbon

03

Responsible for depletion of Ozone layer



Measuring instruments of the ozone layer and international treaties

Unit-Dobson



- ❑ **Viena (Austria) conference - 1985**
- ❑ **Montreal Protocol-1987, Prohibition of ozone damaging gases**
- ❑ **Kigali Protocol**
- ❑ **Location: Kigali, Rwanda**
- ❑ **Year: 15 October 2016**
- ❑ **Under: Montreal Protocol**
- ❑ **Aim: Phase out the production and use of HFCs (Hydrofluorocarbons).**

Water Pollution

- ❑ Water Pollution = Water + Organic + Inorganic + Biological + Radioactive substances whose unwanted presence is responsible for deterioration in water quality.



Dissolved Oxygen (DO)

- ❑ Oxygen from the atmosphere dissolves in pond, river, and reservoir water, which aquatic organisms use for respiration.
- ❑ Dissolved Oxygen decreases when the amount of organic matter in water increases because a large number of bacteria consume oxygen while decomposing waste materials.
- ❑ If the amount of dissolved oxygen is less than 8 mg/litre, the water is called polluted; if it is less than 4 mg/litre, the water is termed highly polluted.

Biological Oxygen Demand (BOD)

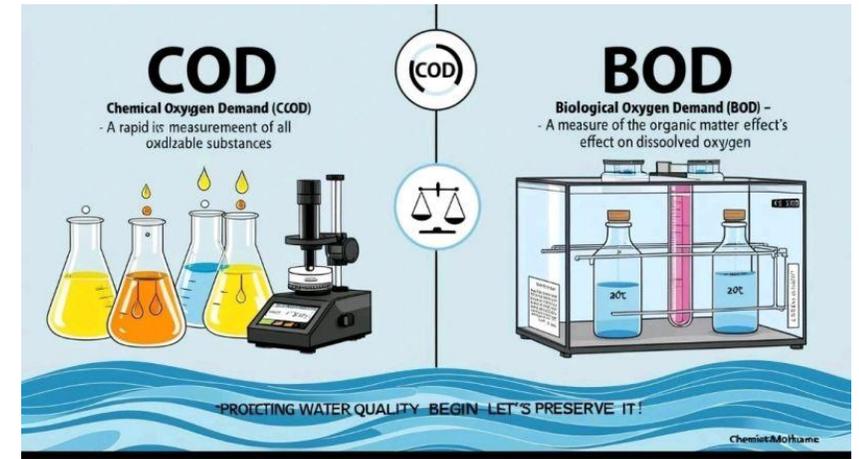
- ❑ The amount of oxygen required for aquatic animals is known as Biological Oxygen Demand (BOD).
- ❑ BOD measures water polluted by organic materials.
- ❑ Higher BOD indicates greater presence of organic waste and lower dissolved oxygen.



BOD Level (in ppm)	Water Quality
1-2	Very Good There will not be much organic waste present in the water supply.
3-5	Fair: Moderately Clean
6-9	Poor: Somewhat Polluted Usually indicates organic matter is present and bacteria are decomposing this waste."
100 or greater	Very Poor: Very Polluted contains organic waste.

Chemical Oxygen Demand (COD)

- ❑ COD is a better index for measuring water pollution than BOD.
- ❑ The key difference is that COD measures the total amount of oxygen required to oxidize both organic and inorganic substances chemically,
- ❑ whereas BOD measures the amount of oxygen used by microorganisms to break down organic matter.



Mercury Pollution

- ❑ Mercury is the only metal found in liquid state.
- ❑ Discovered by Buddhist monk Nagarjuna, called 'Rasaraja'.
- ❑ Consumption of water or fish contaminated with mercury (Hg) causes Minamata disease—a neurotoxin disorder affecting the nervous system.
- ❑ Symptoms include muscle weakness, blindness, and paralysis.
- ❑ Minamata disease was first discovered in 1956 in Minamata city, Kumamoto Prefecture, Japan.



Cadmium Pollution

- ❑ Cadmium is a toxic metal used in batteries, metal coatings, and stabilizers.
- ❑ It affects kidneys and bones and may cause cancer.
- ❑ It causes Itai-Itai disease, a bone disease marked by severe joint pain.
- ❑ The disease was first observed in Japan's Toyama Prefecture in Jinzu River Basin due to cadmium-polluted rice and water.



Fluorosis Pollution

- ❑ Fluorosis is caused by excessive fluoride intake, affecting teeth and bones.
- ❑ In some regions, groundwater naturally contains high fluoride.
- ❑ Excessive fluoride from toothpaste, mouthwash, and medicines can also cause Fluorosis.
- ❑ **Dental Fluorosis:** White, brown, or black spots on teeth; sometimes pits form.
- ❑ **Skeletal Fluorosis:** Bone stiffness, joint pain, reduced movement, deformities.



Blue Baby Syndrome or Cyanosis

- ❑ Soluble nitrate in water enters the human body and forms toxic Methaemoglobin with haemoglobin, reducing oxygen transport capacity of red blood cells.
- ❑ The disease caused is called Methemoglobinemia or Blue Baby Syndrome.



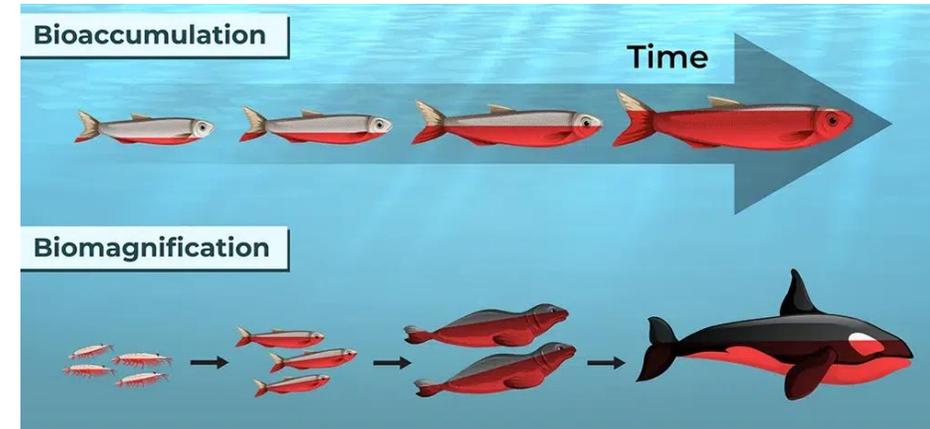
Arsenic Pollution

- ❑ Arsenic is a dangerous toxin found in groundwater.
- ❑ Millions in India and Bangladesh suffer arsenic-related diseases.
- ❑ Exposure causes skin rashes, itching, diarrhea, hyperkeratosis, and Blackfoot disease—collectively called Arsenicosis.



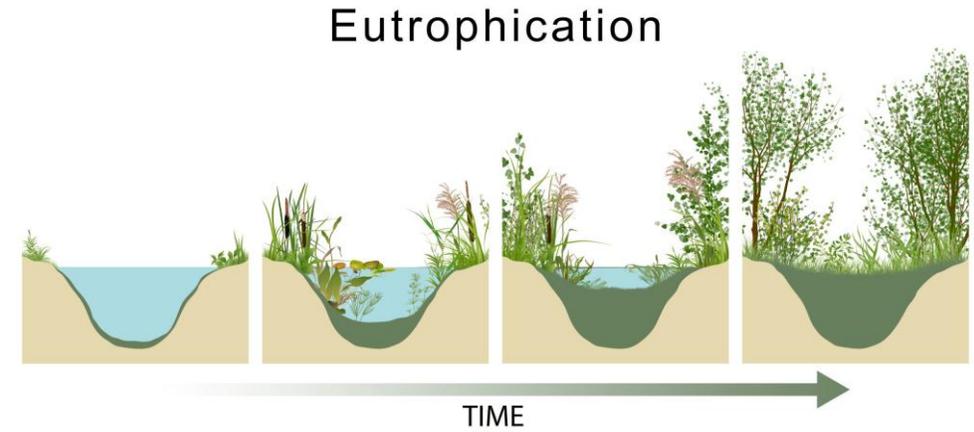
Bio Magnification

- ❑ Bio Magnification is the process where concentration of toxic substances increases upward in the food chain.
- ❑ Toxins accumulate in tissues and pass to higher trophic levels, resulting in very high toxin concentrations at the top of the food chain.



Eutrophication

- ❑ Eutrophication is the accumulation of nutrients in a water body, causing excessive plant and algal growth.
- ❑ It reduces oxygen in water and harms the ecosystem.

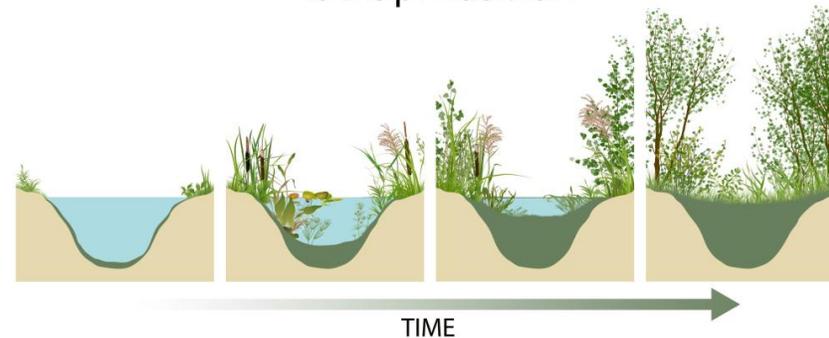


❑ Algal Bloom

- ❑ Extensive use of fertilizers in agriculture dissolves in water, reaching rivers and reservoirs, increasing fertility and algal production massively—called Algal Bloom.



Eutrophication



DDT

- ❑ DDT (Dichlorodiphenyltrichloroethane) is a pesticide used to control agricultural pests.
- ❑ Banned for agricultural use in India since 1972 but still used by the Ministry of Health for mosquito control in rural and urban spraying.

Endosulfan

- ❑ A pesticide banned in India since 2011, used on crops like cotton, cashew, fruits, tea, rice, and tobacco.
- ❑ Listed under Rotterdam and Stockholm Conventions on Persistent Organic Pollutants (POPs).



Environmental Days

World Wetland day	2 February
World Wildlife day	3 March
World Forest day	21 March
World Water day	22 March
World Meteorological day	23 March
Earth day	22 April
World Biodiversity day	22 May
World Environment day	5 June
World Ocean day	8 June
World Population day	11 July
International Tiger day	29 July
World car free day	22 September
World Soil day	5 December

Statutory Measures for Environmental Protection



Wildlife Protection Act, 1972

- ❑ The United Nations Conference on Human Environment held in Stockholm, Sweden on 5 June 1972 was a landmark event that marked the beginning of global environmental diplomacy.
- ❑ The Wildlife Protection Act, 1972 was framed in this light.
- ❑ It is an important law for the protection of wildlife and their habitats.

Important points of Act :

- ✓ This Act makes provision of punishment to those who involved in illegal hunting and trading.
- ✓ Wildlife Crime Control Bureau was established to control illegal practices.
- ✓ The penalty and punishment for offences under the Act have been made more stringent.
- ✓ This Act empowers the government to establish wildlife sanctuaries and national parks.
- ✓ This Act also provides for the establishment of Wildlife Advisory Board.



Forest Conservation Act, 1980

- ❑ In 1976, the 42nd Constitutional Amendment Act added Article 48A to the Constitution
- ❑ which stated that the State shall endeavour to protect and improve the environment and safeguard the forests and wildlife of the country
- ❑ In this context, the Forest Conservation Act was enacted in 1980
- ❑ Its main objective is to protect the forests of India and control their felling. This Act provides an important legal framework for maintaining environmental balance, saving the natural resources of forests and preventing the reduction of forest area.



❑ Air (Prevention and Control of Pollution) Act, 1981:

- ❑ Prevent and control air pollution, improve air quality, control industrial pollution, protect environment, protect human health.**
- ❑ Establishment of Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs)**
- ❑ The Act lays down standards for emission of pollutants from industries and other sources.**
- ❑ Control measures: require industries to install equipment to reduce pollutant emissions, monitor air quality and issue orders to shut down industries when necessary.**
- ❑ The Act also provides for penalising individuals and industries for causing pollution.**
- ❑ The CPCB and SPCBs are given powers and duties for the control of air pollution, such as inspecting polluting sources, taking samples, and taking action.**

Environment Protection Act, 1986:

- ❑ On 2/3 December 1984, a horrific gas tragedy occurred in Bhopal.
- ❑ This was the most serious disaster caused by environmental pollution and human negligence.
- ❑ In this context, a comprehensive Act was enacted by the Parliament in 1986 to protect and improve the environment.
- ❑ The Act came into force from 19 November 1986.
- ❑ **Key features:**
- ❑ Definition of environment Includes water, air, land and living beings associated with them.
- ✓ Government was given power to control, prevent or stop any industrial activity in protection of environment.
- ✓ To make and enforce rules for pollution control.
- ✓ To set standards (example: air quality, water quality).



National Green Tribunal Act, 2010:

- ❑ This Act was enacted for speedy and effective disposal of cases relating to environment.
- ❑ Under this Act, a special tribunal – the National Green Tribunal (NGT) – was established.
- ❑ The Act came into force from 2 June 2010.
- ❑ **Objectives:**
 - ✓ To promote environmental protection, conservation of forests and natural resources.
 - ✓ To apply the principles of compensation and restoration for environmental damage.
 - ✓ To provide speedy and easy access to justice.
- ❑ **Special Tribunal:**
 - The NGT is a special judicial body that hears only environmental cases.
 - It is headquartered in New Delhi, and has four regional benches (i.e. Bhopal, Pune, Kolkata, Chennai).



International Conferences on the Environment

- ❑ United Nations Conference on the Human Environment (Stockholm, 1972):
- ❑ This was the first major UN conference on the environment, drawing global attention to environmental issues.
- ✓ **Stockholm Declaration:** This declaration, based on 26 principles, placed environmental issues at the forefront of the international community's concerns.
- ✓ **Establishment of the United Nations Environment Program (UNEP):** A major outcome of the Stockholm Conference was the establishment of UNEP, a premier international organization for addressing global environmental issues.
- ✓ **World Environment Day:** The United Nations General Assembly established World Environment Day in 1972 during the Stockholm Conference, which is celebrated every year on June 5.

International Conferences on Environment

- ❑ United Nations Conference on Environment and Development (Rio de Janeiro, 1992):
- ❑ This conference, also called the "Earth Summit", focused on establishing harmony between environment and development.
- ✓ **Time and place:** June 3 to 14, 1992, in Rio de Janeiro, Brazil.
- ❑ The Earth Summit initiated the United Nations Framework Convention on Climate Change (UNFCCC), whose signatory countries have met every year since 1995.
- ❑ Agenda 21 is an action plan adopted by 178 countries at the United Nations Conference on Environment and Development (Earth Summit) held in Rio de Janeiro in 1992. It aims to achieve sustainable development at the global level.
- ✓ **UN Environment World Summit on Sustainable Development (Rio+20 Summit, 2012):**
- ❑ This conference was held 20 years after the first Earth Summit in Rio de Janeiro, and aimed to develop a new strategy to achieve the Sustainable Development Goals.

National Green Tribunal Act, 2010:

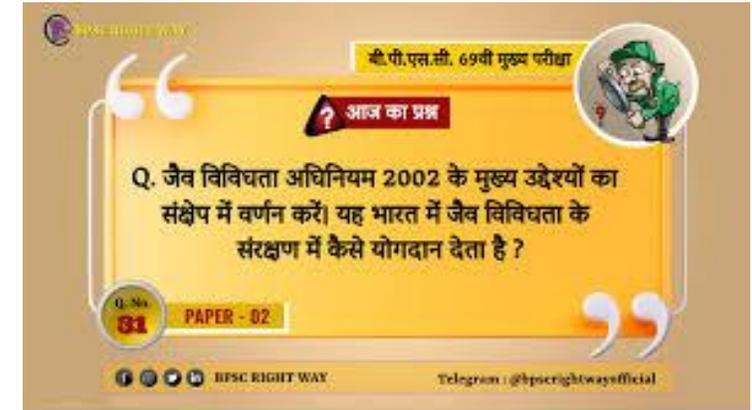
Jurisdiction:

- ✓ Forest Conservation Act, 1980
- ✓ Environmental Protection Act, 1986
- ✓ Water (Prevention and Control of Pollution) Act, 1974
- ✓ Air (Prevention and Control of Pollution) Act, 1981
- ✓ Biodiversity Act, 2002
- ❑ The NGT has jurisdiction over cases falling under these Acts.
- ❑ **Limited Appeal:** An appeal against the decision of the NGT can be made only in the Supreme Court.
- ❑ **Decision Time:** The tribunal has to dispose of cases within 6 months.
- ❑ **Composition:**
 - Chairperson - Retired Judge of the Supreme Court
 - Ten judicial members and ten expert members
 - Judicial Members - Retired Judges of High Courts
 - Expert Members - Any person having a minimum work experience of 15 years in the areas of forest conservation and environment
- ❑ Justice Prakash Srivastava is the current Chairperson of the National Green Tribunal since August 2023.



Biodiversity Act, 2002:

- ❑ The Act focuses on conservation of biodiversity and equitable sharing of benefits arising from the use of biological resources.
- ❑ **Act enacted:** 11 December 2002
- ❑ **Provisions:**
 - ✓ Biodiversity Management Committees (BMC),
 - ✓ National Biodiversity Authority (NBA) It is headquartered in Chennai.
 - ✓ NBA was established on 1 October 2003 to comply with the terms of an international treaty called Convention on Biological Diversity (CBD).
- ❑ Establishment of Madhya Pradesh State Biodiversity Board (SBB).



