UNIT-1 (Ecosystem)

→ Define Ecosystem - It is a life supporting unit of nature where there is an interaction between living Organism (plants, animals, microorganisms) and non-living things organism (soil, water, air, Sun).

→ Interactions involves the exchange of Energy, nutrients and creating a Self-Sustaining System.

Structure of an Ecosystem

Two main Components : 1. Biotic (living)
2. Abiotic (non-living).

1. Biotic Components

These are the living organisms within an Ecosystem & further classified as (i) producers
(ii) Consumers
(iii) Decomposers.

(i) producers (Autotrophs)
These are the Organisms that produce their own food through photosynthesis (e.g. plants, algae).
They form the base of the food chain by converting Solar Energy into chemical energy stored in Organic Compounds.

(ii) Consumers (Heterotrophs): These Organisms obtain Energy by Consuming other Organisms. These are classified as → Primary Consumers (Herbivores): Usually that eat plant resources. (e.g. goat, rabbit)
→ Secondary Consumers (Carnivores) Animals that eat primary Consumers. (e.g. wolves, Lion)
→ Tertiary Consumers - Carnivores that eat Other Carnivores (e.g. eagles, Hawk)

→ Omnivores - Animals that eat both plants and animals e.g. bear, humans).

(iii) Decomposers :- These organisms break down dead organic matter, returning nutrients to the soil for use by producers. e.g - bacteria, fungi & Earthworm.

2. Abiotic Components

These are the non-living factors that influence the ecosystem and determine the conditions under which the biotic components live (basically biotic components dependence).

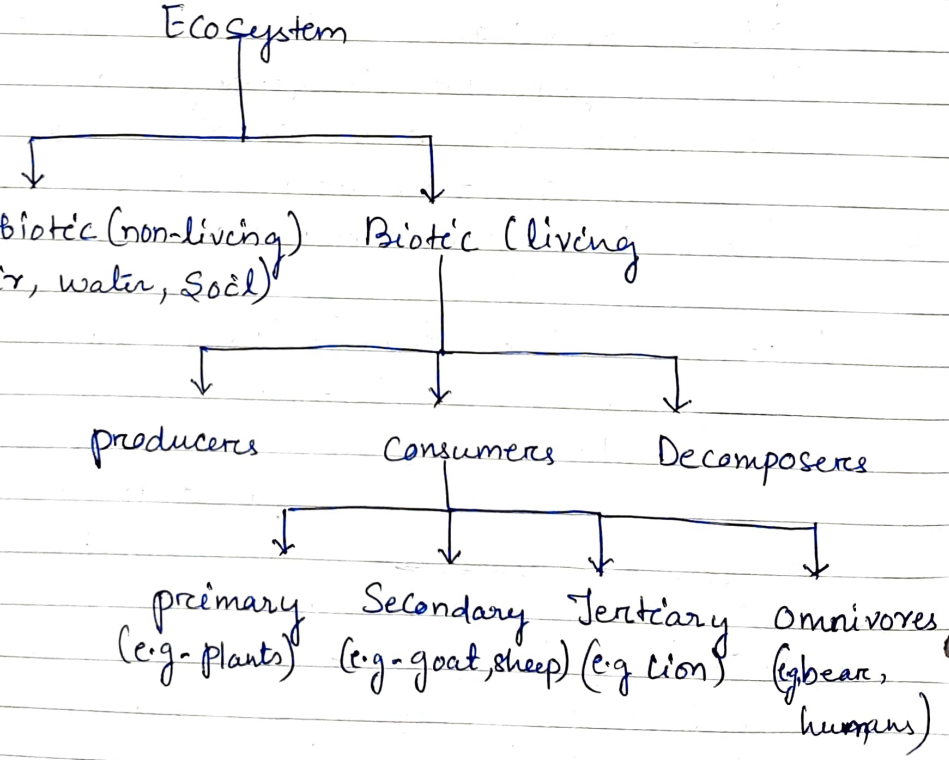
Abiotic Components are # climate (includes temperature, Sunlight and wind) for the survival.

