Biogeochemical (Nutrient) Cycles

- *Movement of nutrients between **biotic (living)** and **abiotic (air, water, soil)** components.*
- *Nutrients are **recycled**, unlike energy, which is lost as heat.*
- *Major elements: **C, N, O, H, P** → ~97% of living matter.*

Types

Basis	Types
Reservoir	**Gaseous** (Atmosphere/Hydrosphere) & **Sedimentary** (Earth's crust)
Efficiency	**Perfect** (fast recycling) & **Imperfect** (loss to sediments)

Carbon Cycle (Gaseous Cycle)

- *Carbon is present mainly as **CO_2** in the atmosphere.*
- *Essential for **photosynthesis** → carbohydrates.*
- ***Short-term cycle:** Photosynthesis ↔ Respiration ↔ Decomposition.*
- ***Long-term cycle:** Fossil fuels, carbonate rocks, deep-sea sediments.*
- ***Human role:** Burning fossil fuels releases stored CO_2.*

***Adds CO_2:** Respiration, decay, volcanic action*
***Removes CO_2:** Photosynthesis*

Nitrogen Cycle (Gaseous Cycle)

- *Nitrogen is essential for **proteins, amino acids, DNA, and chlorophyll**.*
- *Atmospheric **N_2 cannot be directly used** by plants.*

Main Steps

1. ***Nitrogen Fixation:***
   $N_2 \rightarrow NH_3 / NH_4^+$ (by bacteria, lightning, industries)
2. ***Nitrification:***
   $NH_3 \rightarrow NO_2^-$ (Nitrosomonas) → NO_3^- (Nitrobacter)
3. ***Ammonification:***
   Organic waste → NH_3
4. ***Denitrification:***
   $NO_3^- \rightarrow N_2$ (Pseudomonas)

***Excess fertilisers** → Eutrophication, acid rain, groundwater pollution.*

Phosphorus Cycle (Sedimentary Cycle)

- ***No gaseous phase** (key difference from C & N cycles).*

- *Reservoir: **Phosphate rocks** (earth's crust).*
- *Released by **weathering → rivers → oceans**.*
- *A major cause of **eutrophication** in freshwater bodies.*
- *Returns to land through **geological uplift** (very slow).*

Sulphur Cycle (Sedimentary Cycle)

- *Reservoir: **Soil, rocks, fossil fuels**.*
- *Exists as **sulphates, sulphides, and organic sulphur**.*
- *Has a **minor gaseous phase** (H_2S, SO_2).*
- *Sources: Volcanic eruptions, fossil fuel combustion, decomposition.*
- *SO_2 + rainwater **→ acid rain (H_2SO_4)**.*
- *Plants absorb sulphur as **sulphates →** proteins.*

Key Pointers

- ***Gaseous cycles:** Carbon, Nitrogen*
- ***Sedimentary cycles:** Phosphorus, Sulphur*
- ***Main eutrophication nutrient:** Phosphorus*
- ***Acid rain contributors:** Nitrogen oxides & Sulphur dioxide*
- ***Fastest cycle:** Gaseous*
- ***Slowest cycle:** Phosphorus*

MCQs

Q1. Which one of the following nutrient cycles does NOT have a gaseous phase?

A. Carbon cycle
B. Nitrogen cycle
C. Phosphorus cycle
D. Sulphur cycle

***Answer:** C*

Q2. The primary reservoir of phosphorus in nature is:

A. Atmosphere
B. Oceans
C. Earth's crust
D. Living organisms

***Answer:** C*

Q3. Which process converts ammonia into nitrites and nitrates in the nitrogen cycle?

A. Nitrogen fixation
B. Ammonification
C. Nitrification
D. Denitrification

Answer: *C*

Q4. Excessive use of nitrogenous fertilizers in agriculture can directly lead to:

A. Desertification
B. Eutrophication of water bodies
C. Ozone depletion
D. Soil salinity only

Answer: *B*

Q5. Which of the following gases is mainly responsible for acid rain formation in the sulphur cycle?

A. Carbon monoxide
B. Methane
C. Sulphur dioxide
D. Nitrogen

Answer: *C*