Biodiversity Heritage Sites (BHS)

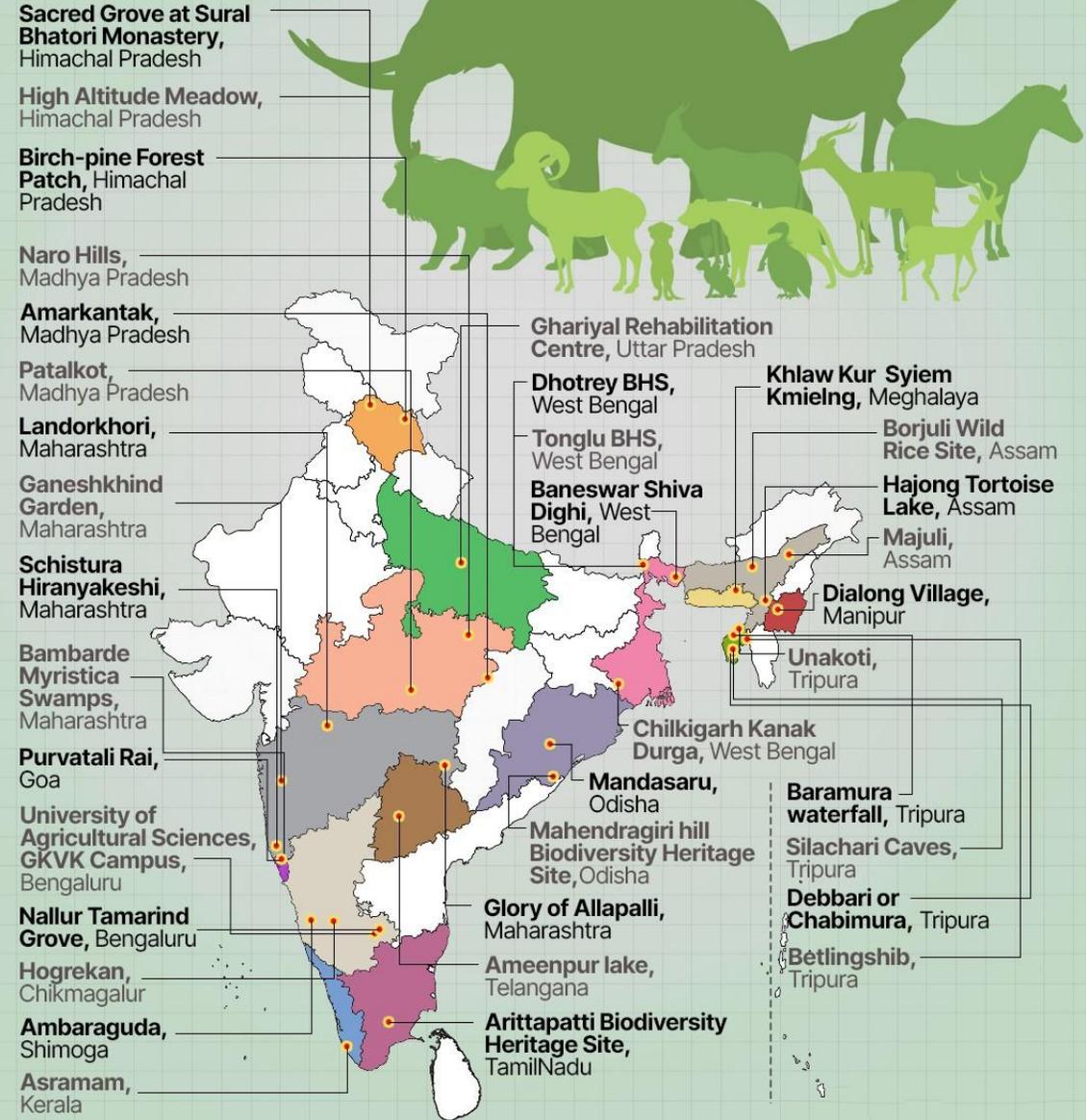
- Biodiversity sites are important for the environment as they provide shelter to a variety of organisms and help maintain ecological balance.
- At present, there are a total of 48 biodiversity heritage sites in India.
- The first biodiversity site of India was declared in 2007 as Nallur Tamarind Grove, Bengaluru.
- On 28 July 2024, Damkheda and Valmi Hills of Chandanpura in Bhopal were declared as the 48th biodiversity heritage site of the country.
- The highest number of biodiversity sites in India is in West Bengal (10).

Total 5 Biodiversity Heritage Sites in Madhya Pradesh

- ❑ Biodiversity sites are declared by the state government under Section 37 of the Biodiversity Act, 2002 (BDA).
- ❑ The Madhya Pradesh government has declared the following 5 sites as Biodiversity Heritage Sites.
 - Naro Hills, Satna
 - Patakot, Chhindwara
 - Amarkantak, Anuppur
 - Sirpur Talab, Indore
 - Valmi Hills, Bhopal
- ❑ Various species of animals, birds, insects, plants and wildlife are being conserved at these places.



Biodiversity heritage sites in India



Biodiversity

- ❑ The term 'Biodiversity' is derived from two words—Biological and Diversity. Generally, it means the occurrence of various species of animals and plants in a specific region.
- ❑ **Importance:** In nature, humans, animals, and plants are interconnected to establish ecological balance.



Methods of Biodiversity Conservation:

❑ In-situ Conservation:

- ❑ Protection of plants and animals in their natural habitats.
- ❑ Examples: Wildlife sanctuaries, National Parks, Species-specific Projects (like Project Tiger, Elephant Project, Crocodile Project), Biosphere Reserves.

❑ Ex-situ Conservation:

- ❑ Conservation of biodiversity in human-made structures.
- ❑ Examples: Zoos, Botanical Gardens. State Botanical Garden—Example: Katara Hills, Bhopal.

Special Facts in Madhya Pradesh and India:

- ❑ First Botanical Garden of MP:
- ❑ Located at Harisingh Gour University, Sagar.
- ❑ All zoos in India are administered by the Central Zoo Authority.
- ❑ In Madhya Pradesh: Wildlife Sanctuaries – 31
- ❑ Highest number of National Parks – 11

National Parks in Madhya Pradesh:

- ❑ Pench National Park - Seoni (MP) & Nagpur (Maharashtra)
- ❑ Kanha National Park - Balaghat
- ❑ Ghughua Fossil National Park - Dindori
- ❑ Bandhavgarh National Park - Umaria
- ❑ Sanjay-Dubri National Park Guru Ghasidas National Park - Sidhi (MP) & Korea (Chhattisgarh)
- ❑ Panna National Park - Panna
- ❑ Madhav National Park - Shivpuri
- ❑ Kuno National Park - Sheopur
- ❑ Satpura National Park - Hoshangabad
- ❑ Van Vihar National Park - Bhopal
- ❑ Dinosaur Fossil National Park - Dhar



❖ राष्ट्रीय उद्यान और वन्य जीव अभ्यारण्य में अंतर

Points	National Park	Wildlife Sanctuary
Equality	Both are protected areas	
Structure	Divided into core and buffer zones	No such division
Rule	Extreme restrictions	Less restrictions
Objets	Conservation of ecosystem, fauna and plants	Mainly for the conservation of animals.
Declaration	Through notification by the Central Government.	Through notification by the State Government.
Change in boundary	No change in the boundary can be made without the permission of Parliament.	The state government can change the limit.

❖ राष्ट्रीय उद्यान और जैव आरक्षित मंडल में अंतर

Points	National Park	Biosphere Reserve
Definition	A protected area where flora, fauna and geographical features are strictly preserved.	A large area where biodiversity conservation, research and sustainable development are promoted together.
Area	It has a relatively small area.	A very large area, which may include national parks, wildlife sanctuaries and human settlements.
Object	Only to promote conservation and Eco-tourism.	To promote conservation as well as research, education and sustainable development of local communities.
Formation	Through notification by the Central Government under the Wildlife Protection Act, 1972.	They are declared by the national government under the "Man and Biosphere Programme" (MAB) of 1971 by UNESCO.

भारत में जैव आरक्षित मंडल (Biosphere Reserves in India)



❖ Included in UNESCO's World Network of Biosphere Reserves (WNBR) - 12

1. Nanda Devi (year, 2004), Uttarakhand
2. Kanchenjunga (year 2018), Sikkim
3. Nokrek (year 2009), Meghalaya
4. Sundarban (year 2001), West Bengal
5. Simlipal (year 2009), Odisha
6. Gulf of Mannar (year 2001), Tamil Nadu
7. Nilgiri (year 2000), Tamil Nadu, Kerala and Karnataka
8. Agasthyamalai (year 2016), Kerala and Tamil Nadu
9. Great Nicobar (year 2013)
10. Panchmarhi (year 2009), Madhya Pradesh
11. Achanakmar-Amarkantak (year 2012), M.P., Chhattisgarh
12. Panna Biosphere Reserve - It is the 12th biosphere reserve of India to be included in UNESCO's global network of protected biospheres.

भारत में जैव आरक्षित मंडल (Biosphere Reserves in India)



❖ Not included in UNESCO's World Network of Biosphere Reserves (WNBR) - 6

1. Cold Desert, Himachal Pradesh
2. Manas, Assam
3. Dibru Shaikhowa, Assam
4. Dehang Debang, Arunachal Pradesh
5. Seshachalam, Andhra Pradesh
6. Great Rann of Kutch, Gujarat

भारत में जैव आरक्षित मंडल (Biosphere Reserves in India)



Biosphere Reserves in Madhya Pradesh

Pachmarhi Biosphere Reserve:

- ❑ Located in Hoshangabad, Betul, and Chhindwara districts of Madhya Pradesh.
- ❑ Total area: 4926.28 sq. km.
- ❑ Contains three wildlife conservation units:
 - ❑ Bori Sanctuary (518.00 sq. km)
 - ❑ Pachmarhi Sanctuary (461.37 sq. km)
 - ❑ Satpura National Park (524.37 sq. km)



Achanakmar-Amarkantak Biosphere Reserve

- ❑ Spanning Madhya Pradesh and Chhattisgarh,
- ❑ covering 3835.51 sq. km. Area distribution:
- ❑ 68.1% in Mungeli district, Chhattisgarh
- ❑ 16.2% in Anuppur district, Madhya Pradesh
- ❑ 15.7% in Dindori district, Madhya Pradesh



Panna Biosphere Reserve

- ❑ Located in Panna and Chhatarpur districts,
- ❑ includes:
 - ❑ Panna National Park
 - ❑ Gangau Sanctuary
- ❑ Ken River (one of Yamuna's least polluted tributaries)
- ❑ Recognized as India's 22nd Project Tiger Reserve in 1994.
- ❑ Declared Biosphere Reserve in 2011.
- ❑ Included in UNESCO's Man and Biosphere (MAB) Programme in 2020.

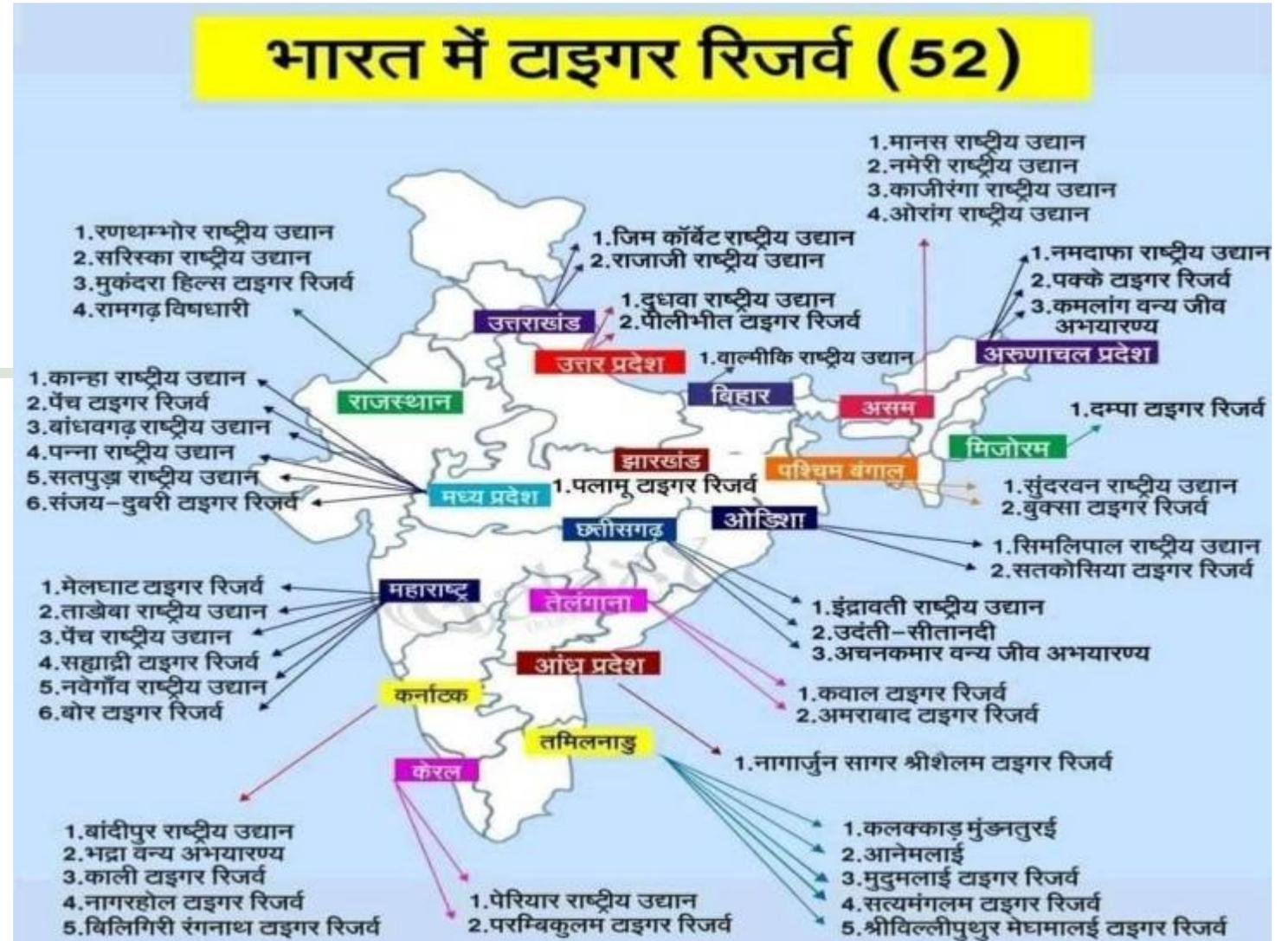


Tiger Reserves in India

❑ Launched in 1973 under Project Tiger to conserve tigers and their habitats.

❑ Initial reserves (1973):

- ❑ Manas (Assam)
- ❑ Palamau (Jharkhand)
- ❑ Simlipal (Odisha)
- ❑ Corbett (Uttarakhand)
- ❑ Ranthambore (Rajasthan)
- ❑ Kanha (Madhya Pradesh)
- ❑ Bandipur (Karnataka)
- ❑ Sundarbans (West Bengal)



Tiger Reserves in Madhya Pradesh

- ❑ Pench National Park
- ❑ Kanha National Park
- ❑ Bandhavgarh National Park
- ❑ Sanjay-Dubri National Park
- ❑ Guru Ghasidas National Park
- ❑ Panna National Park
- ❑ Satpura National Park
- ❑ Ratapani (Raisen)
- ❑ Nauradehi (Sagar)
- ❑ Madhav (Shivpuri) (proposed as the 9th reserve)



2019

में आई बाघों की
रिपोर्ट के अनुसार
भारत में

2967 बाघ

सबसे अधिक

526 बाघ

मध्यप्रदेश में पाए
जाते हैं।

■ देश में 51 टाइगर रिजर्व हैं। इनमें मध्यप्रदेश और महाराष्ट्र में सबसे ज्यादा 6-6 हैं।

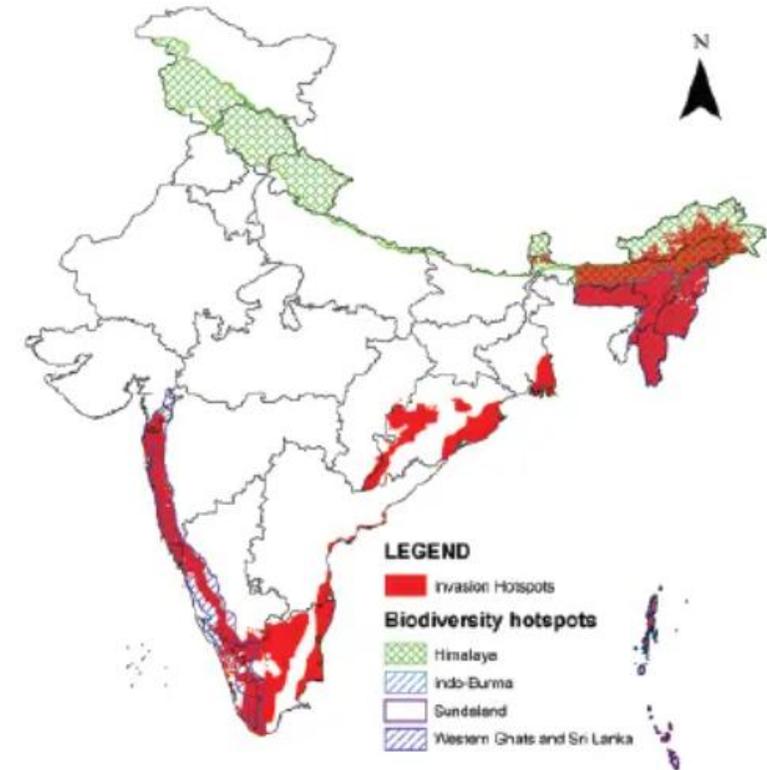
■ दुनिया में सिर्फ कान्हा में ही हार्ड ग्राउंड बारहसिंगा (दलदल का मृग) मिलते हैं। कुल संख्या 1000 से ज्यादा है।

■ देश में सबसे ज्यादा 750 गिद्ध पन्ना नेशनल पार्क में हैं।

Biodiversity Hotspots

- ❑ Concept given by Norman Myers (1988) based on tropical forest studies.
- ❑ Criteria:
 - ❑ High Endemism: At least 1500 vascular plants found nowhere else.
 - ❑ Significant Habitat Loss: At least 70% of original habitat lost.

- ❑ Global: 36 biodiversity hotspots identified.
- ❑ India: 4 hotspots:
 - ❑ Eastern Himalayas
 - ❑ Western Ghats
 - ❑ Indo-Burma
 - ❑ Sundaland (including Andaman & Nicobar Islands)



Biodiversity Convention-1

✓ Cartagena Biosafety Protocol

Ensures biosafety

Protocol: Adopted in 2000 and entered into force in 2003.

The main objective of the protocol is to:

✓ Reduce the risks posed by genetically modified organisms (GMOs) that may pose a potential threat to ecosystems, human health, and agriculture.

