CHY 1002

Environmental Sciences

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Digital Assignment – 1 [ONE]

CARBON CYCLE

CARBON CYCLE :

The carbon cycle is the biogeochemical cycle by which the carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.

Carbon is the main component of biological compounds as well as a major component of many minerals such as limestone. Along with the nitrogen cycle and the water cycle, the carbon cycle comprises a sequence of events that are key to make Earth capable of sustaining life.

It describes the movement of carbon as it is recycled & reused throughout the biosphere, as well as long-term processes of carbon sequestration to and release from carbon sinks.

The carbon cycle was discovered by Joseph Priestley and Antoine Lavoisier, and popularized by Humphry Dave.

Main components of the Carbon cycle :—

The global carbon cycle is now usually divided into the following major reservoirs of carbon interconnected by pathways of exchange :—

1. The atmosphere
2. The terrestrial biosphere

③ The ocean, including dissolved inorganic carbon and living and non-living biodata.

④ The sediments, including fossil fuels, freshwater systems, and non-living organic material.

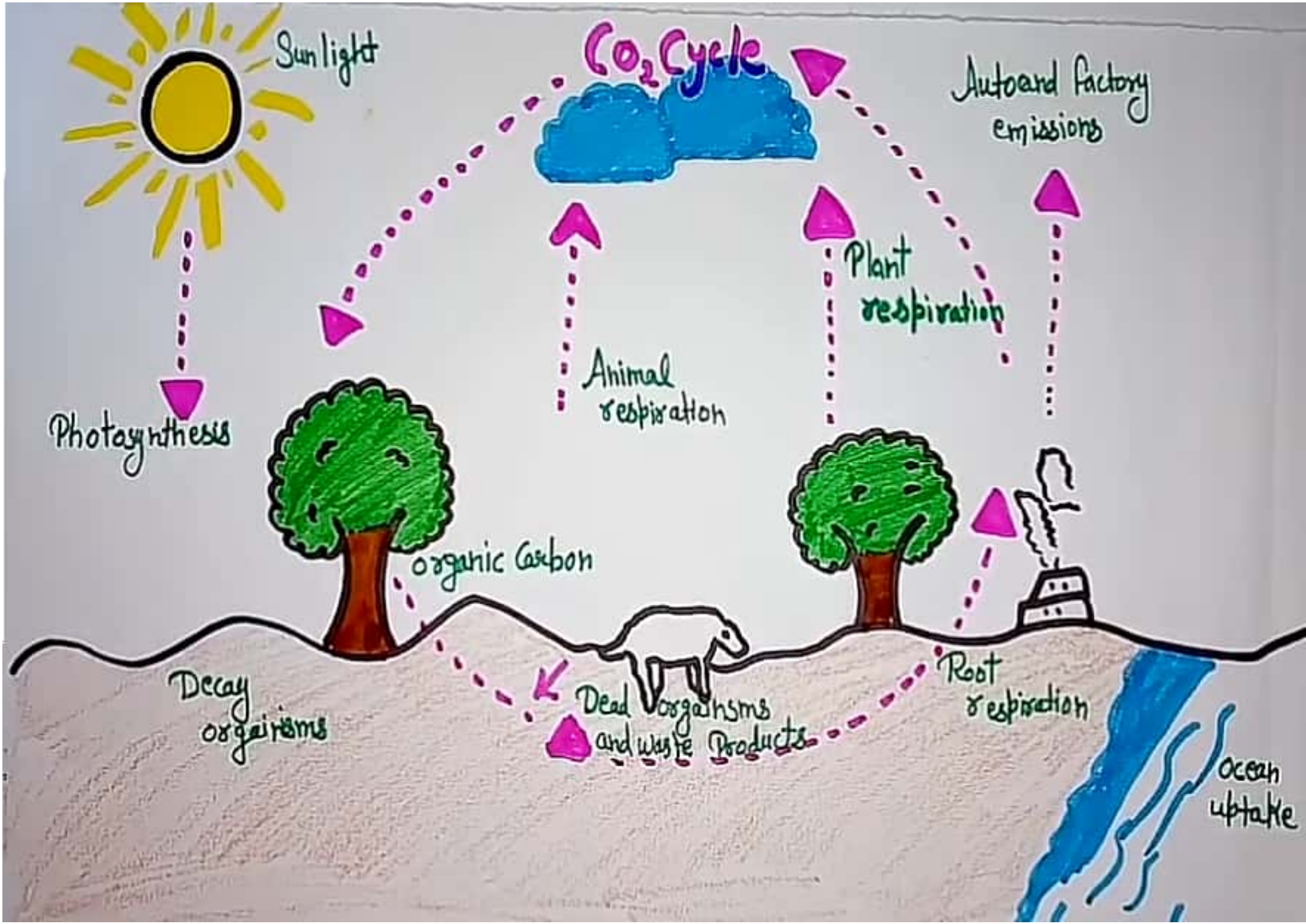
⑤ The Earth's interior (mantle & crust). These carbon stores interact with the others components through geological processes.