#Soil which provides nutrients for plants growth

water - Essential for all living organisms.

Nutrients - chemicals elements like Carbon, nitrogen, and phosphorus).

Ecosystem Interacts includes Energy flow, nutrient cycling, Ecological succession.



① food chain

It is a linear sequence that shows how energy and nutrients flow from one organism to another in an ecosystem.

→ It begins with producers (plants) which creates their own food through photosynthesis using sunlight. These producers are then eaten by primary consumers, which are herbivores (animals that eat plants). Next, primary consumers are eaten by secondary consumers, which are usually carnivores (animals that eat other animals). Sometimes tertiary consumers eat other carnivores).

finally, the chain ends with decomposers like bacteria and fungi which break down dead organism and return nutrients to the soil, where they can be used again by producers. completing the cycle.

e.g. 1) Plants → grasshoper → frog → Snake → Hawk/Eagle

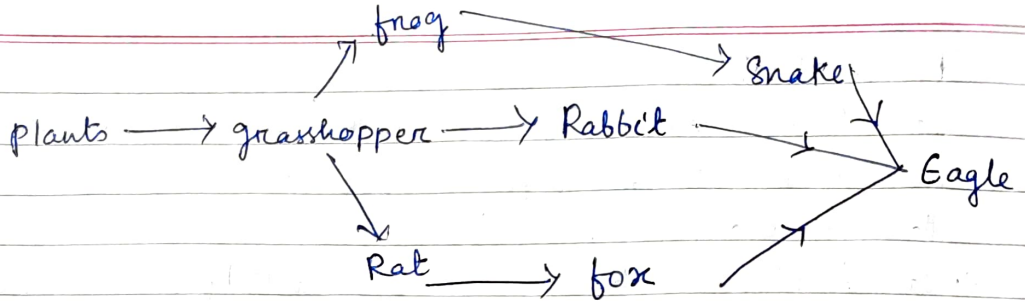
② food web

→ It is a multiple and complex network of interconnected food chains within an ecosystem, showing how energy and nutrients flow between different organisms.

→ Unlike a simple food chain, which follows a linear path, a food web illustrates multiple feeding relationships, demonstrating how various species are interdependents.

⇒ Energy flows from producers to various level of consumers, however, as energy transfers from one level to the next, a significant portion is lost as heat, resulting in less energy available for higher tropic level.

e.g.



=> (Aquatic Ecosystem)

It is a water-based environment where living organisms interact with the physical and chemical characteristics of the water. These Ecosystems are diverse and include a variety of habitats, such as oceans, rivers, lakes, wetland and estuaries.

It plays a crucial roles in maintaining biodiversity regulating climate, and supporting human activities like fishing, agriculture and recreation. They are also vital for water purification and nutrient cycling.

Different types of aquatic Ecosystem

1. fresh water Ecosystem (lakes, ponds, rivers)
2. Lotic Ecosystem (rapid flow or fast moving)
3. Lentic Ecosystem (Stable or slow moving)
4. wetland Ecosystem (swamps, marshy areas covered in water)
5. Marine Aquatic Ecosystem - (covers the largest surface on the earth usually oceans, seas)
6. ~~Ocean Ecosystems~~

-> Lotic Ecosystem - These mainly refers to the rapidly flowing waters that move in a unidirectional way including the rivers and streams. This Ecosystem contains various species like mayflies, beetles and several species of fishes.

Lentic Ecosystem

They include all standing water habitats or stable/slow moving. Eg. Lakes, ponds etc.
It has species like crabs, shrimps (prawn).

Terrestrial Ecosystem

Ecosystem that are found on land. E.g tundra, temperate deciduous forest, deserts, grassland.

- Terrestrial Ecosystems differs from aquatic Ecosystem by predominant presence of soil rather than water at the surface
- Terrestrial Ecosystem are essential for maintaing biodiversity, regulating climate and providing resources for human use, such as timber, food and medicine.

Key features of terrestrial Ecosystem

- Diversity of flora and fauna - Different terrestrial ecosystems host a variety of plants & animal species adapted to the specific environmental conditions.