Biodiversity Convention-2

✓ Nagoya Protocol

☐ Adopted in 2010 in Nagoya City, Japan

☐ Entered in 2014

➤ **Objective:** To ensure equitable distribution of benefits related to the use of traditional knowledge and biological resources

➤ The main objective of the protocol is to ensure respect for the rights and participation of communities holding traditional knowledge (such as tribal and local communities), sharing of benefits derived from the use of biological resources with communities holding traditional knowledge and to ensure transparency of permissions and agreements required for the use of biological resources and traditional knowledge.

Biodiversity Convention- 3

✓ Aichi Goal

Adopted in 2010 in Aichi City, Japan

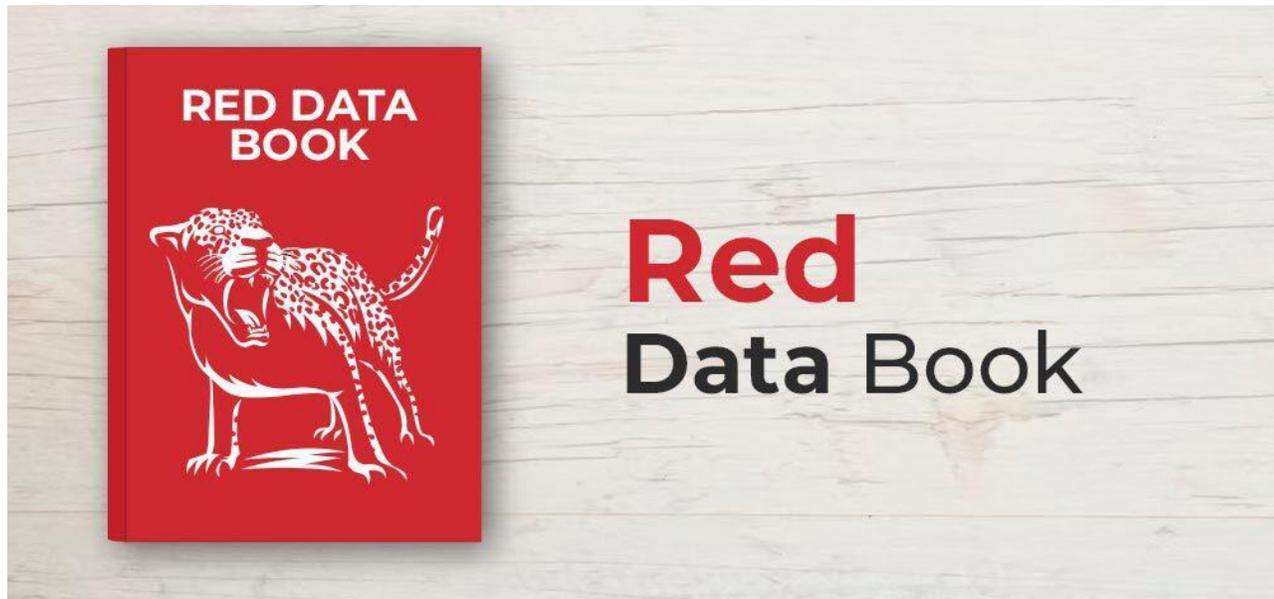
Objective: These goals ensure the conservation and sustainable management of global biodiversity by 2020

Encourage countries to develop their national plans in accordance with this framework

Encourage a shared approach to biodiversity conservation and promote cooperation among countries

Red Data Book

- ❑ Published by IUCN since 1964.
- ❑ Lists endangered plant and animal species, their status, habitat, and conservation measures.



Classification of species in the Red Data Book - 9 categories

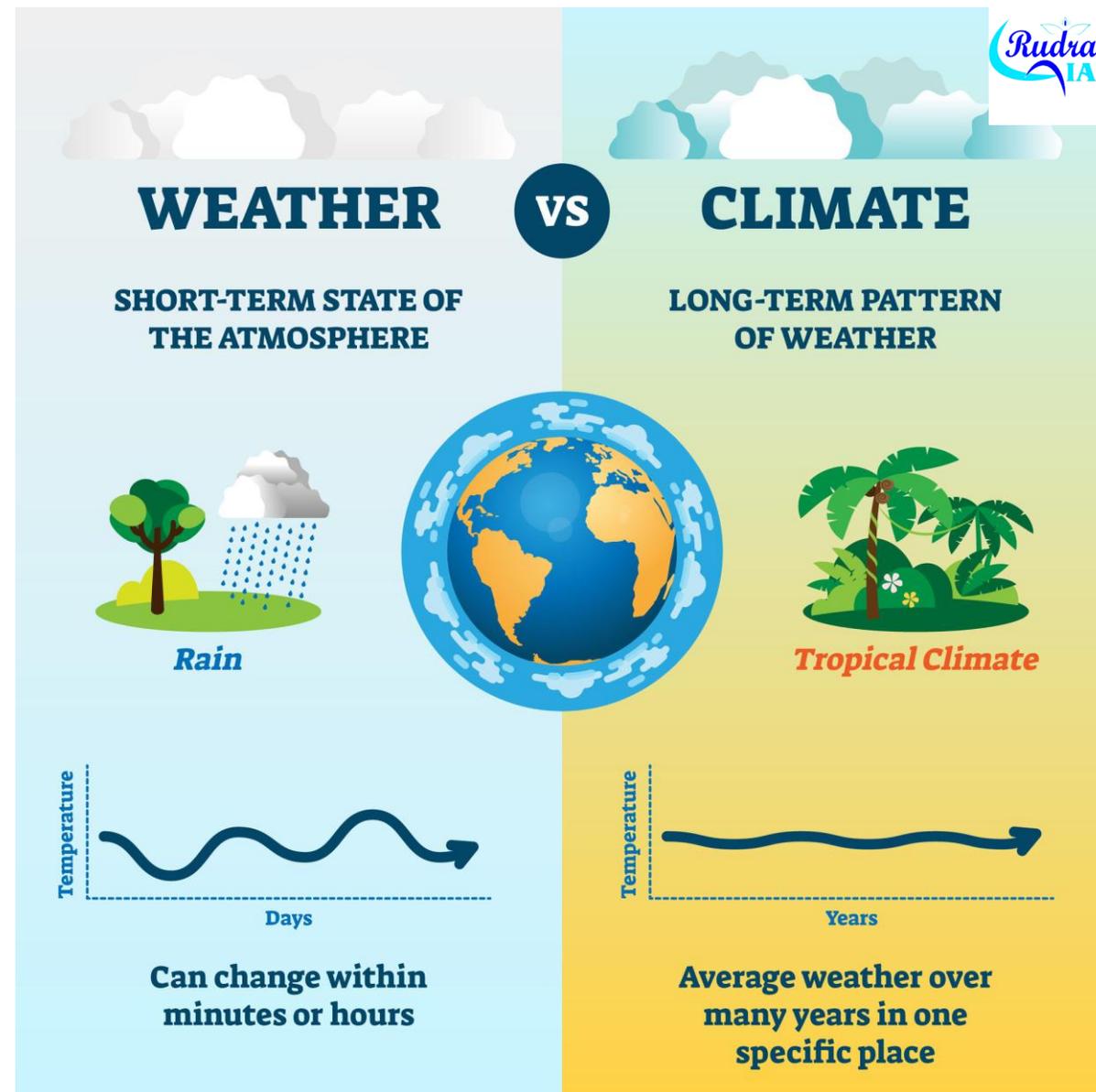
1	Extinct-EX	Species that have been completely extinct
2	Extinct in wild-EW	Species that are not in their natural habitat but are being protected in reserves
3	Critically Endangered- CR	Species most at risk of extinction
4	Endangered-EN	Species that are on the verge of extinction, but their situation is not that serious yet.
5	Vulnerable-VU	If these are not taken care of in time, then there is a danger of them getting extinct
6	Near Threatened- NT	Species that are not endangered but may become endangered in the future.
7	Least Concern	Species that are not threatened and whose status is stable.
8	Data Deficient	Species for which the conservation status is not sufficiently known.
9	Not Evaluated	

Climate Change



Difference between Climate and Weather:

- ❑ Weather: Short-term atmospheric conditions.
- ❑ Climate: Long-term average weather pattern.
- ❑ India: Tropical climate.



❑ Climate Change

❑ Long-term change in Earth's climate patterns, causing global warming, desertification, etc.

❑ Main Cause: Greenhouse gases from fossil fuel burning, deforestation.

❑ Major Greenhouse Gases:

❑ CO₂

❑ Methane

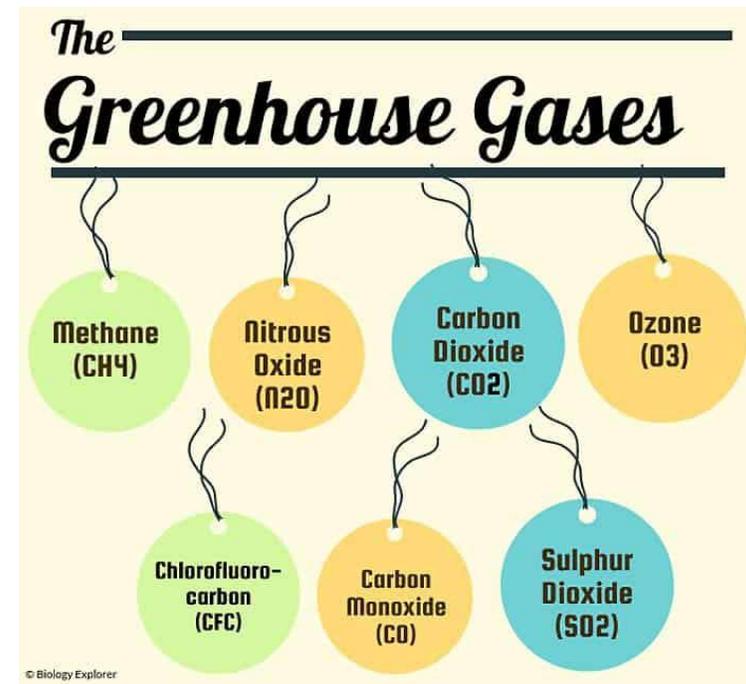
❑ Nitrous Oxide

❑ CFCs

❑ Water Vapor

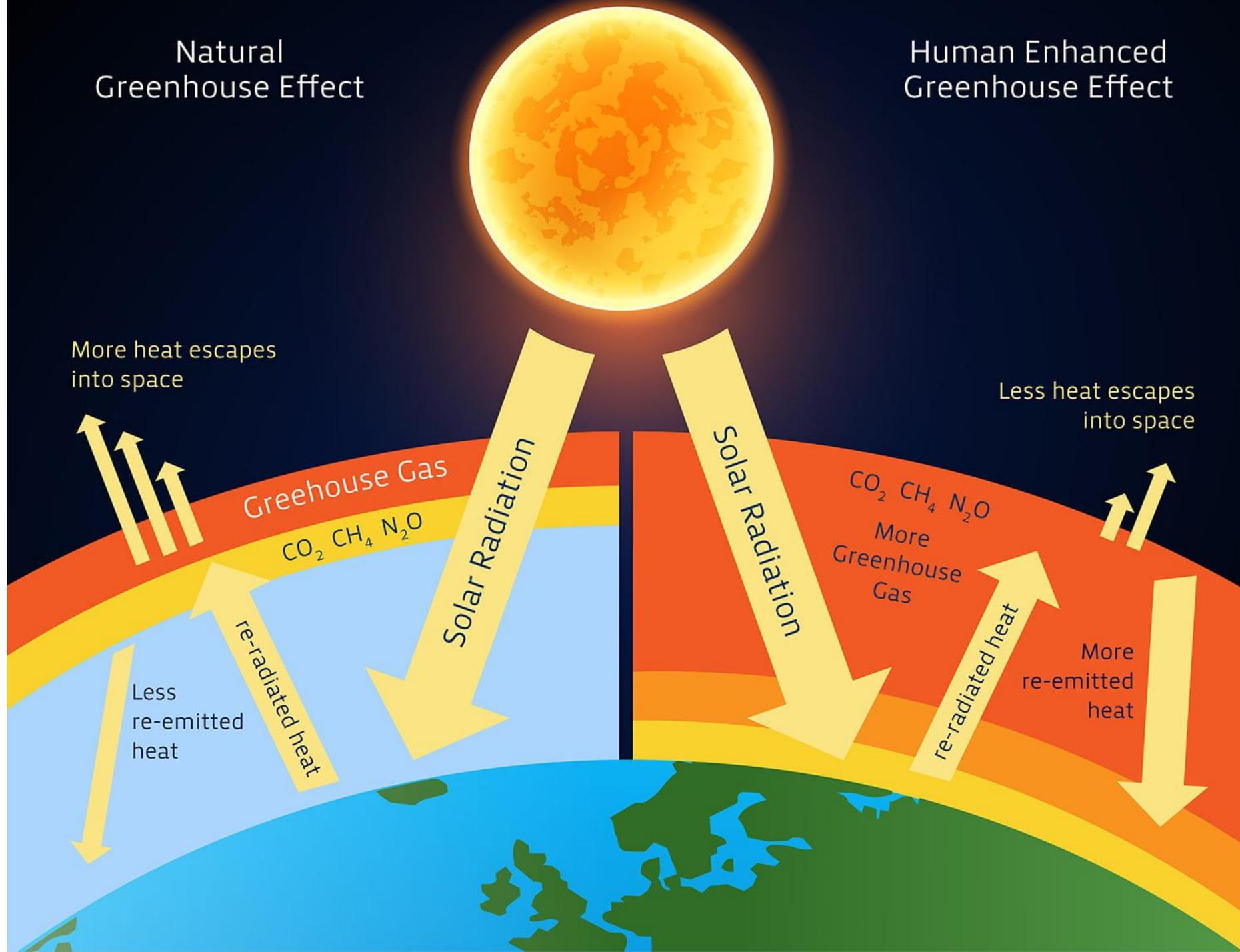
❑ PM-10

❑ Tropospheric Ozone



Natural Greenhouse Effect

Human Enhanced Greenhouse Effect



Greenhouse effect

- The emission of greenhouse gases and their increase in the atmosphere allows short range solar radiation to enter the troposphere but traps long range terrestrial radiation by preventing it from leaving the troposphere. This causes the temperature of the troposphere to increase continuously.

This is called global warming.

How can greenhouse gases be reduced?

Reduction of greenhouse gases -

- ✓ By increasing carbon sinks
- ✓ By reducing carbon footprint
- ✓ By offsetting
- ✓ By using new technology
- ✓ By encouraging the use of renewable energy