The carbon exchanges between reservoirs occur as the result of various chemical, physical, geological, and biological processes.

The ocean contains the largest active pool of carbon near the surface of the Earth.

The natural flows of carbon between the atmosphere, ocean, terrestrial ecosystems, and sediments are fairly balanced so that carbon levels would be roughly stable without human influence.

In summary, although the amount of carbon potentially stored in the Earth's core is not known, recent studies indicate that the presence of iron carbides can explain some of the geophysical observations.



• Effect of Human Activities on the Carbon cycle :—

Since the industrial revolution, human activities have modified the carbon cycle by changing its components' functions and directly adding carbon to the atmosphere :—

① The largest human impact on the carbon cycle is through direct emissions from burning fossil fuels.

② The rest of this increase is caused mostly by changes in land-use, particularly deforestation.

③ Another direct human impact on the carbon cycle is the chemical procen of calcination of limestone for clinker production, which releases CO_2.

④ Humans also influence the carbon cycle indirectly by changing the terrestrial and oceanic biosphere. For instance, LUCC has led to loss of biodiversity.

⑤ Air pollution, due to human activities, damages plants and soils, while many agricultural and land use practices lead to higher erosion rates.

⑥ Arctic methane emissions indirectly caused by anthropogenic global warming also affect the carbon cycle & contribute to further warming in what is known as climate change feedback.

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NITROGEN CYCLE

Nitrogen Cycle :-

The nitrogen cycle is the biogeochemical cycle by which nitrogen is converted into multiple chemical forms as it circulates among atmosphere, terrestrial, & marine ecosystems.