- Energy flow - The primary sources of energy in terrestrial Ecosystems is sunlight, which plants convert into chemical energy through photosynthesis. This energy is then transferred through the food chain from producers to consumers & decomposers.

- Climate influence - climate plays a significant role in determining the type of terrestrial ecosystem in a particular area.
for. e.g in desert areas there is little rainfall and in tropical areas high rainfall.

Carbon Cycle (Biogeochemical cycle)

The circulation and recycling of Carbon from the atmosphere to living organism and after their death back to the atmosphere is called Carbon cycle.

Carbon is the chemical backbone or basis of life on Earth.
Carbon is continuously cycled & reuse.

Carbon in the atmosphere is present in the form of Carbon dioxide. Carbon enters the atmosphere through natural processes such as respiration and industrial application such as burning fossil fuels. These CO_2 is converted by plants into Carbohydrates by process of photosynthesis.

$$6CO_2 + H_2O + \text{energy} \longrightarrow C_6H_{12}O_6 + 6O_2$$

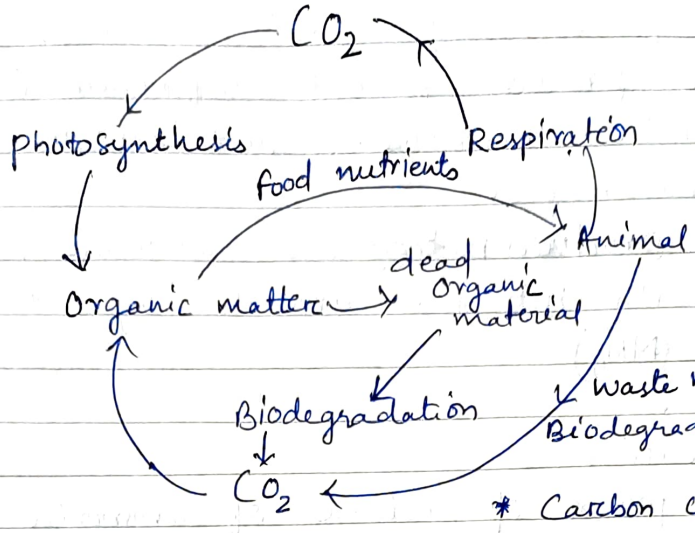
$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy.}$$

($C_6H_{12}O_6$: glucose)

In photosynthesis process CO_2 is absorbed by plants. The Carbohydrates formed are Used by living organism and after their death, the decomposers eat the dead organism and return the Carbon from their body back into the atmosphere.
This continues in a cyclic manner

Importance.

- Carbon provides energy;
- It's vital for maintaing a stable climate and Carbon balance on our planet.



* Carbon cycle.

Nitrogen cycle

It is a biogeochemical process which transforms the inert nitrogen present in the atmosphere to more usable form for living organism biotic and abiotic compounds.

Or

Biogeochemical process that describes how nitrogen moves through the atmosphere, soil, water, plants, animals and bacteria.

The nitrogen cycle is made up of several process including: 1) Nitrogen fixation
2) Ammonification
3) Nitrification.
4) Denitrification.

1) Nitrogen fixation - Conversion of Atmospheric Nitrogen (N_2) into nitrates (NO_3) & nitrites (NO_2) through atmospheric industrial and Biological process.

$N_2 \longrightarrow NO_3$ & NO_2.

→ Occurs due to Atmospheric fixation by lightning N_2 breaks and combine with O_2 to form NO (Nitrogen oxide) it dissolve in the rain forming nitrates.

→ Biological fixation by certain microbes.
The entire process of Nitrogen fixation is completed by symbiotic bacteria called Diazotrops (Rhizobium) plays a major role.
Here, it produces nitrogenase enzyme, this combine with nitrogen and hydrogen to form ammonia (NH_4)

2) Ammonification
It is the process of release of ammonia through decomposition of dead bodies & excretory waste of organisms various fungi & prokaryotes decompose the tissue (containing organic nitrogen) and release inorganic Nitrogen back into the ecosystem as ammonia.