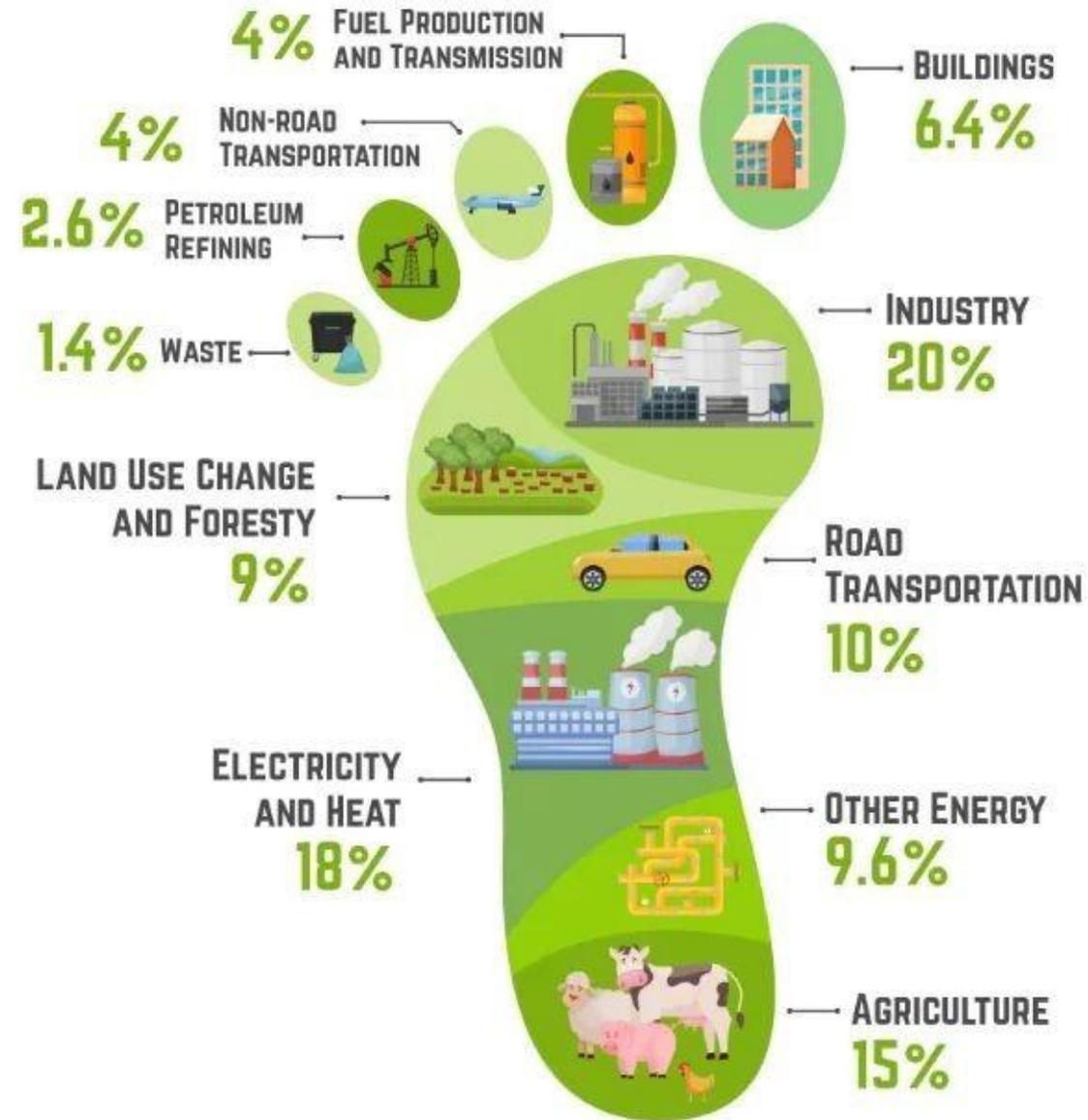
Carbon Footprint

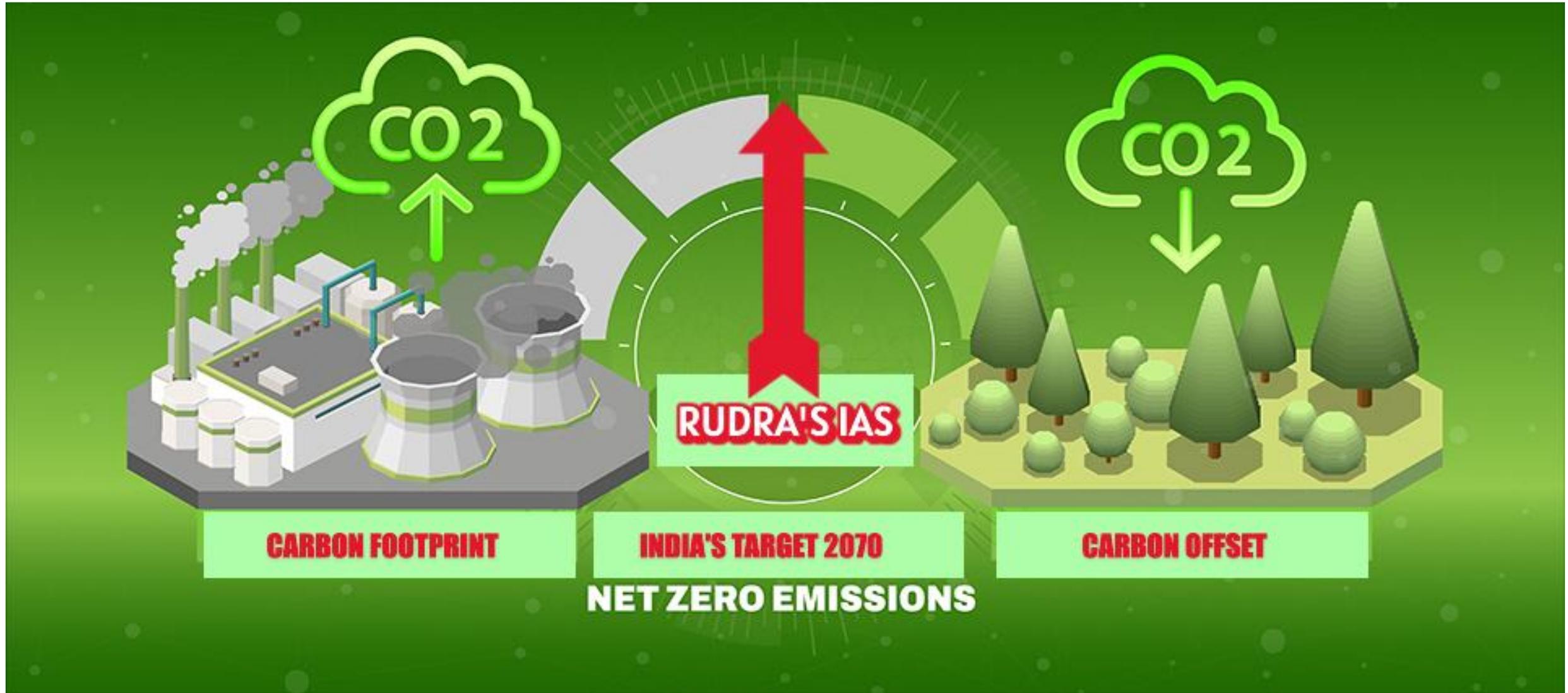
- Carbon footprint refers to the amount of total greenhouse gases (mainly carbon dioxide - CO₂) emitted directly or indirectly by a person, organization, product or service.
- It shows how much carbon dioxide or similar greenhouse gases were emitted into the atmosphere by our daily activities - such as cooking, traveling, running lights, fans, AC, motors etc. in the house, the manufacture and distribution of the things we are using.
- Carbon footprint is measured in tons.
- ✓ The average carbon footprint per person in the United States is 16 tons per year, which is the highest in the world.
- ✓ The average carbon footprint per person in India is 1.6 tons per year.
- ✓ Globally, the average carbon footprint per person is close to 4 tons per year.

Ways to reduce carbon footprint:

-  **Planting trees**
-  **Using renewable energy sources**
-  **Using energy efficient appliances**
-  **Using public transport or bicycle**
-  **Online trading**

CARBON FOOTPRINT





CARBON FOOTPRINT

INDIA'S TARGET 2070

CARBON OFFSET

NET ZERO EMISSIONS

RUDRA'S IAS

❑ Carbon offsetting

- ❑ Carbon offsetting is the process in which a person, company or organisation compensates for the greenhouse gases (GHGs) it emits by absorbing or reducing an equal or greater amount of carbon elsewhere.
- ❑ For example – if a company emits 100 tonnes of CO₂ and invests in activities (such as tree planting or renewable energy projects) that absorb 100 tonnes of CO₂, it may be considered "Carbon Neutral".



⚙️ How does carbon offsetting work?

- ❑ The emitting entity assesses its carbon footprint. It then invests in carbon offset projects to balance those emissions.
- ❑ Tree plantation/afforestation Solar or wind power projects Energy efficiency programs Organic manure/biogas plants The "carbon credits" from these projects compensate for the emissions.



❑ Trading of carbon credits:

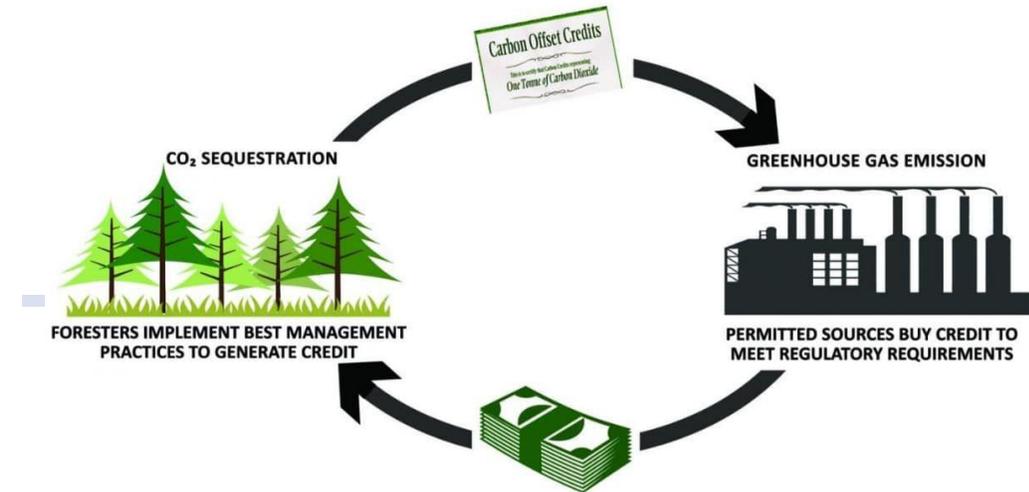
❑ The most popular method of carbon offsetting is trading of carbon credits, which originated from the Kyoto Protocol (1997).

❑ Carbon buyers:

❑ Companies that emit greenhouse gases above a certain limit trade carbon credits to offset their emissions.

❑ Carbon offsetters:

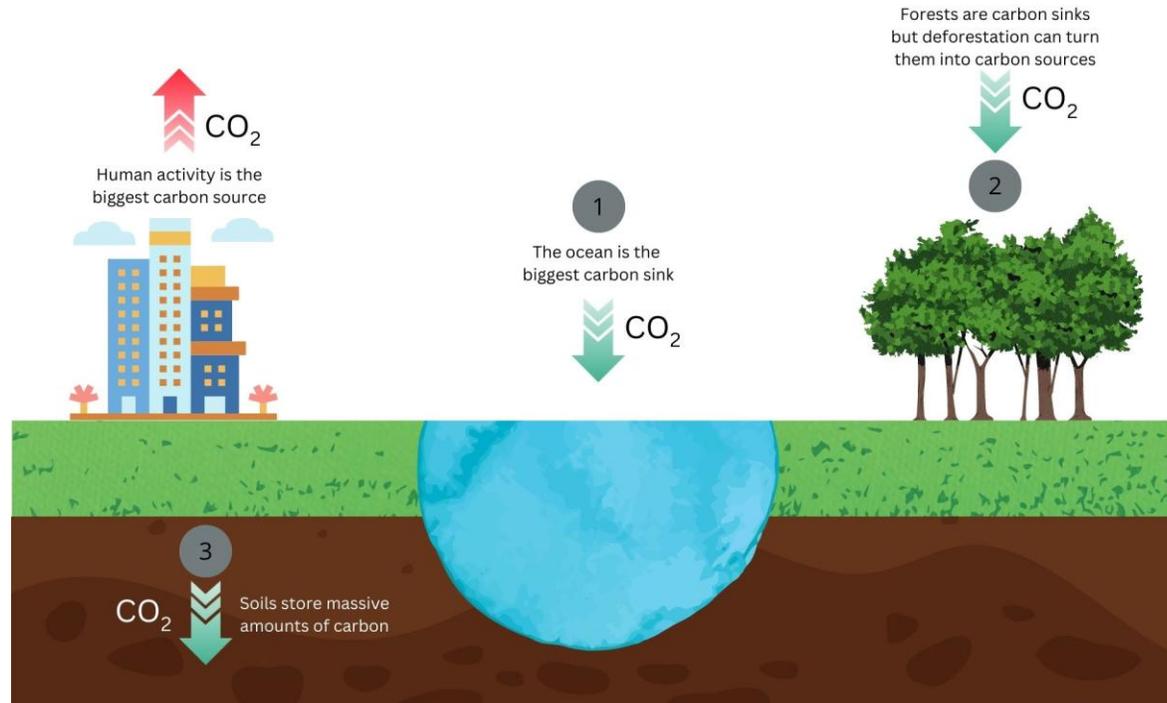
❑ Organizations that develop either green belts to absorb greenhouse gases or technologies to promote energy efficiency. Such organizations get credit for their work.



Carbon Sink

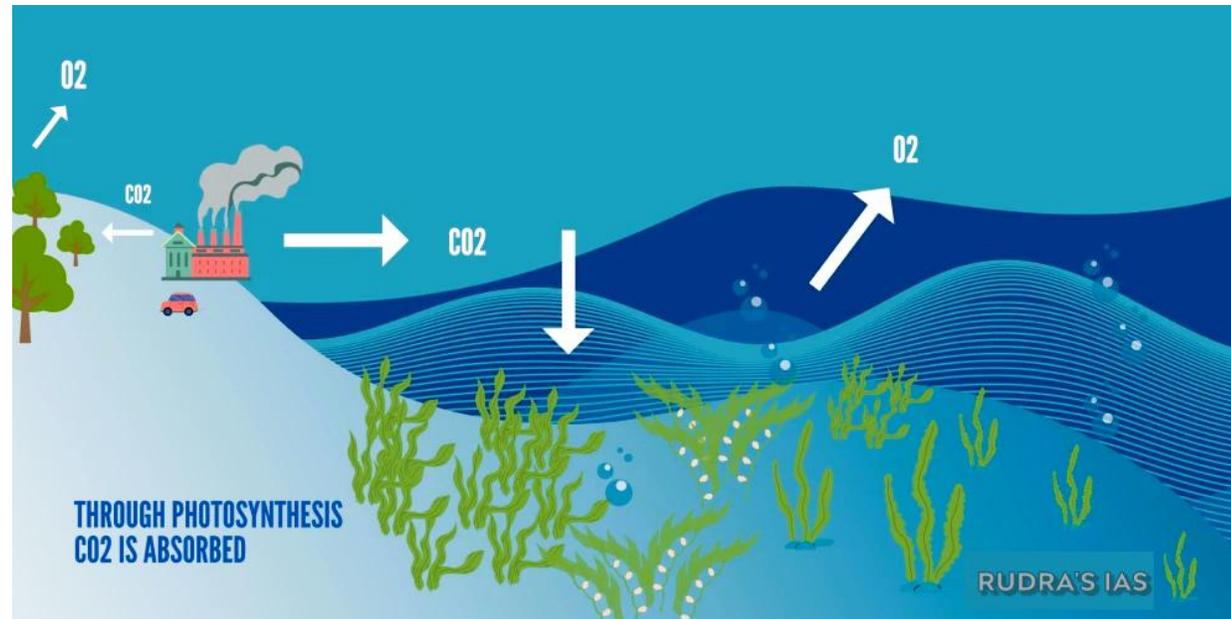
☐ Carbon sinks are those means that remove carbon by absorbing carbon dioxide (CO₂) from the atmosphere.

Plants, forest soil and oceans etc. are examples of carbon sinks.



Blue Carbon Ecosystems

- ❑ "Blue Carbon" ecosystems, particularly mangrove forests, seagrass meadows and salt marshes, are coastal and marine ecosystems that have the ability to store carbon in their biomass and sediments.
- ❑ These ecosystems play a vital role in reducing the amount of carbon dioxide in the atmosphere.



Carbon Farming

- ❑ Carbon farming includes farming activities that aim to develop carbon sinks through farming and try to store carbon.
- ❑ Agroforestry is the best example of carbon farming.
- ❑ Tree plants convert carbon into glucose through photosynthesis and store it in the roots of the plant.
- ❑ Farmers can also increase their income through carbon farming by doing carbon trading.



❑ Carbon Credit Certification

- ❑ Carbon credits are issued by organizations that certify projects that reduce greenhouse gas emissions.
- ❑ In India, carbon credits are awarded by the Bureau of Energy Efficiency (BEE) under the Energy Conservation Act 2002.



❑ Carbon Exchanges

- ❑ Carbon exchanges are a part of the carbon market, where carbon credits are sold and bought.
- ❑ Entities seeking carbon credits can sell their credits on carbon exchanges.

MORE CARBON FARMING MORE MONEY





Top 4 Carbon Exchanges

- **CTX (Carbon Trade Exchange):** The first global online exchange for carbon markets
- **ACX (America Carbon Exchange):** US-based carbon exchange
- **Expansive's CBL:** Carbon exchange network that offers a variety of carbon projects and offsets.
- **Toucan Protocol:** It uses blockchain technology to buy and sell carbon offsets.



**Carbon
TradeXchange
India**

Global concern on climate change

- Earth Day:** 22 April every year
- Father of the concept:** US Senator Gaylord Nelson
- When:** At a conference held in Seattle, Washington in September 1969
- Objective:** To make people aware of environmental issues
- First time:** 22 April 1970
- Nelson founded Earth Day to promote environmental education.



United Nations Conference on Environment and Development or Earth Summit

Objective: A meaningful effort by the United Nations to reduce carbon emissions and protect the earth from the ill effects of climate change

Time and place: 3-14 June 1992, Rio de Janeiro (Brazil)

Other name: United Nations Conference on Environment and Development or Earth Summit

Important progress: In this conference, the implementation of a treaty called United Nations Framework Convention on Climate Change (UNFCCC) was considered.

Objective of UNFCCC: To prepare a framework through negotiations to limit climate change

Secretariat of "UNFCCC": Bonn, Germany



रियो पृथ्वी शिखर सम्मेलन 1992



Important Conferences of UNFCCC

First Conference of Parties (COP-1) Berlin, Germany 1995

COP-3 (1997) Kyoto, Japan

Developed countries were committed to reduce the emission of greenhouse gases to less than the 1990 level. (Kyoto Protocol)

Carbon Emission Trading (Development of concepts like carbon credit, trading)

Clean Development Mechanism (Development of ecofriendly technology to reduce emissions)

Joint Implementation (Developed countries invest in clean projects of developing countries to balance their emissions)

US did not support because reduction in emissions would either hamper development or put additional economic burden on the country

COP-7 (2001) Marrakech, Morocco

Efforts to garner support to implement Kyoto Protocol

COP-8 (2002) Delhi, India

Needs of extremely poor countries were taken into consideration



Important conferences of UNFCCC

COP-21 (2015) Paris, France

Its main objective is to keep the global temperature rise below 2 degrees Celsius from pre-industrial levels and try to limit it to 1.5 degrees Celsius.

Each country has to take action to tackle climate change through its Nationally Determined Contributions (NDC).

India's Nationally Determined Contribution (NDC)

India's target is to reduce the emission intensity of GDP by 33-35% from 2005 levels by 2030.

India wants to generate about 40 (revised to 50 in 2022) percent of its electricity capacity from non-fossil fuel based energy sources by 2030.

India wants to create 2.5 to 3 billion tonnes of carbon sinks by 2030.



United Nations
Climate Change

❏ International Solar Alliance (ISA)

- ◆ International Solar Alliance (ISA) is a global platform, which was jointly established by India and France.
- ◆ On 30 November 2015 at the Paris Climate Conference (COP-21).
- ◆ **Headquarters:** Gurugram, Haryana (India).
- ◆ It is the first international organization affiliated to the United Nations (UN) whose headquarters is in India.

◆ **Main objectives:**

- ☀️ To promote the use of solar energy.
- 🌍 To increase research, innovation and investment in solar technology.
- 🌱 To meet the solar energy needs of developing countries.
- 💰 To provide affordable financial assistance for solar projects.
- 🌐 Creation of a global solar energy market.
- ◆ **Membership:** ISA is mainly an organization of 121 countries which are located between the Tropic of Cancer and the Tropic of Capricorn.



❑ International Solar Alliance (ISA)

◆ Important initiatives of ISA:

- ✓ **One Sun One World One Grid (OSOWOG):** India's ambitious plan to create a common grid of solar energy globally.
- ✓ **Solar Finance Facility:** Provision of financial assistance for solar projects.
- ✓ **STAR-C (Solar Technology Application Resource-Center):** Capacity building in the field of solar technology in member countries.
- ✓ **Solar Risk Mitigation Initiative:** Reducing the risk of investing in solar projects.

❑ COP-26 (2021) Glasgow, Scotland, UK

- ❑ Most countries set a target of Net Zero Emissions by 2050.**
- ❑ India announced a target of Net Zero by 2070.**
- ❑ Developed countries reiterated their commitment to provide climate finance of \$100 billion per year to developing countries.**
- ❑ More than 100 countries pledged to reduce global methane emissions by 30% by 2030. India did not join this pledge.**

❑ India's Role in COP-26 and Panchamrit Declarations (5 Amrit Elements)

❑ Prime Minister Shri Narendra Modi announced the 'Panchamrit' policy:

1. 500 GW of non-fossil energy capacity by 2030 (214.68 GW by 2025).
2. 50% of total energy needs from renewable sources by 2030.
3. 1 billion tonnes of carbon emissions reduction by 2030.
4. 45% reduction in emissions intensity of GDP (from 2005 levels).
5. Net Zero Carbon target by 2070.