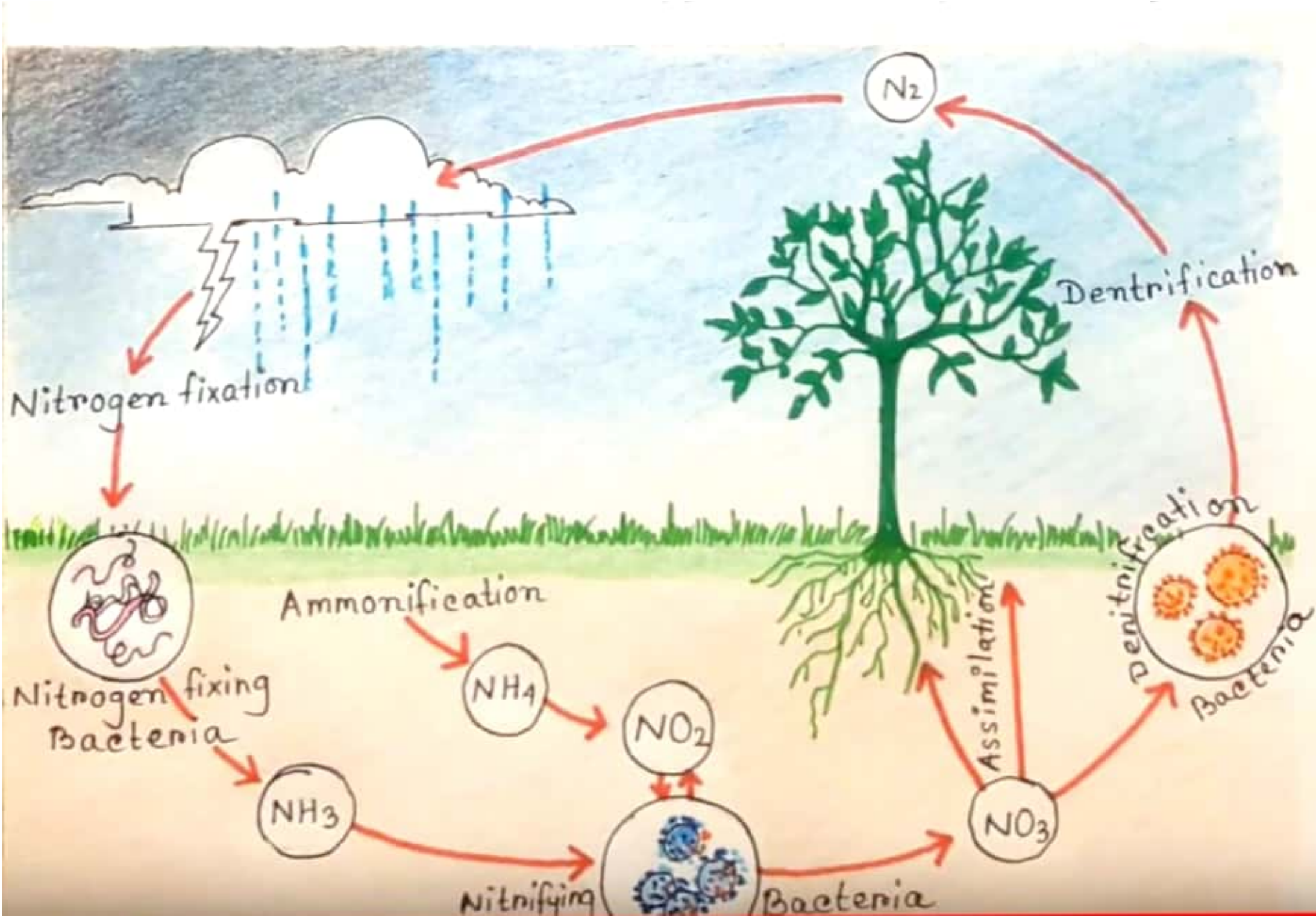
The conversion of nitrogen can be carried out through both biological and physical processes. Important processes in the nitrogen cycle include fixation, ammonification, & denitrification.

The majority of Earth's atmosphere (78%) is atmospheric nitrogen, making it the largest source of nitrogen. However, atmospheric nitrogen has limited availability for biological use, leading to a scarcity of usable nitrogen in many types of ecosystems.

The nitrogen cycle is of particular interest to ecologists because nitrogen availability can affect the rate of key ecosystem processes, including primary production & decomposition.

Processes :—

Nitrogen is present in the environment in a wide variety of chemical forms including organic nitrogen, ammonium (NH_4^+), nitrite (NO_2^-), nitrate (NO_3^-), nitrous oxide (N_2O), nitric oxide (NO) or inorganic nitrogen gas (N_2).



The different processes include :—

1. Nitrogen fixation.
2. Assimilation
3. Ammonification
4. Nitrification
5. Denitrification
6. Dissimilatory nitrate reduction to ammonium
7. Anaerobic ammonia oxidation
8. Other processes

- Effect of Human activities on all 4 and other proceses of Nitrogen cycle :—

1. Impacts on natural systems :-

Increasing levels of nitrogen deposition have a number of negative effects on both terrestrial and aquatic ecosystems. Increase of base cation leaching in the soil and amounts of aluminium and other potentially toxic metals, along with decreasing the amount of nitrification occuring and increasing plant-derived litter. Also, oceanic dead zones near the mouth of the Mississipi in the Gulf of Mexico are a well-known example of algal boom-induced hypoxia.

2 Impacts on human health :—

Leakage of Nr from human activities can cause nitrate accumulation in the natural water environment, which can create harmful impacts on human health. Excessive use of -N- fertilizer in agriculture has been one of the major sources of nitrate pollution in groundwater and surface water.

The WHO standard for drinking water is 50 mg $NO_3^- L^{-1}$ for short-term exposure, and for 3 mg $NO_3^- L^{-1}$ chronic effects. Once it enters human body, nitrate can react with organic compounds through nitrosation reactions.