3) Nitrification.
The process in which the ammonia is converted into Nitrite (NO_2) and then Nitrate (NO_3) is called nitrification. By oxidation of Ammonia, nitrites are formed with the help of Nitrosomonas bacterium species.

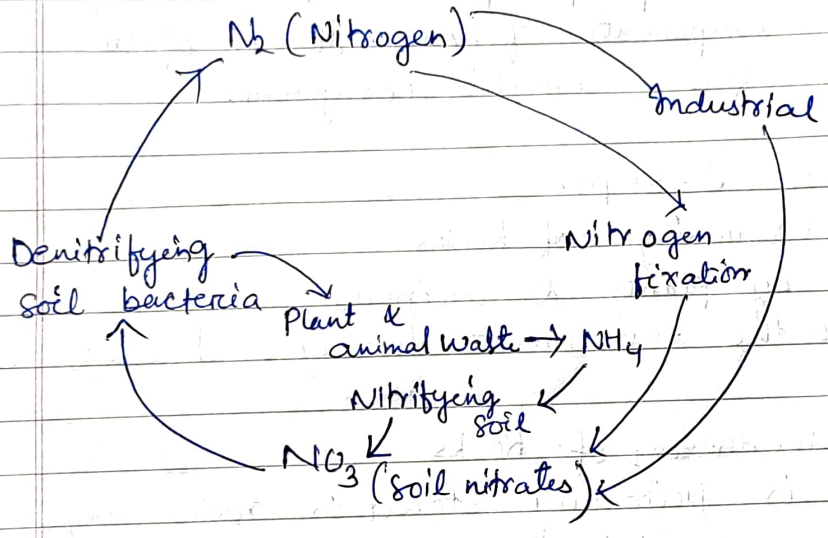
$$2NH_4^+ + 3O_2 \longrightarrow 2NO_2^- + 4H^+ + 2H_2O$$
$$2NO_2^- + O_2 \longrightarrow 2NO_3^-$$

4) Denitrification- Process in which the nitrogen compounds makes it way back into the atmosphere by converting nitrate into nitrogen.

It is carried out by the denitrifying bacteria species - Clostridium & pseudomonas.
It occur in absence of Oxygen (O_2).

Importance

- It helps plant to synthesis chlorophyll from the nitrogen compound.
- Helps in converting the N_2 gas into usable form for plant through biochemical process
- indirectly clean up the environment
- enriching soil with necessary nutrients.



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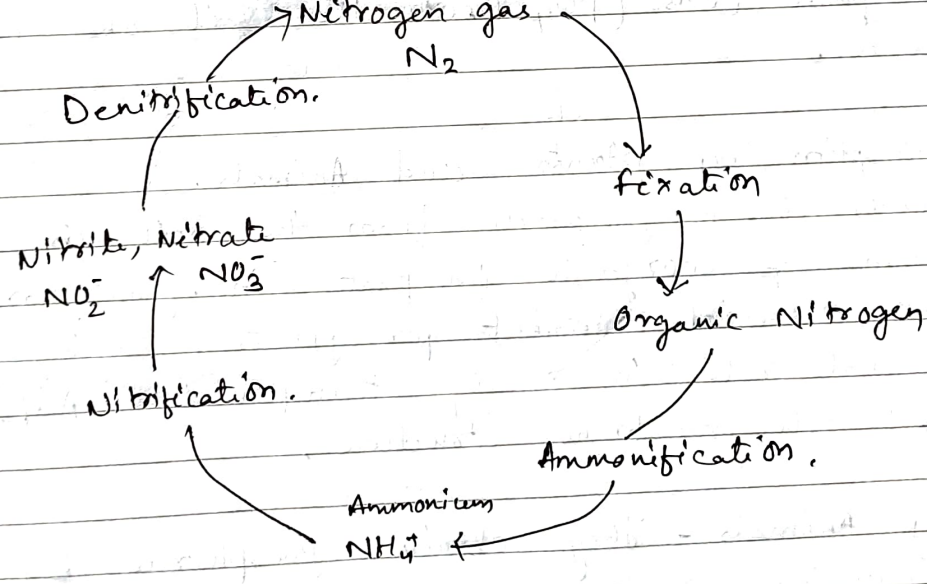


NITROGEN CYCLE

phosphorus cycle

It is a biogeochemical process that involves the movement of phosphorus through the lithosphere, hydrosphere & biosphere layer of life. Basically on land.