❑ How much of India's total energy needs are currently from renewable sources.

❑ Base Renewable Energy Share

- ✓ Total Primary Energy (TPES) ~2.6% (2021)
- ✓ Electricity generation (2024-25) ~12–15%
- ✓ Installed capacity ~46% (March 2025)



Mission LiFE (Life Style for the Environment)

- ❑ **Announcement** - By the Prime Minister of India, Shri Narendra Modi at the COP-26 Glasgow Conference (2021)
- ❑ **Objective** - We should contribute to environmental protection by making small positive changes in our daily lifestyle.
- ◆ **Key points of LiFE Mission:**
- ✓ **Pro-Planet People (PPP) Movement:**
- ❑ A mass movement in which the aim of every citizen is to adopt a 'lifestyle friendly to the earth'.
- ✓ Its motto is - 🙌 "Reduce, Reuse, Recycle"
- ❑ **Emphasis on individual efforts:** such as - ✓ Less use of plastic ✓ Saving water and electricity ✓ Use of energy efficient devices ✓ Cycling, use of public transport ✓ Waste management etc.
- ❑ **LiFE Global Movement:** Called upon all the countries of the world to adopt this change in their lifestyle.
- ❑ **Contribution to SDGs (Sustainable Development Goals):** The LiFE mission is instrumental in addressing several SDGs related to climate change, water conservation, clean energy, reducing land degradation, sustainable production and consumption.



IPCC (Intergovernmental Panel on Climate Change)

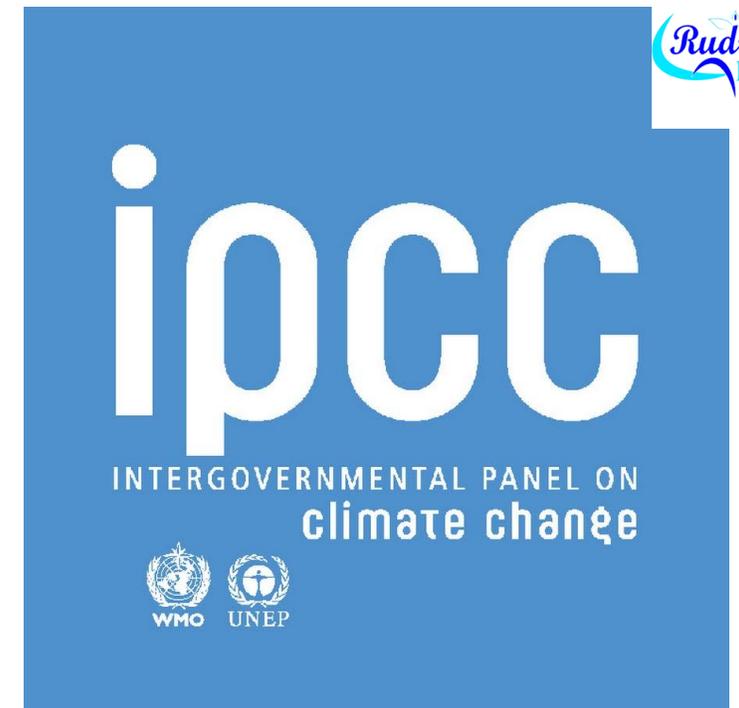
❑ **Formed: 1988**

❑ **Headquarters: Geneva, Switzerland**

✓ A United Nations body that publishes scientific reports (AR) on climate change and provides guidance to policymakers.

➤ **1st AR published in 1990**

➤ **6th AR in 2023**



❑ Carbon Neutrality

❑ Prime Minister Narendra Modi announced at the COP-26 conference (Glasgow, 2021):

❑ India will achieve 'Net Zero Carbon Emissions' by 2070.

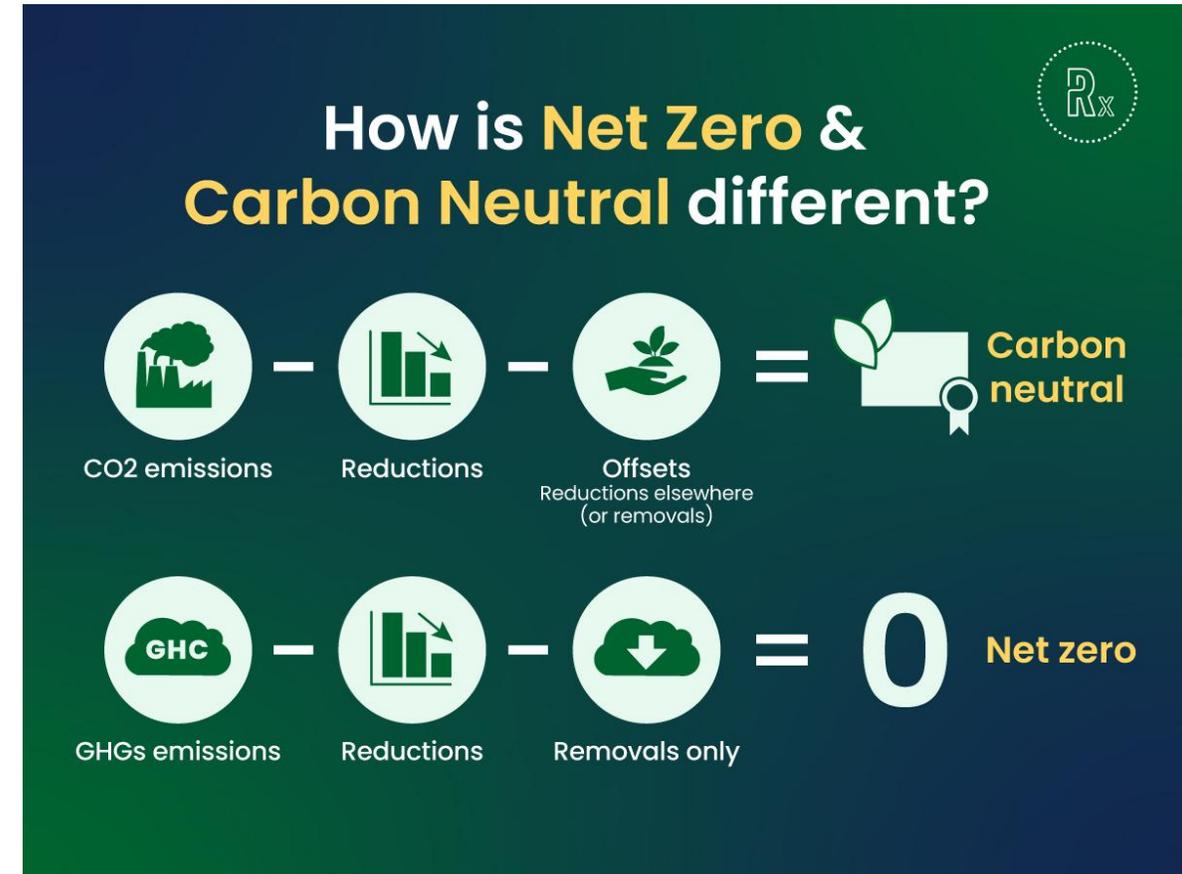
❑ Main Differences Between Carbon Neutral and Net Zero

✓ Carbon Neutral:

❑ Balance of emissions and absorption of CO₂ only.

✓ Net Zero:

❑ Balance of emissions and removal of all greenhouse gases from the atmosphere.



Ecology



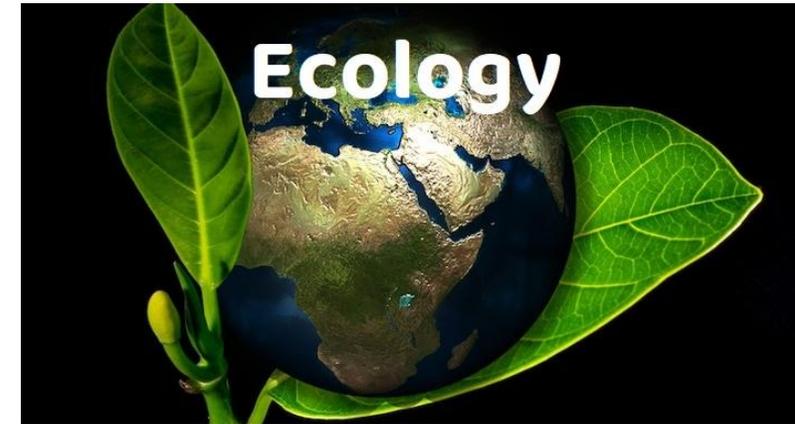
□ Ecology

Ecology is the science that studies the relationships between living organisms (plants, animals, microorganisms) and their environment.

- ◆ It examines how living beings interact with their physical environment (such as water, air, temperature, soil) and with other organisms (consumers, producers, decomposers).
- ◆ Components of Ecology:

Biotic Components: Plants, animals, microorganisms

Abiotic Components: Sunlight, water, air, temperature, minerals



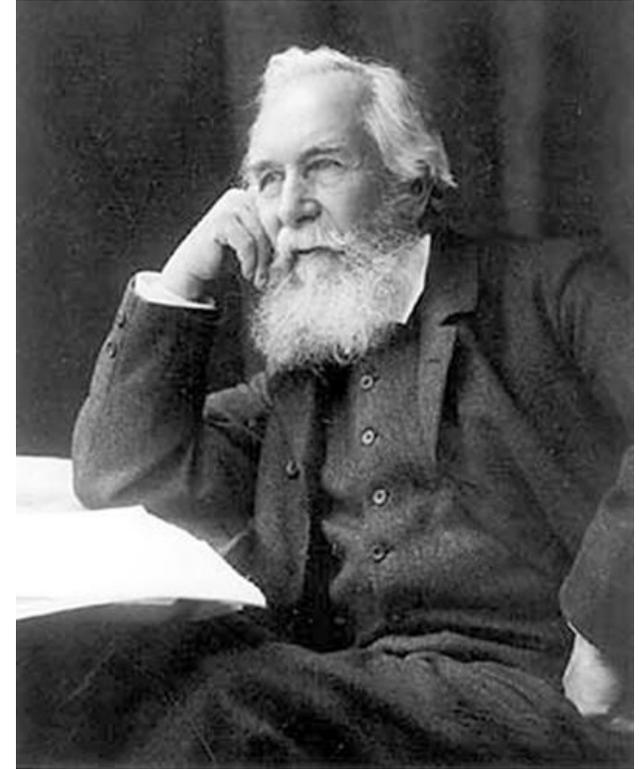
Definition of Habitat

- ❑ Habitat is the specific natural place where a species lives and fulfills all its essential needs such as food, shelter, reproduction, etc.
- ❑ Examples – Forest, seashore, desert, grassland, etc.

❑ Relation between Ecology and Habitate

Ecology	Habitate
Ecology studies the relationships between organisms and their environment.	Organisms carry out their life activities in the habitat.
In this, the life style, nutrition, mutual relations etc. of living beings are studied.	This determines where organisms are found.
Food chain and energy flow among tigers, deer, grass etc. in forests.	Habitat of tiger - Dense forests

- ✓ The term ecology – first used by Ernst Haeckel in 1866.
- ✓ Habitat change – Deforestation, urbanization leads to loss of habitats.
- ✓ Important habitats in India: Forests, wetlands, deserts, mountainous regions, marine regions.



Ecosystem

- ❑ An ecosystem is a unit in which biotic components (plants, animals, microorganisms) and abiotic components (water, air, soil, temperature, light) interact with each other through nutrient cycling and energy flow.
- ❑ The size of an ecosystem can be as small as a pond or as large as an ocean.
- ❑ The term ecosystem was coined by A.G. Tansley (1935) (Sir Arthur George Tansley).



Types of ecosystems

Terrestrial ecosystems: Forest, grassland, desert

These have diversity of flora and fauna according to physical factors like soil, temperature, rainfall.

Aquatic ecosystems: Pond, lake, wetland, river, estuary

In these ecosystems, factors like water depth, temperature, salinity and light penetration affect biodiversity.

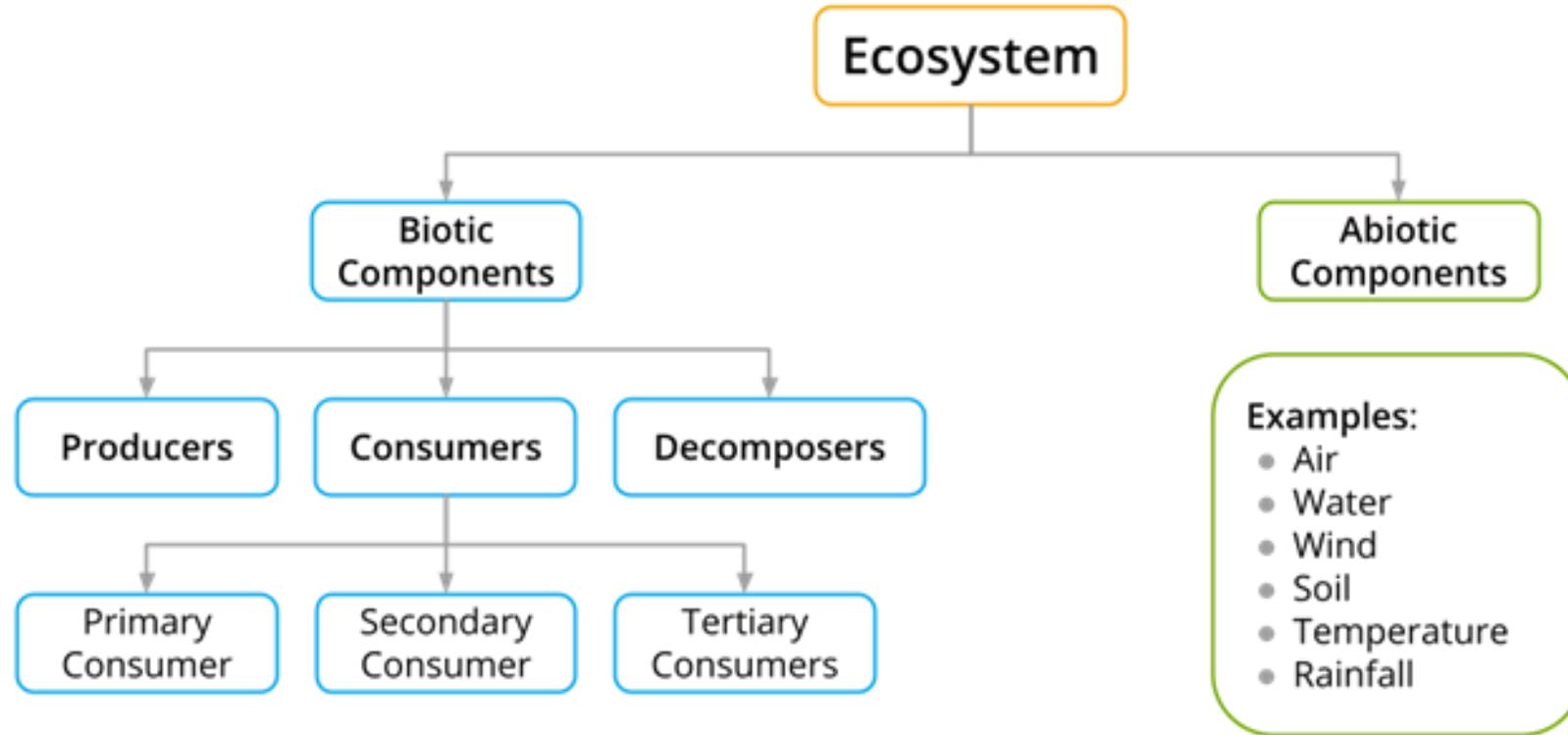
Man-made ecosystems: Crop field, aquarium

In these, biological components are selected by humans and environmental conditions are controlled artificially.

Characteristics of ecosystem:

- There is a balance between biological and abiotic components.
- Energy flow is always unidirectional – from sun → producers → consumers → decomposers
- Nutrient cycles – like carbon cycle, nitrogen cycle, etc. – ensure the repetition of substances.
- Self-regulation.

Components of an ecosystem

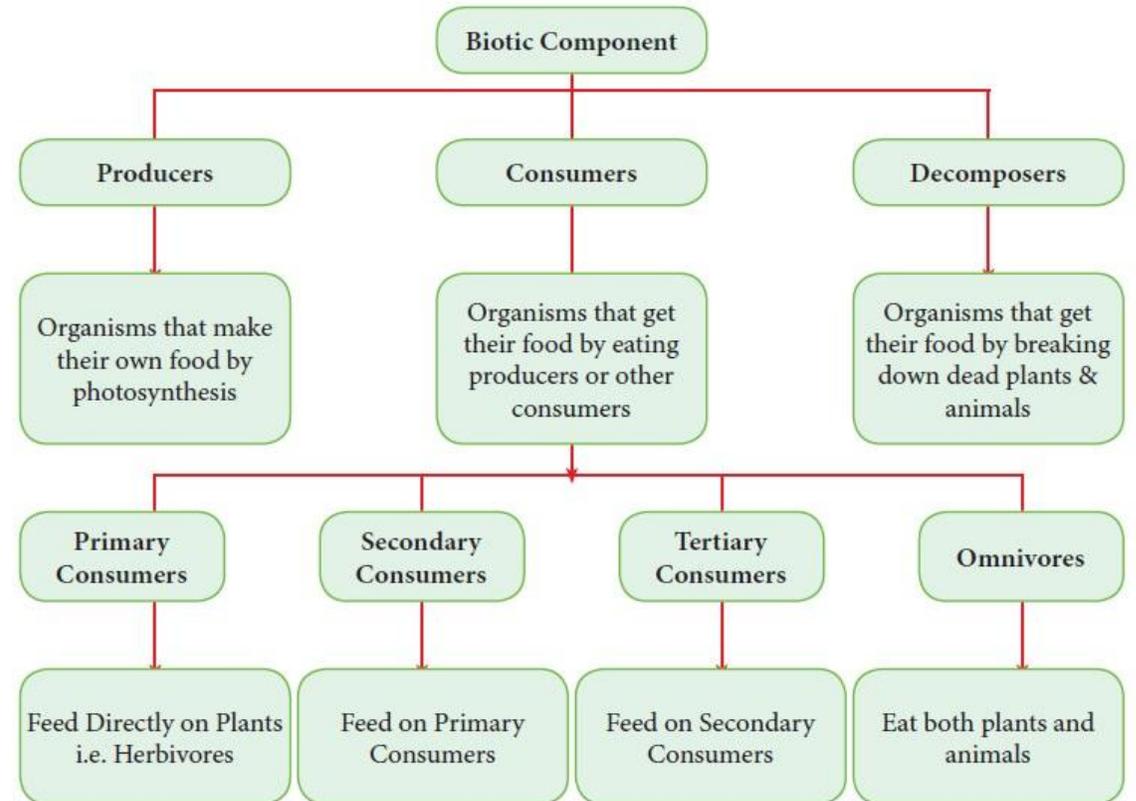


Biotic components of the ecosystem

□ Biotic components in the ecosystem are all those living organisms that directly or indirectly depend on each other.