There are multiple sources of atmospheric reactive nitrogen (Nr) fluxes. Agricultural sources of reactive nitrogen can produce atmospheric emission of ammonia (NH_3), nitrogen oxides (NO_x), & nitrous oxide (N_2O).

In the atmosphere, NO_2 can be oxidized to nitric acid (HNO_3), and it can further react with NH_3 to form ammonium nitrate, which facilitates the formation of particular nitrate. Moreover, NH_3 can react with other acid gases [sulfuric & hydrochloric acid] to form ammonium-containing particles, which are the precursors for the secondary organic aerosol particles in photochemical smog.

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Phosphorous Cycle

Phosphorous cycle :

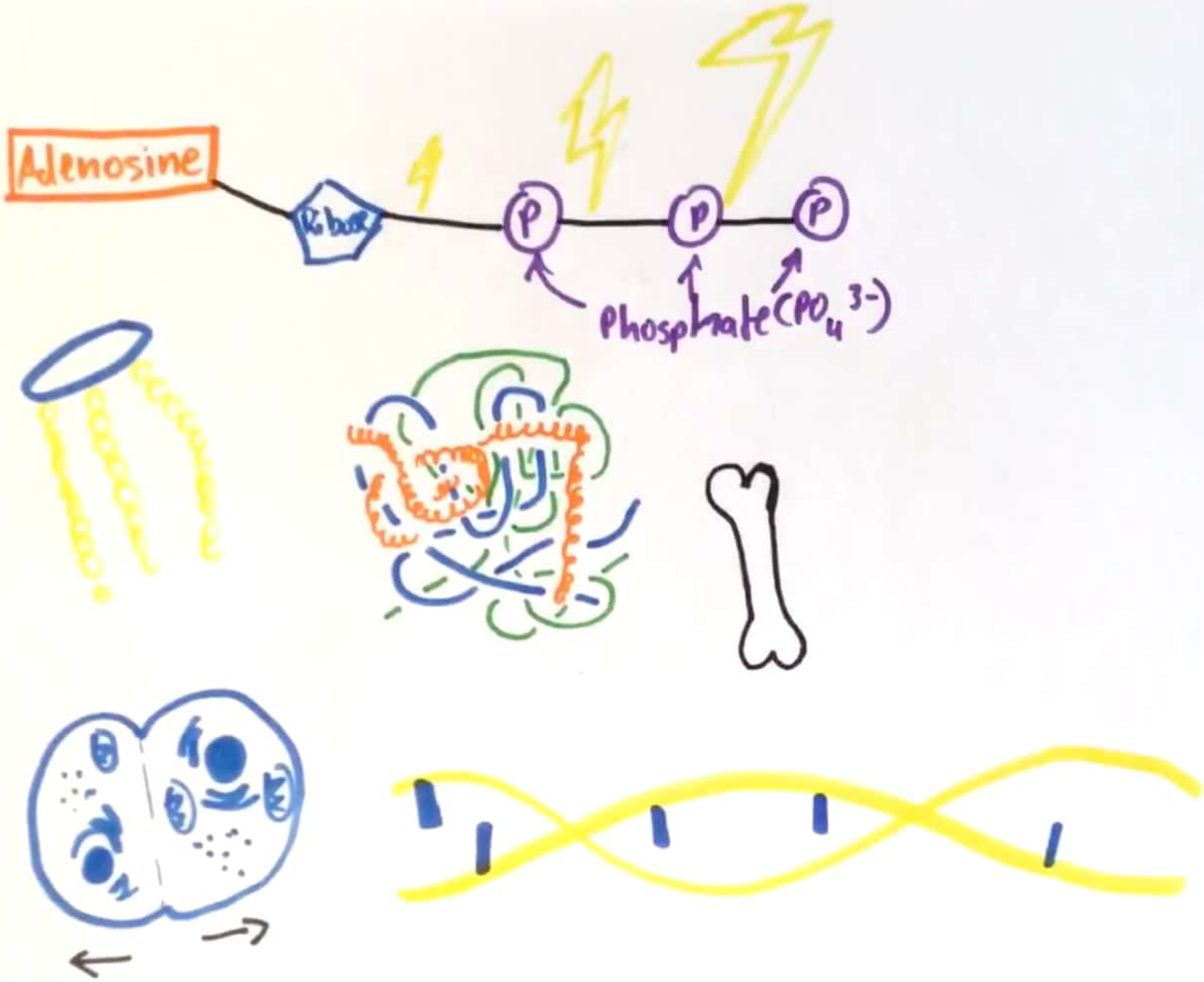
The phosphorous cycle is the biogeochemical cycle that describes the movement of phosphorous through the lithosphere, hydrosphere, and biosphere. Unlike many other bigeochemical cycles, the atmosphere does not play a significant role in the movement of phosphorous, because these are usually solids at the typical ranges of temperature and pressure found on Earth.

