BIOCHEMICAL CYCLE

(UNIT-I)

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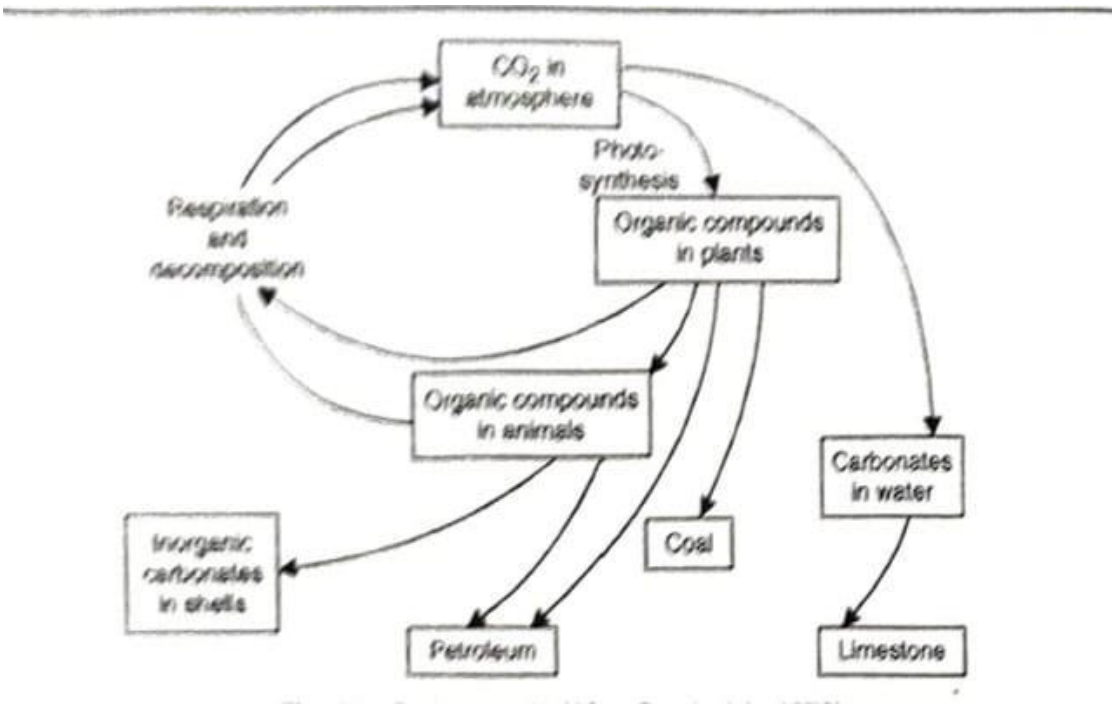
CARBON CYCLE

The atmospheric concentration of carbon dioxide is 0.03-0.04 per cent while oceanic water can retain up to fifty times of this level, and hence capable to regulate carbon dioxide in the atmosphere.

-The carbon enters the food chain in gaseous phase (CO_2) from atmosphere to producers through respiration and photosynthesis as organic compound.

- From the plant carbon enters to as organic compound in animals.



(Fig:1 Carbon Cycle)

- Carbon basically returned to the atmosphere through two processes.

(i)Biological process

(ii)Non-Biological process

(i)Biological process:

- Carbon dioxide respired out at each trophic level through animal, plant.

-After death of living component i.e. plant and animals, it finally released during decomposition and thus returned to the atmosphere.

(ii)Non-Biological process:

- However more than the amount of CO_2 getting locked up in the biomass in the form of coal, petroleum, shells etc.

- These locked up CO_2 is being thrown into the atmosphere by the processes of combustion of fossil fuels, burning of wood and volcanic activities.