They are divided into three major classes:

1. ✓ Producers
2. ✓ Consumers
3. ✓ Decomposers / Detritivores



1. Producers

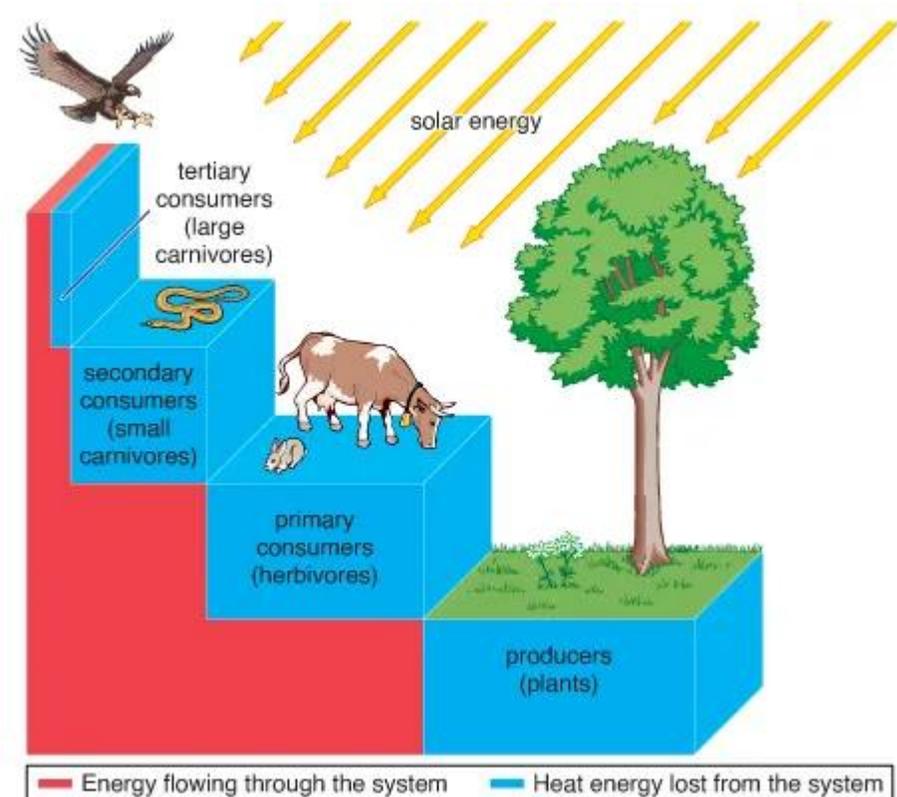
✓ They are also called autotrophs.

✓ These organisms make food by photosynthesis from simple inorganic substances (CO_2 , H_2O) in the presence of sunlight.

✓ Example – Green plants, algae, phytoplankton.

◆ In terrestrial ecosystem – trees, bushes, grass etc.

◆ In aquatic ecosystem – algae, phytoplankton.



2. Consumers

✓ They are called Heterotrophs because they cannot make their own food, they are dependent on other organisms.

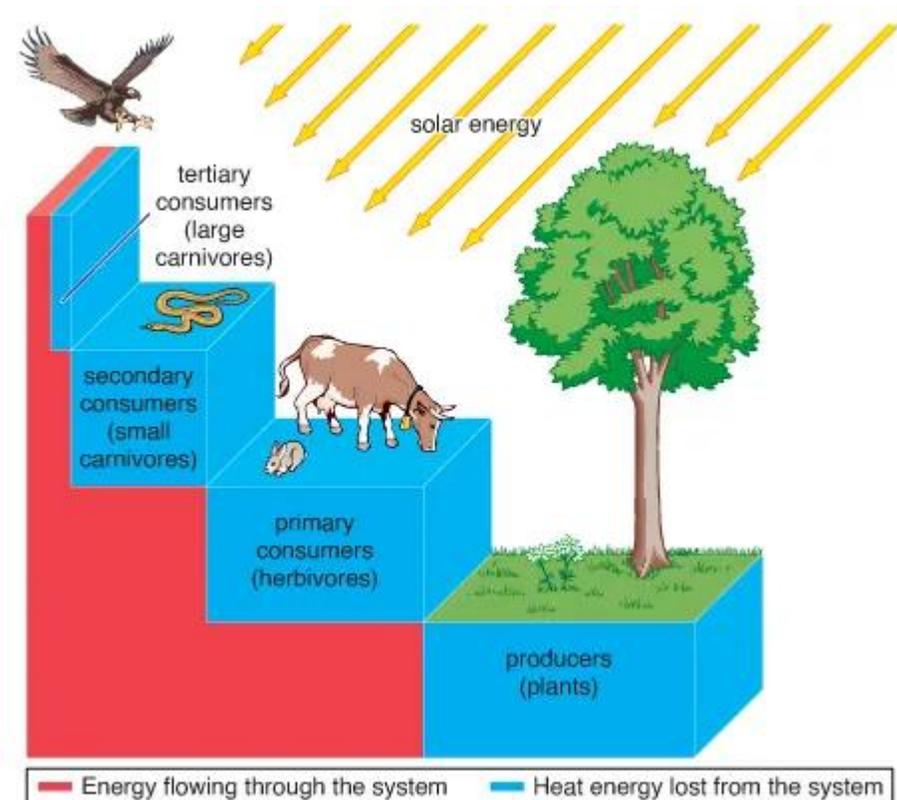
Types of Consumers:

➤ Primary Consumers / Herbivores

- ✓ Directly dependent on producers.
- ✓ Example – Cow, deer, rabbit.

➤ Secondary Consumers / Carnivores

- ✓ Eat herbivorous organisms.
- ✓ Example – Snake, wolf.



➤ **Tertiary Consumers (Tertiary Consumers / Top Carnivores)**

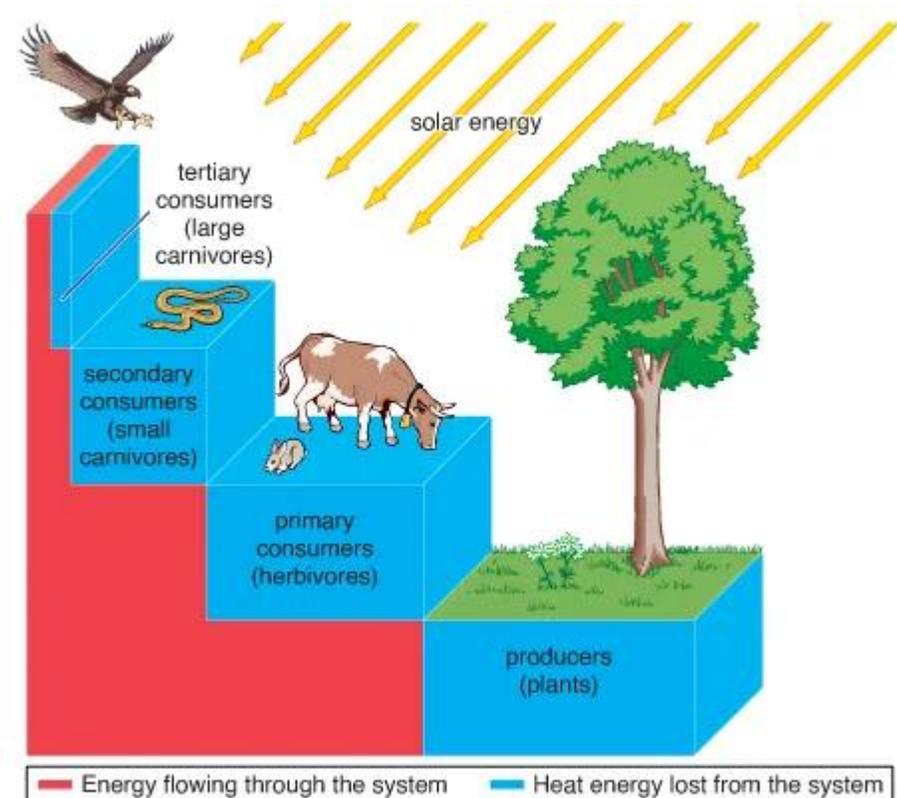
✓ They hunt secondary consumers.

✓ Example – Lion, tiger, big shark, eagle.

➤ **Omnivores**

✓ Those who eat both vegetarian and non-vegetarian food.

✓ Example – Human, bear, pig.

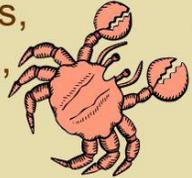


3. **Decomposers / Detritivores**

- These organisms decompose dead plants, animals and their remains.
- They release enzymes on dead matter, which forms inorganic substances.
- They maintain the nutrient cycle in the ecosystem.
- Example – Bacteria, Fungi.

Detritivore vs Decomposers

<ul style="list-style-type: none">● Detritivores eat the remains of dead plants and animals	<ul style="list-style-type: none">● Decomposers breakdown (decay) organic matter and feed on it
Crabs, mites, earthworms, snails	Bacteria & fungi





Role of Decomposers

- Decomposers are organisms of the ecosystem that decompose dead plants, dead animals or their remains.
- Decomposers do not swallow food. They obtain nutrition through external digestion. They release enzymes on dead plants and animals which convert organic substances into soluble form.
- They absorb some part of the soluble substances formed by them, the rest becomes available to other components of the ecosystem (producers).
- In this process, they release nutrients like carbon, nitrogen, phosphorus back into the soil, water and atmosphere, due to which producers get these elements again through the nutrition cycle.

◆ **Importance of decomposers in the ecosystem:**

- ✓ **Complete the nutrition cycle.**
- ✓ **Increase the fertility of the soil.**
- ✓ **Keep the environment clean by decomposing waste and dead organisms.**
- ✓ **Ensure the re-availability of inorganic elements.**

Main examples:

Fungi

Bacteria



Principle of Uniformitarianism

- Propounded by Hutton (1785).
- Physical and biological processes of ecosystem do not change fundamentally with time.
- The intensity or frequency of the process can change with time.
- Example:**
 - Rivers still deposit sediments, just as they did in ancient times.
 - Plants still produce energy through photosynthesis, just as they did centuries ago.
 - Nutrient cycles (such as the nitrogen cycle) will remain the same in the past, present and future.



Interaction of Organisms with Environment in Ecosystem

- ◆ "No organism has a separate existence, rather every organism continuously interacts with its physical (abiotic) environment and other organisms."
- ✓ Ecosystem comes into existence due to this mutual relationship between organisms and their environment.
- ✓ This relationship is two-way—
 - ❑ Environment affects organisms (e.g.: temperature, water, nutrients).
 - ❑ Organisms also play important role to change the environment (e.g.: plants increase oxygen in the atmosphere, organisms release CO₂).

☀️ Energy Flow in Ecosystem

✔️ The basic source of functioning in the ecosystem is solar energy.

Producers – such as green plants – use this solar energy in photosynthesis.

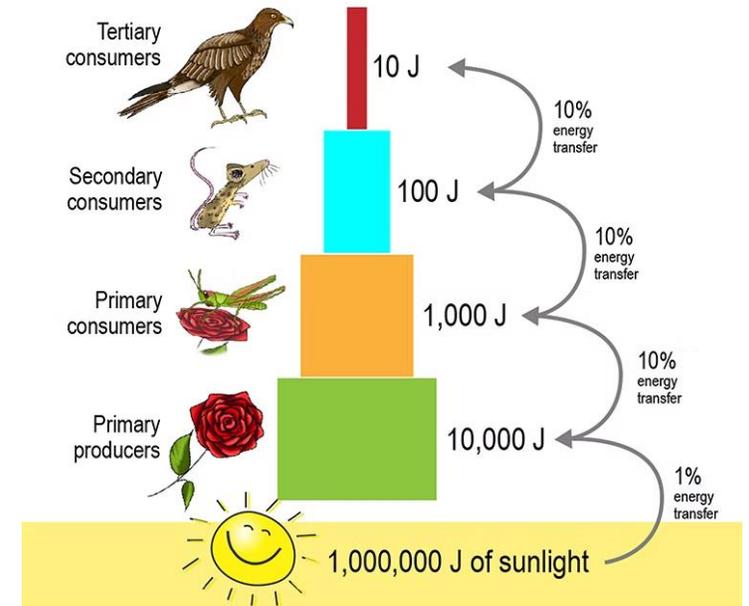
✔️ The energy stored by the producer is transferred to different trophic levels of consumers—



✔️ In this way the flow of energy is unidirectional—

☀️ Sun → Producer → Consumer → Decomposer → Atmosphere

(Heat loss)



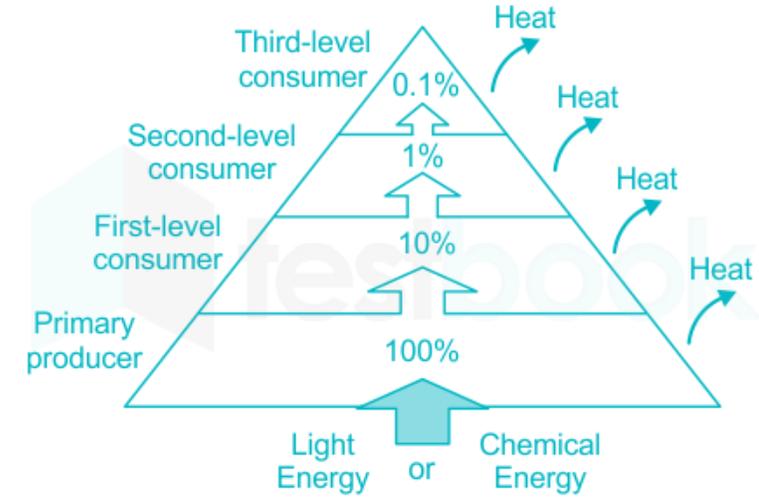
10 Percent Law of Energy Transfer

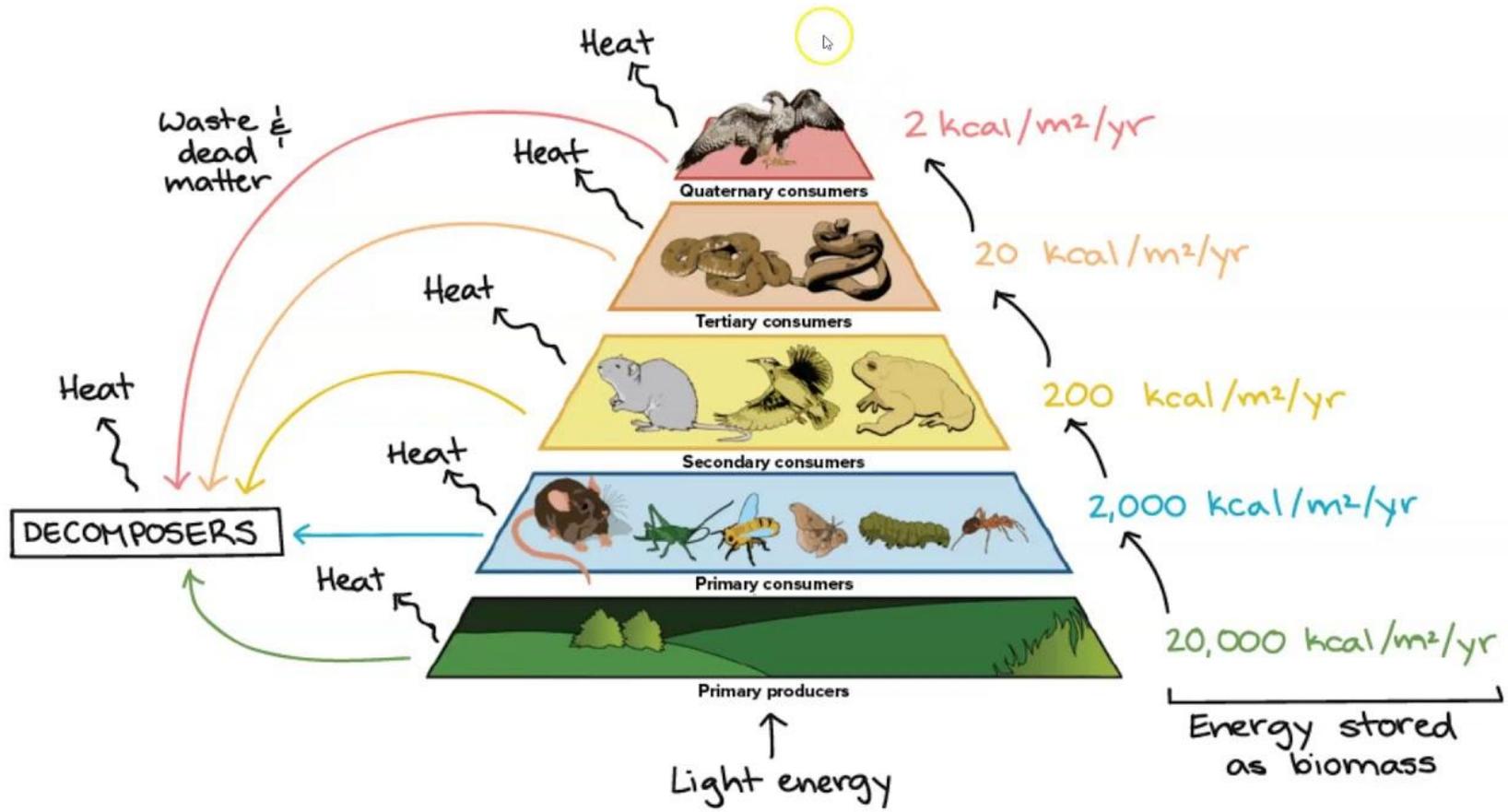
◆ During energy flow in the ecosystem, only about 10 percent of the total available energy at each trophic level reaches the next trophic level.