On the land, phosphorous gradually becomes less available to plants over thousands of years, since it is slowly lost in run off. Low concentration of phosphorous in soils reduces plant growth, and slows soil microbial growth.

Humans have caused major changes to the global phosphorous cycle through shipping of phosphorous minerals, and use of phosphorous fertilizer, and also the shipping of food from farms to cities, where it is lost as effluent.

Phosphorous in the environment :

1. Ecological function
2. Biological function
3. Phosphorous cycling
4. Phosphatic minerals



Effect of human activities on Phosphorous cycle :—

① Humans have greatly influenced the phosphorous cycle by mining phosphorous, converting it to fertilizer, and by shipping fertilizer and products around the globe. Transporting phosphorous in food from farms to cities has made a major change in the global phosphorous cycle.

② Excessive amounts of nutrients, particularly phosphorous, is detrimental to aquatic ecosystems.

③ Waters are enriched in phosphorous from farms' run-off, and from effluent that is inadequately treated before it is discharged to waters.

④ Cultural or anthropogenic eutrophication is water pollution caused by excessive plant nutrients which is directly influenced by human intervention.

⑤ Repeated application of liquid hog manure in excess to crop needs can have detrimental effects on soil phosphorous status.

⑥ Human interference in the phosphorous cycle occurs by overuse or careless use of phosphorous fertilizers. This results in eutrophication which devastates water ecosystems by inducing anoxic conditions.