Major requirement is it is the Component of nucleic acid & phospholipids also makes up the supportive Components of bones. It is often necessary for aquatic ecosystem.

It Involves 3-Steps.

→ ~~Weathering~~ Weathering of Rocks
→ Absorption by plants & animals
→ Return back to the environment through Decomposition.

~~Weathering~~ Weathering of Rocks

- Phosphorus is premarily stored in rocks and sediments as phosphate minerals. Over time, weathering and erosion break down these rocks, releasing phosphate ions (PO_4^{3-}) into the soil and water bodies.

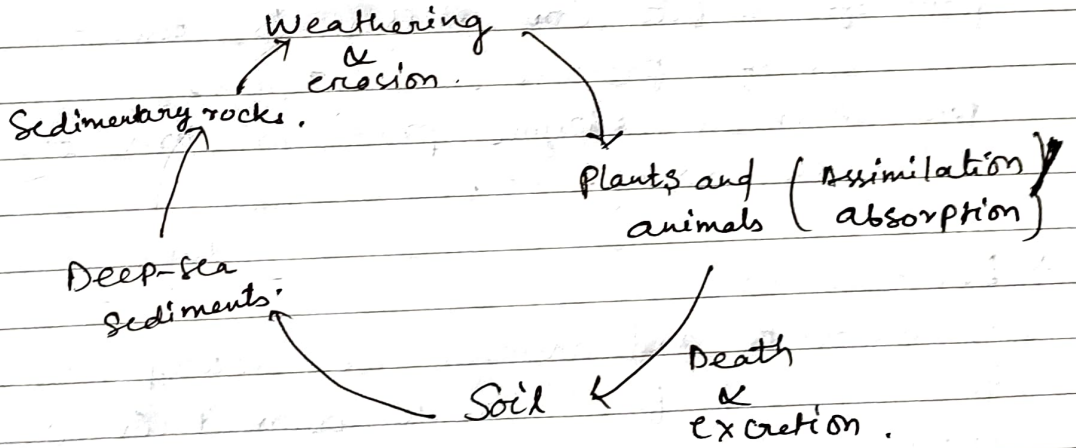
- Absorption by plants and Animals.
Plants absorb phosphorus from the Soil in the form of inorganic phosphate ions. phosphorus is an essential nutrients for plants, playing a Critical role in energy transfer (as ATP), DNA and Cell membrane Structure.

By Animals - They obtain phosphorus by consuming plants or other animals. In animals, phosphorus is a key Component of bones, teeth, and DNA

- Return back to the Environment through Decomposition.
When plants and animals die, decomposers (such as bacteria and fungi) break down their organic matter, releasing phosphorus back into the soil as inorganic phosphate.

* Sedimentation
Some of the phosphorus that is washed into water bodies (rivers, lakes & oceans) settles into sediments at the bottom. Over long geological timescales, these sediments can be transformed into new phosphate rock, completing the cycle.

Overall the phosphorus cycle is crucial for maintaining the productivity of ecosystems and health of organisms, but it is also vulnerable to disruption by human activities.



*phosphorus cycle

Sulfur cycle

It is a biogeochemical cycle that describes the movement of Sulfur through the atmosphere, lithosphere, hydrosphere and biosphere. Sulfur is an essential element for life, as it is a key component of certain amino acids, proteins and vitamins. The Sulfur cycle involves both terrestrial and atmospheric processes, which makes it dynamic and complex.

Key steps in the Sulfur cycle

* Weathering of Rocks

Sulfur is stored in rocks and minerals, primarily in the form of Sulfates (SO_4^{2-}) and Sulfides (S^{2-}). Weathering and erosion release these Sulfur compounds into the soil, where they can be taken up by plants.