The remaining 90% of energy is wasted in the form of -

- ✓ metabolic activities,
- ✓ respiration,
- ✓ excretion,
- ✓ and heat.
- ✓ This law was propounded by Lindeman (1942).

❖ This law is called "Lindeman's 10% Law of Energy Transfer" |





☀ Solar Radiation and Productivity of Ecosystem

✓ The most important factor of productivity of ecosystem is solar radiation.

✓ Solar radiation is the basic energy from which producers make food by photosynthesis.

◆ Effect of solar radiation on ecosystem:

✓ The more the solar radiation, the more the primary productivity.

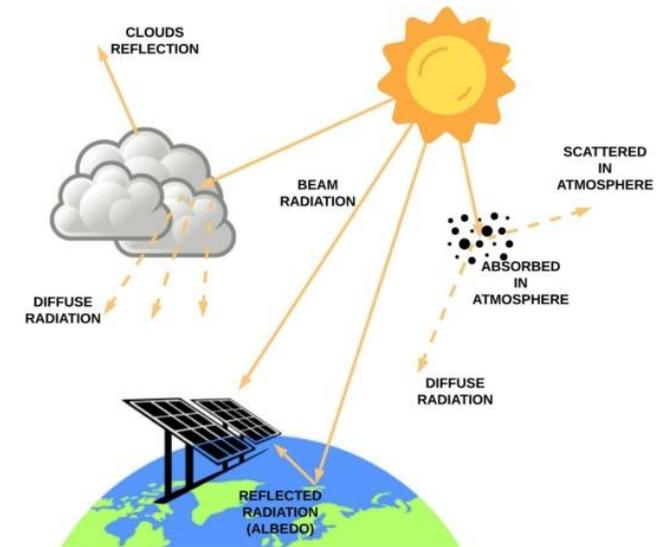
✓ Availability of solar radiation also controls biodiversity.

✓ As we move from the equator towards the poles—

→ Solar radiation decreases.

→ Due to which the productivity of the ecosystem decreases.

→ Biodiversity also decreases.



Ecological Niche

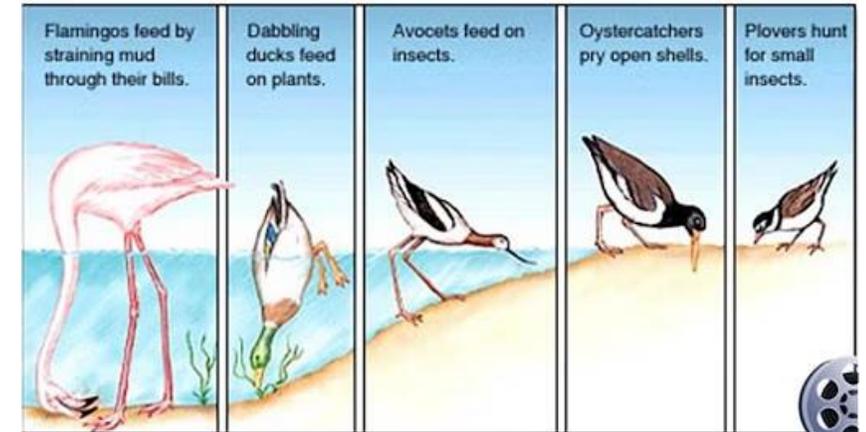
◆ Ecological niche refers to the functional role played by a species in the ecosystem.

 It tells that the species:

- ✓ what it eats,
- ✓ where it lives,
- ✓ how it relates to other organisms,
- ✓ and what is its contribution to the energy and nutrient cycle.

◆ This theory was first propounded by Joseph Grinnell.

An organism's **habitat** is its "address" while its **niche** is its "occupation"



Types of Ecosystem

- ❖ Ecosystems are mainly divided into two categories—
- ❖ Natural ecosystem and artificial ecosystem

Natural ecosystem

✔ These are formed automatically without human intervention.

◆ (A) Terrestrial ecosystem - also called biome

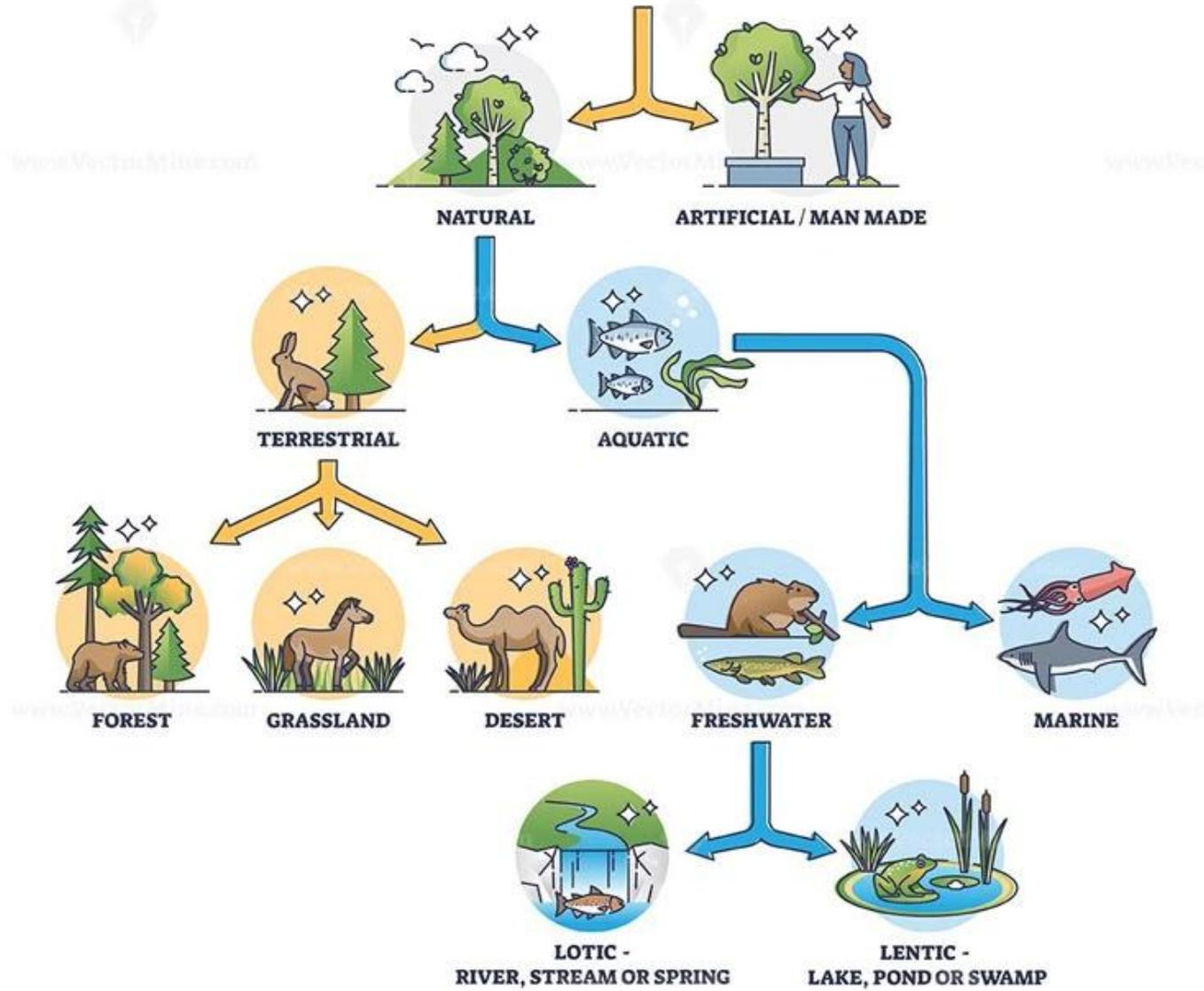
 Forest ecosystem - tropical rainforest, deciduous forest, dry forest, desert forest, coniferous forest, tundra forest etc.

 Grassland -

Tropical grasslands - savanna, compass

Temperate grasslands - prairie, pampas etc.

TYPES OF ECOSYSTEM





Desert -

 Continents	 Examples of hot deserts
Asia	<p>Thar Desert (India, Pakistan)</p> <p>Arabian Desert (Saudi Arabia, Oman)</p> <p>Karakum Desert (Turkmenistan)</p> <p>Qizilkum Desert (Kazakhstan, Uzbekistan)</p>
Africa	<p>Sahara Desert (world's largest hot desert)</p> <p>Kalahari Desert (South Africa, Namibia, Botswana)</p> <p>Namib Desert (Namibia)</p>
North America	<p>Mojave Desert (United States)</p> <p>Sonora Desert (United States, Mexico)</p> <p>Chihuahuan Desert (Mexico)</p>
South America	Atacama Desert (Chile, Peru) — the driest desert in the world
Australia	<p>Great Victoria Desert</p> <p>Great Sandy Desert</p> <p>Simpson Desert</p>
Europe	Natural hot deserts are not found in Europe.



 **Cold deserts:**

- ❑ **Antarctica - the world's largest cold desert,**
- ❑ **Arctic - Greenland, Alaska, Siberia,**
- ❑ **Gobi Desert - Mongolia and China**



◆ (B) Aquatic Ecosystem

Freshwater Ecosystem

◆ Freshwater Ecosystem is related to those water areas where the salinity in water is very low (less than 0.05%). It is also called freshwater ecosystem.

◆ Main types:

Lentic

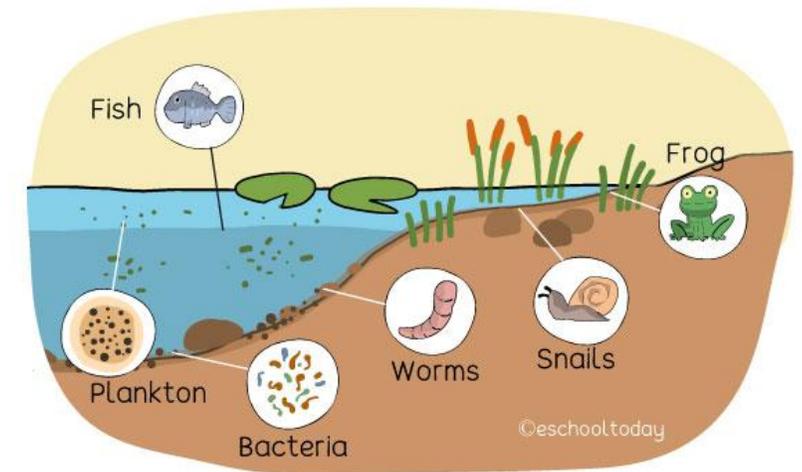
Steady or stagnant water

Pond, lake, wetland

Lotic

Flowing water

Rivers, waterfalls, mountain streams



◆ **Main features:**

- ✓ **Low Salinity**
- ✓ **High biodiversity**
- ✓ **Major source of drinking water**
- ✓ **Important for agriculture, fisheries and irrigation**

◆ **Problems:**

- ✗ **Water pollution**
- ✗ **Overexploitation**
- ✗ **Encroachment and urbanization**
- ✗ **Decrease in biodiversity**

Marine Ecosystem (also called Saltwater Ecosystem)

◆ "Marine ecosystem is an ecosystem related to oceans and seas with salty water, in which special types of biotic and abiotic components are found."

◆ **Main parts (division into 4 parts):**

Open Sea - The deep part of the sea where sunlight reaches less. Pelagic organisms (such as whales, tuna fish) are found here. Biodiversity is low.

Barrier Islands - Islands of sand or sediment located parallel to the coastline that protect the coasts from sea waves. Special vegetation and birds are found here.

Coral Reefs - Areas with the richest biodiversity. They are also called 'rainforests of the sea'. Structures like Sundarbans.

Shoreline - The boundary of the marine and terrestrial ecosystem.

The effects of tides, mangrove vegetation, oysters, crabs etc. are found here.

Importance of Marine Ecosystem:

- ✓ 70% of the earth's oxygen is produced here.
- ✓ Source of fish production, minerals, salt etc.
- ✓ Conservation of biodiversity.
- ✓ Center of human economic, cultural and scientific activities.

◆ Main problems:

- ✗ Pollution (plastic, oil spill)
- ✗ Overfishing
- ✗ Ocean Acidification
- ✗ Coral Bleaching



Artificial Ecosystem

✓ These are created and controlled by humans.

🚜 Cropland- farm, gardening area.

🐟 Aquarium- fish tank.

🌸 Garden- flower garden, city garden.

Artificial ecosystems



Garden



Aquarium



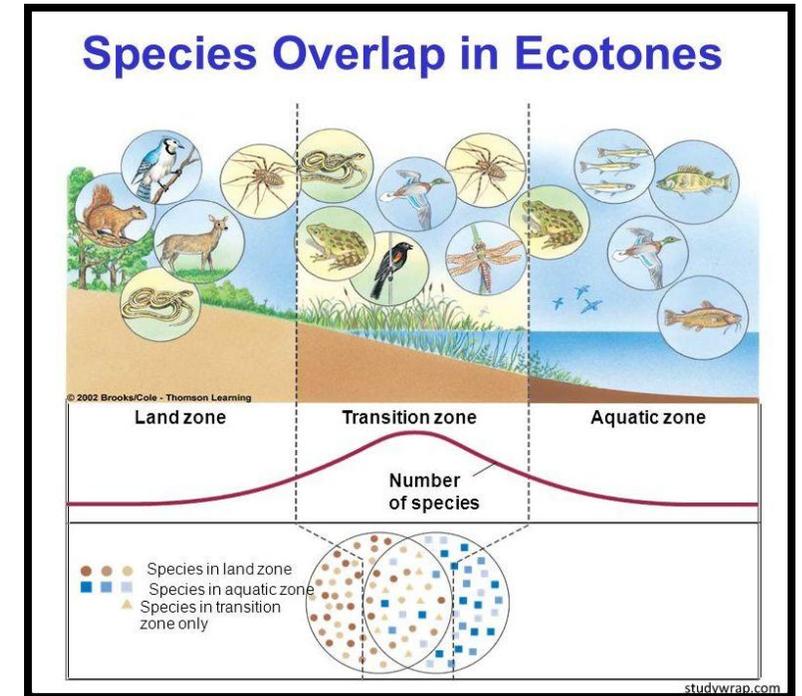
Crop field



Zoo

Transitional Ecotone:

- ❑ An ecosystem situated between two different ecosystems (e.g. water and land, forest and grassland)
- ❑ It is a transition zone where biological components of both ecosystems are found.
- ❑ The number of species and biomass is high here.
- ❑ Sometimes some special species are also found in it which flourish only in this transition zone - these are called indicator species.



Types of Ecotones:

❑ Estuary:

- ❑ Where freshwater from a river meets saltwater from the sea. It is highly fertile and serves as a nursery for many aquatic organisms.

❑ Wetlands:

- ❑ Areas where water is stored for a long time or seasonally. It plays an important role in biodiversity and water purification.

❑ Mangrove Ecosystem:

- ❑ Ecosystem of plants found on saltwater seashores. They provide protection from sea storms and are extremely important for marine biodiversity.



Ecological Productivity:

- The amount of gross energy stored per unit surface area and per unit time by primary producers in an area is called ecological productivity.

Primary Production:

- The process of converting solar energy into chemical form (organic substances) by primary producers (green plants, algae etc.) is called primary production.

Major factors affecting productivity:

- The amount of solar energy available in the area.
- The ability of green plants to convert this solar energy into chemical energy (food energy).

Two types of primary productivity:

1. Gross Primary Production (GPP):

- ❖ Total energy produced by primary producers through photosynthesis

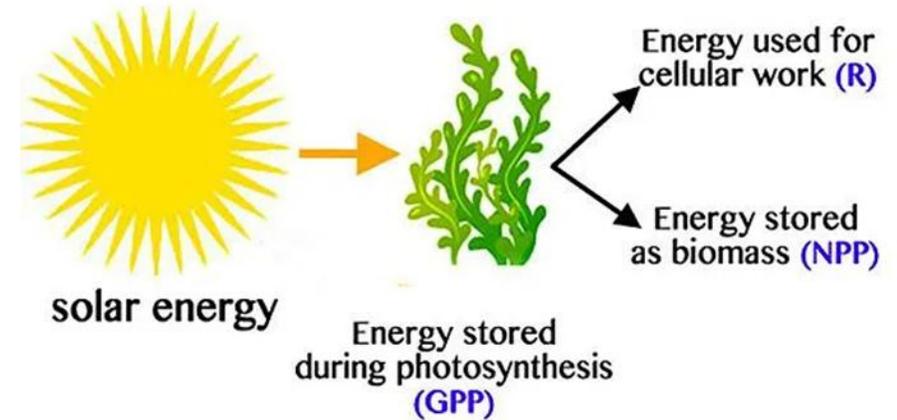
2. Net Primary Production (NPP):

- ❖ Energy left after subtracting energy spent in respiration of plants from GPP.

✓ **Relation:** $NPP = GPP - R$

❑ Here R = Energy spent in respiration

❑ Unit of measurement: Gram/square meter/day ($gm/m^2/day$)



$$NPP = GPP - R$$

net primary productivity gross primary productivity respiration

Net Primary Productivity (NPP) in the world

🌿 World average net primary productivity: 320 g/m²/year

🌱 **Ecosystems with the highest net primary productivity:**

✓ Tropical Rainforests

✓ Swamps

✓ Estuaries

👉 In all these, NPP is found to be around 2000 g/m²/year.

Important facts:

➤ The lowest NPP is found in deserts.

➤ The ocean contributes the most to the total NPP in the world, but the NPP per unit area is low.