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WATER CYCLE

Water Cycle :-

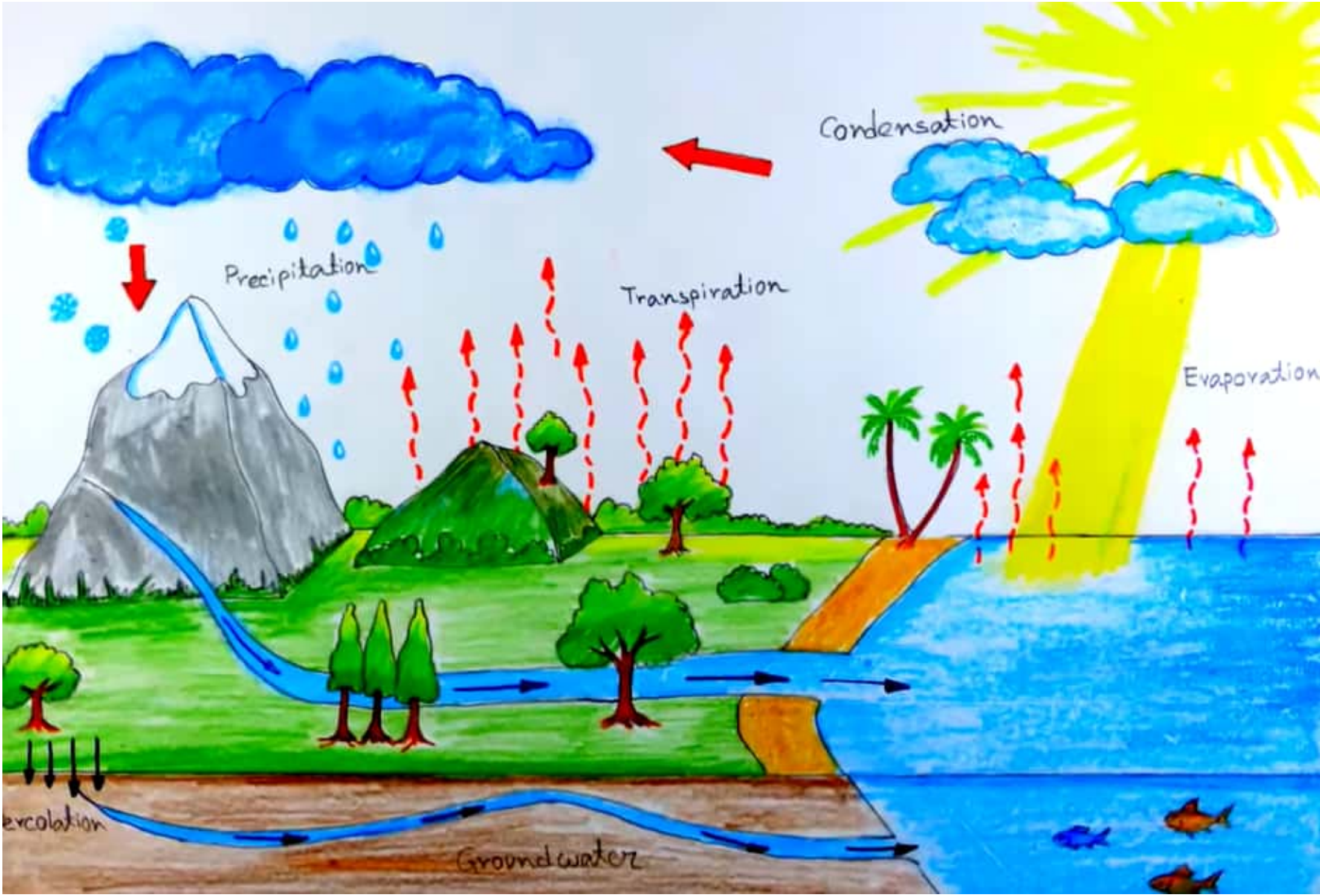
The water cycle, also known as the hydrologic cycle or the hydrological cycle, describes the continuous movement of water on, above and below the surface of the Earth. The mass of water on Earth remains fairly constant over time but the partitioning of the water into the major reservoirs of ice, fresh water, saline water and atmospheric water is variable depending on a wide range of climatic variables.

The water moves from one reservoir to another, such as from river to ocean, or from the ocean to the atmosphere, by the physical processes of evaporation, condensation, precipitation, infiltration, surface run-off and subsurface flow.

The Water cycle involves the exchange of energy, which leads to temperature changes.

The evaporative phase of the cycle purifies water which then replenishes the land with freshwater. The flow of liquid water and ice transports minerals across the globe.

It is also involved in reshaping the geological features of the Earth, through processes including erosion and sedimentation. The water cycle is also essential for the maintainance of most life and ecosystems on the planet.



Processes :—

1. Precipitation
2. Canopy interception
3. Snowmelt
4. Run off
5. Infiltration
6. Subsurface flow
7. Sublimation
8. Evaporation
9. Deposition
10. Advection
11. Condensation
12. Percolation

Human activities' adverse effects on Water cycle :—

1. Large-scale human manipulation of water has significantly altered global patterns of stream flow.
2. Resulting changes in sea level, ocean sanity, and in biophysical properties of the land surface could ultimately generate climate feedbacks.
3. According to a study by GISS, human regulation of river flow and vegetation clearing has reduced river runoff, representing nearly 1% of the total annual streamflow.
4. A 14 meter drop in the Aral sea since the 1960s and high rates of coastal erosion and land inundation are just sum of the major environmental problems associated with upstream water diversion.

(5) Discharging untreated substances to the water is one of the major human intervention.

As precipitation falls on the ground and moves into rivers & creeks, it picks up a whole range of pollutants.

(6) In rural areas these pollutants may include farm pesticides, herbicides and fertilizers as well as wastes from faulty septic systems & improperly handled manure.

(7) In urban areas, the pollutants may include gas, oil, pet waste, fertilizers, pesticides, salt and treated human waste from sewage treatment plants.

(8) During the process of cloud seeding, the substances that fall from the clouds [toxic materials like HNO_3, H_2SO_4 which gets evaporated after dispersion] causes cloud condensation which further affects the water cycle.

(9) The Green House Effect which is a direct influence of human intervention affects the water cycle adversely & brings down change in the climate of the Earth.