* Absorption by plants and Consumption by Animals

plants absorb Sulfur from the soil in the form of Sulfate ions. Sulfur is essential for synthesis of proteins and enzymes.

for Animals, Enzyme production, preventing Cell damage etc.

* Decomposition

When plants and animals die, decomposers (such as bacteria and fungi) break down their organic matter, releasing Sulfur back into the environment as hydrogen Sulfide (H_2S) and other Sulfur Compounds.

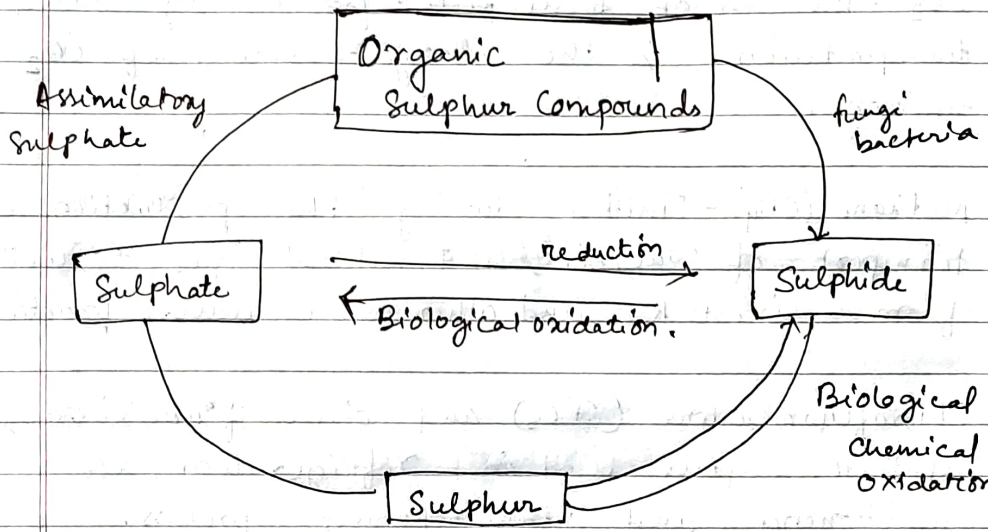
* When Sulfur is release through weathering process ~~It is absorbed by plants and animals~~ intake it, It combines with oxygen forming Sulphur dioxide then to Sulphuric acid (H_2SO_4) then to Sulphur trioxide (SO_3) and SO_4

$S + O_2 \rightarrow SO_2 \longrightarrow H_2SO_4 \longrightarrow SO_3 + SO_4$

SO_2

These were assimilate (absorbed) by plants and microbes & convert it into organic forms.

Overall, the Sulphur cycle is essential for life on Earth, but it is also sensitive to human activities, which can lead to significant environmental consequences, such as acid rain and ecosystem damage.



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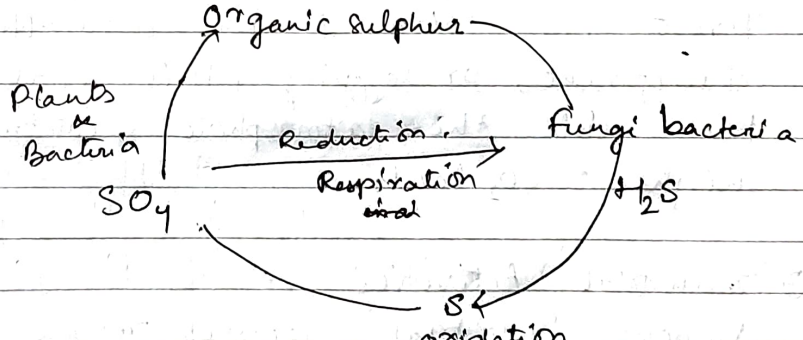

Global warming

Global warming refers to the long-term rise in Earth's average surface temperature due to human activities, primarily the emission of greenhouse gases. These changes are driving significant impacts on the environment impacts on the environment, weather patterns and ecosystem worldwide.