Biomass Definition:

- ✓ The gross dry weight of all living organisms available per unit area and per unit time in any ecosystem is called biomass.
- ☐ It includes the dry weight of both plants and animals.
- ☐ In the determination of biomass, only living matter is included, not dead matter (such as dead leaves, wood, etc.).
- ☐ It is an important indicator of the productivity and biodiversity of the ecosystem.
- ☐ **Unit of measurement:** gram / square meter (gm/m^2) or ton / hectare (ton/ha)



Food Chain

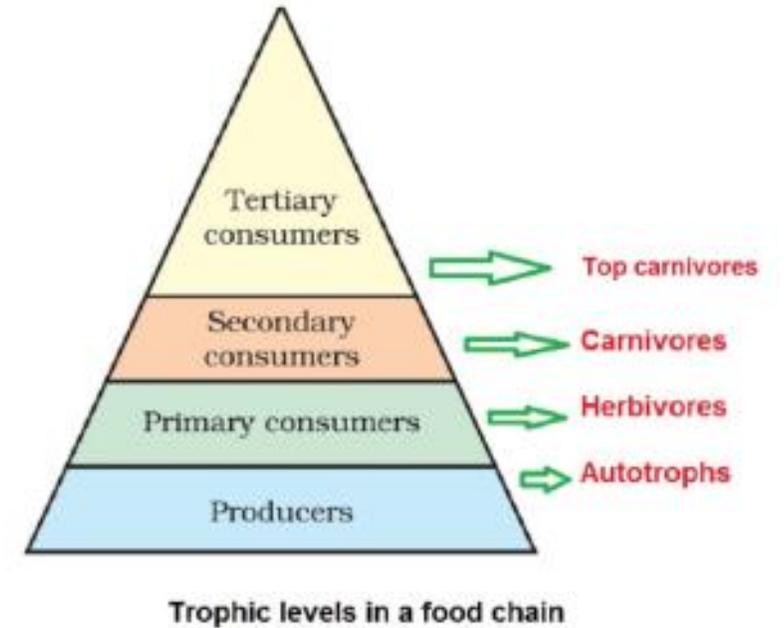
□ The sequence of different organisms within an ecosystem where one organism becomes food for another organism is called a food chain.

👉 Every organism is at a specific trophic level.

Trophic Level

◆ The level of organisms in a food chain at which they get their energy and nutrition is called a trophic level.

👉 Every organism is a part of some trophic level based on its method of nutrition and energy acquisition.



Trophic level

Trophic level	Component organisms	Function	Example
1. First Trophic level	Producers	synthesize solar energy and make food	Green plants, algae
2. Second Trophic level	Primary Consumers	Herbivores eat producers	Deer, cow, rabbit
3. Third Trophic level	Secondary Consumers	Eat primary consumers	Frog, mouse, lizard
4. Fourth Trophic level	Tertiary Consumers	Eat secondary consumers	Snake, owl
5. Fifth Trophic level	Apex predators	Top predators, whom no one eats	Tiger, lion, eagle

 Some organisms eat only one type of diet, so they are members of only one food chain.

 Some organisms eat different types of diet, so they can be part of many food chains.

Types of food chains:

1. Grazing Food Chain

- In this the flow of energy starts from green plants.
- Example: Grass → Grasshopper → Bird → Eagle

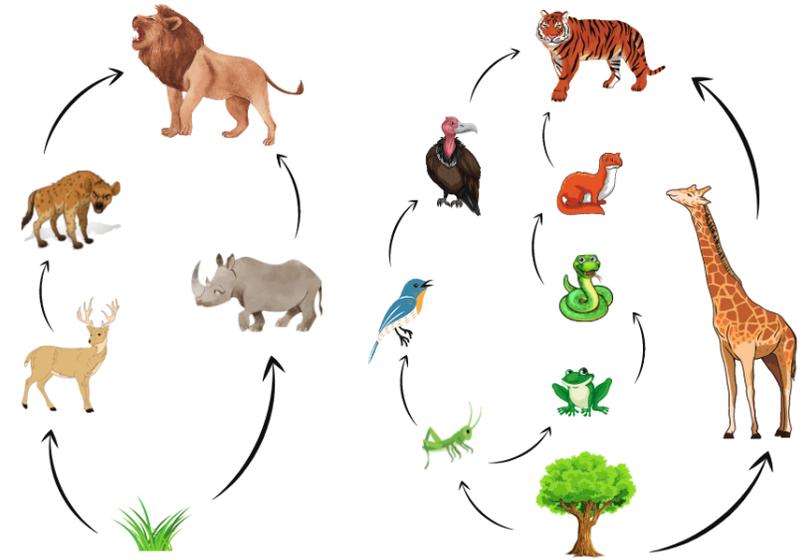
2. Detritus Food Chain

- In this the energy starts from the remains of dead plants and animals.
- Dead matter → Microorganisms → Detritus Eaters → Predators
- Example: Garbage → Springtails → Small spiders

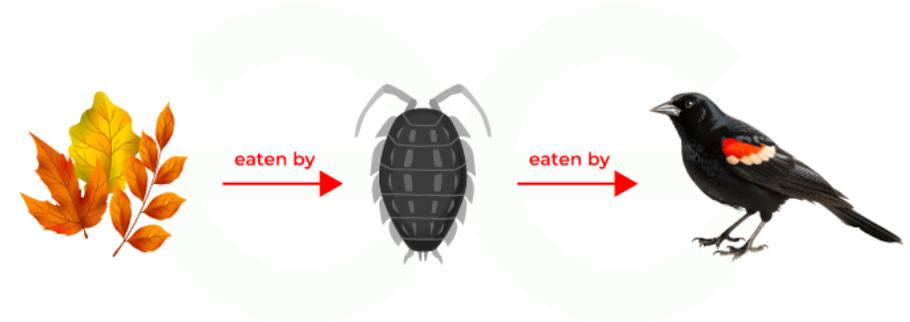
◆ **Note:** About 80% of the total energy available in shallow marine ecosystems flows in the detritus chain.

Important facts:

- ✓ Grazing chain is mainly based on solar energy.
- ✓ Detritus chain is based on dead organic matter.



Detritus Food Chain



Food Web

◆ In an ecosystem, many food chains are interconnected in such a way that one organism establishes a food relationship with many other organisms, then this complex relationship is called a food web.

👉 Food web = Network of many food chains

👉 Food web helps in maintaining the stability and resilience of the ecosystem.

Example:

🌿 Grass → Grasshopper → Frog → Snake → Eagle

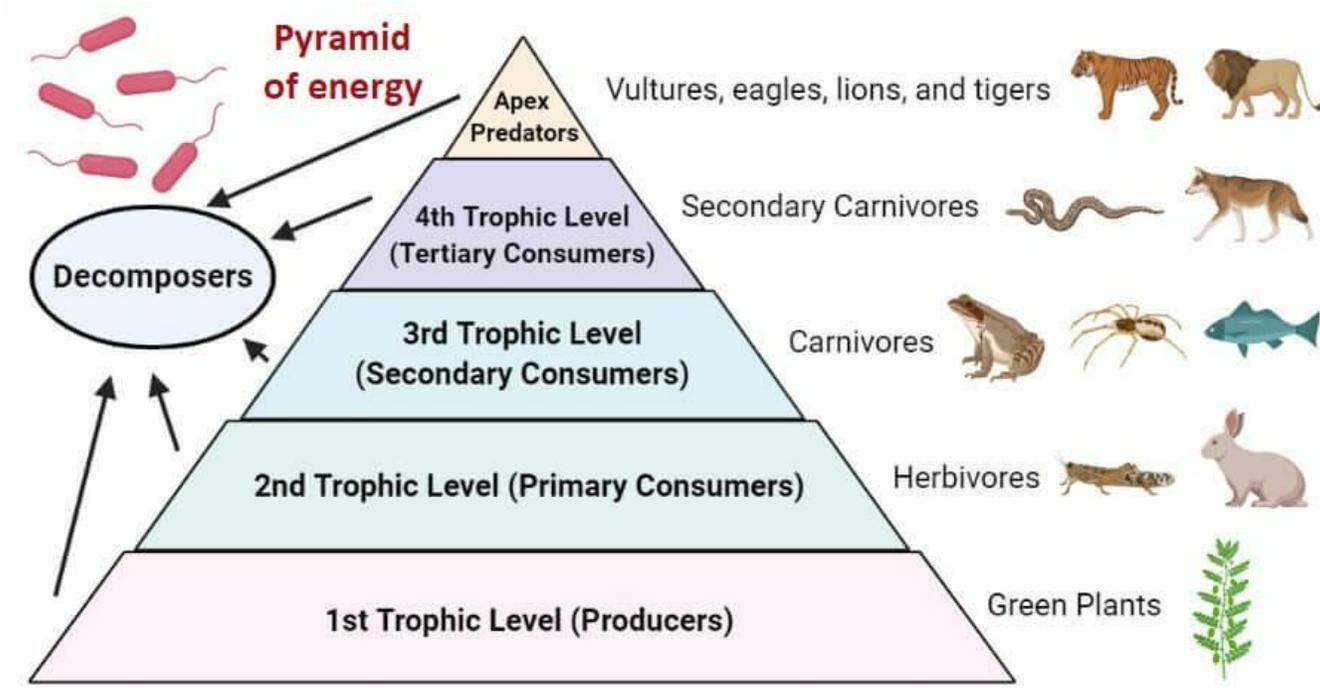
🌿 Grass → Rat → Snake → Eagle

🌿 Grass → Grasshopper → Rat → Snake → Eagle

👉 All these together form a food web.

Ecological Pyramid:

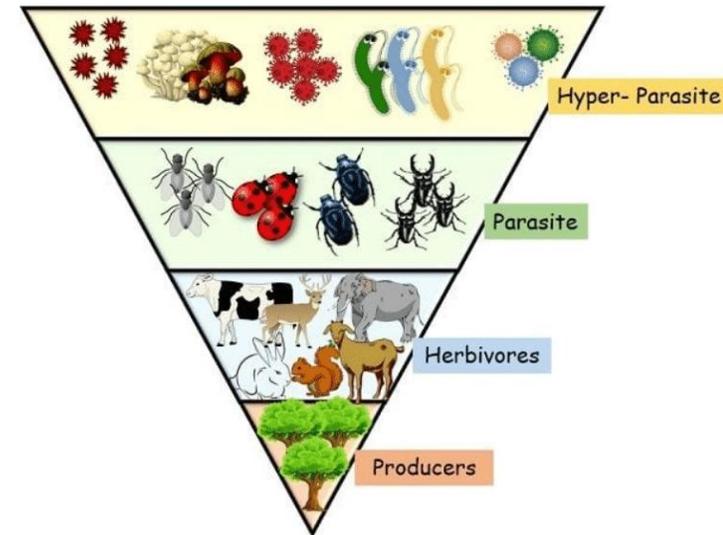
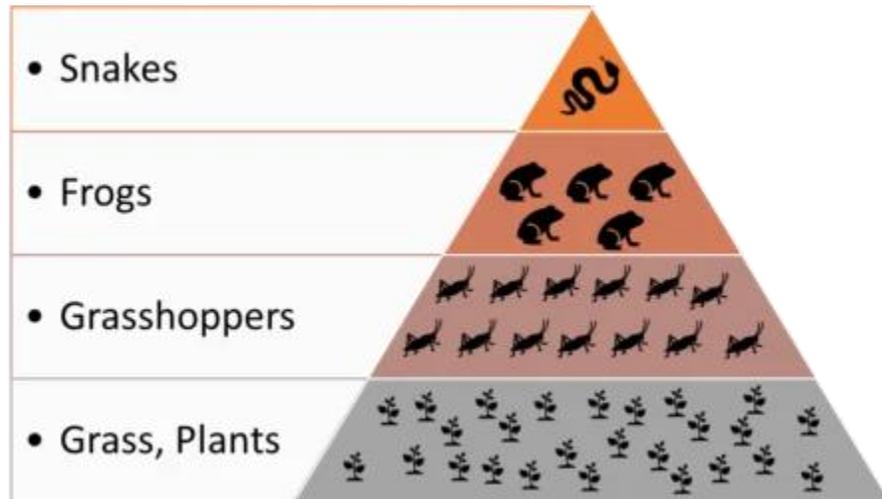
- The graphic representation of the distribution of numbers, biomass or energy across trophic levels in an ecosystem is called an ecological pyramid.
- 🙌 This pyramid starts with producers at the base and moves upwards to higher consumers.



Types of ecological pyramids:

1. Pyramid of Number

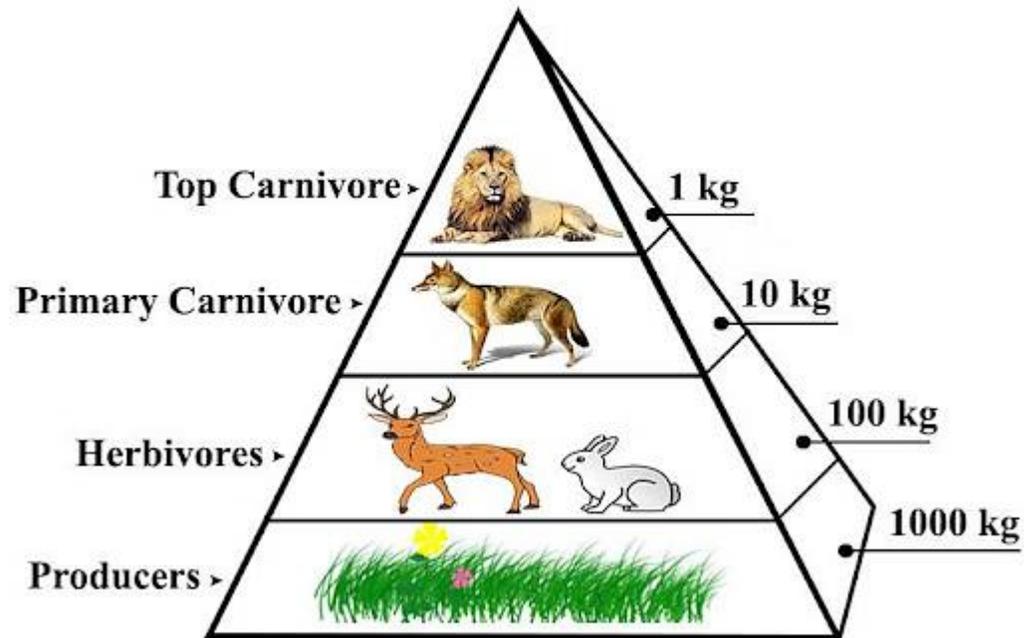
- Shows the number of organisms at trophic levels. Generally, the number of organisms at the top is less.
- Exception: Heterotrophic pyramid (e.g. insects on trees).



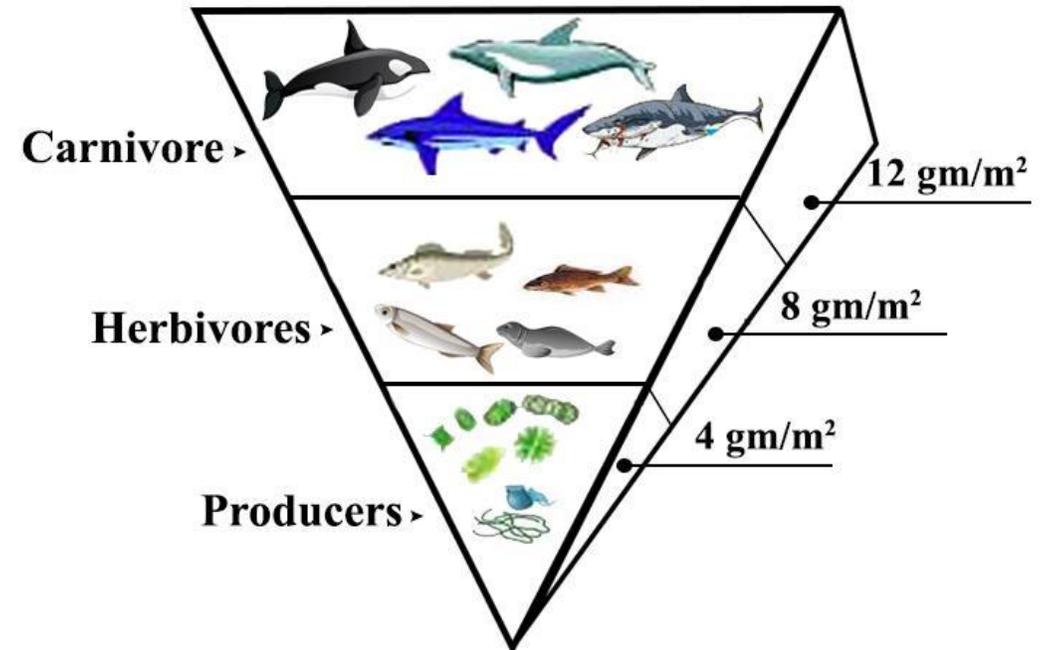
2. Pyramid of Biomass

- Shows the total dry weight (biomass) available at each trophic level. Usually it is a straight pyramid.
- Exception: Marine ecosystem (where the biomass of producer algae is low).

Upright Pyramid of Biomass in a Terrestrial Ecosystem



Inverted Pyramid in a Aquatic Ecosystem

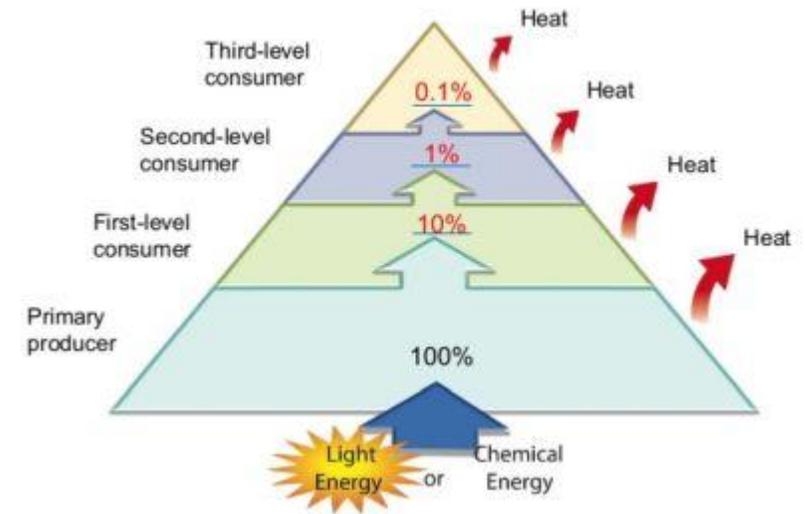


3. Pyramid of Energy

☐ Shows the availability of energy at each trophic level.

Always upright as energy is transmitted in one direction only and there is loss of energy at each level.

Pyramid of Energy



Important points (for Prelims/MCQ):

- ✓ Energy pyramid is never inverted.
- ✓ Biomass pyramid can be inverted in marine ecosystem.
- ✓ Exceptions are possible in number pyramid also (eg. insects dependent on trees).