Causes of Global warming:

1. Greenhouse gas emissions:

→ CO_2 - burning of fossil fuels for energy and transportation is the largest source of CO_2 emissions.

→ Methane (CH_4) - Emitted during the production and transport of coal, oil, and natural gas as well as from livestock and other agricultural practices.

→ Chlorofluorocarbons (CFCs) and other fluorinated gases Synthetic gases used in refrigeration, air conditioning, and manufacturing process.

2. Deforestation

Trees absorb CO_2 from the atmosphere. When forests are cleared for agriculture, urban development, or logging, this carbon is released back into the atmosphere, contributing to higher CO_2 levels.

3. Industrial Activities

Various industrial processes release greenhouse gases directly and indirectly through energy consumption & chemical reactions.

4. Agriculture - fertilizer use releases nitrous oxide, which is very harmful and activites leads to the emission of greenhouse gas.

effect of global warming.

→ Rising Temperature.
global average temperatures have been rising, leading to more frequent and intense heatwaves. This impacts ecosystem, human health and energy demand.

→ Melting Ice and snow.
glacier, polare ice caps and Arctic sea ice are melting at an accelerated rate, contributing to sea level rise and the loss of habitats for species like polar bears.

→ Changes in the Ecosystem.
It can lead to the loss of biodiversity and change in the patterns.

→ Impact on Agriculture
This may effect the growth and crop yield leading to less production and economic loss.

→ Health Impacts
Rising temperatures and changing weather patterns can increase the spread of diseases, heat-related illnesses, respiratory issue due to air pollution.

process of global warming.

1. Greenhouse Effect
It trap heat in the Earth's atmosphere, preventing it from escaping into Space. This natural process is essential for life, but human activities have intensified it, leading to global warming.

2. Feedback loops -
• positive feedback loops : Warming leads to proces

that further increase temp. Such as melting of polar ice reducing the Earth albedo (refectivity) cause more heat absorption.

- Negative feedback loop
Increase cloud cover reflecting sunlight, may help mitigate warming, ~~through these~~.

Conclusion.
It is a multifaceted issue that requires Coordinated global action.
Also effect the adaptation change due to effect of climate change which is necessary to protect ecosystem, human health & economies.

Green house gas effect
These are the gases in earth's atmosphere that trap heat. They allow sunlight to enter the atmosphere freely, but when the Earth absorbs this sunlight and radiates it as heat, these gases absorb and re-radiate the heat, ~~prop~~ preventing it from escaping into space.
This process is known as the greenhouse effect.

Major Greenhouse gases
1) CO_2 - produced by burning fossil fuel (Coal, oil, natural gas), deforestation and some industrial processes.

(2) Methane CH_4 - Emitted during the production and transport of coal, oil and natural gas and from livestock and other agricultural practices.

3. Nitrous oxide (N_2O) - Emitted from agricultural activities & industries as well as during combustion of fossil fuel and biomass.

4. Fluorinated gases : Synthetic gases used in a variety of industrial applications, including refrigerants, solvents and manufacturing process. These include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulfur hexafluoride.

Effect of Greenhouse gases-

→ global warming

The increase in GHGs, particulary CO_2, has led to an enhanced greenhouse effect, causing the Earth's average temperature to rise. This global warming contributes to more frequent and severe weather events such as heatwaves, droughts.

2. Climate change - Beyond warming, increased GHGs disrupt global climate patterns. This can lead to altered precipitation patterns, more intense storms & shifting wildlife populations.

3. Sea Level Rise - Warming temperatures cause polar ice to melt and thermal expansion of seawater, leading to rising sea level.

4. Impact on Agriculture - Changes in temp. and the frequency of extreme weather events affect crop yields and food security.

5. Health - effect of climate change, such as heatwaves, poor air quality and changing patterns of disease, pose direct & indirect threats to human health.

Adi

Mitigation strategies;

→ Reducing Emissions - Transitioning to renewable energy resources, improving energy efficiency and adopting low-carbon technologies can reduce GHG emission.

→ Techniques like reforestation, soil management.

→ Adaptation - developing sustainable agricultural practices.