* Mechanism of formation of Carbonate in water:

-The dissolved CO_2 combines with water in the soil or in aquatic ecosystem to form carbonic acid (H_2CO_3) in a reversible reaction.

$$H_2O + CO_2 \leftrightarrow H_2CO_3$$

-Carbonic acid dissociates into hydrogen (H+) and bicarbonate ions (HCO_3^-).

$$H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$

- The latter ions, in turn, dissociate in another reversible reaction into hydrogen ion and carbonate ions.

$$HCO_3^- \leftrightarrow H^+ + CO_3^{2-}$$

1. Finally the carbonate (CO_3) combines with the calcium to give Calcium carbonate ($CaCO_3$) i.e. limestone.

NITROGEN CYCLE

Although 79% of nitrogen is present in the atmosphere, it cannot be used by the organism as N_2 form. Nitrogen is used by the organism in its reduced (NH_4^+, NH_3) or Oxidized form (NO_3). The nitrogen cycle basically includes four steps.

1. Nitrogen Fixation:

Since free nitrogen is not utilized as such by plants, it is converted into ammonium and or/nitrate forms. Such conversions of gaseous nitrogen into ammonia or nitrates is called nitrogen fixation. It is achieved in nature by two ways:

(i) Physical fixation

(ii)Biological fixation

(i)Physical fixation:

-In the atmosphere, the reactions between N. H and O require very high amount of energy which becomes available from cosmic radiations, meteorite trails, lightning to convert atmospheric nitrogen (N_2) into nitrates (NO_3) and Ammonia (NH_3).

- The resulting NH_3 and NO_3 are carried to the earth with rain water as dilute alkali (NH_4OH) and acids (HNO_3).

(ii)Biological fixation

Major agencies of biological fixation are:

(a) Symbiotic bacteria: These are associated mostly with the root nodules of leguminous plants. E.g. - Rhizobium bacteria

(b) Free living bacteria: These species fix nitrogen in ammonia form Azotobacter (aerobic) and Clostridium (anaerobic).

(c) Blue green algae: Most of these species are successful in paddy fields where water stagnates. The commonly used species are Callothrix and Anabaena.

2. Ammonification:

The resultant NH_3 and NO_3 they may be

(i) Stored or modified and stored as proteins or nucleic acids within the plant.

(ii) They may be transferred to animal tissues through consumption and assimilation by animal.

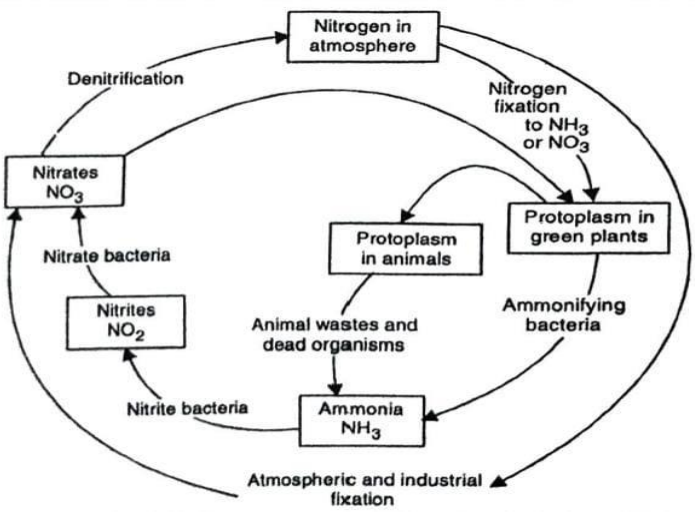
(iii) They may be decomposed to NH_3 through death and bacterial action like Pseudomonas, Proteus, etc.

3. Nitrification:

The conversion of ammonia into nitrates is termed as nitrification. This process takes place in two steps:

(i) Ammonia or ammonium salts are converted to nitrite (NO_2). This is mediated by nitrite bacteria, Nitrosomonas.

(ii) Conversion of nit to nitrates (NO_3) by nitrate bacteria, Nitrobacter. Nitrates are then direct absorbed by plants for amino acids and proteins synthesis



(Fig.2 Nitrogen Cycle)

4. Denitrification:

-The conversion of nitrates to molecular or gaseous nitrogen (N_2 as well as to nitrous oxide (NO) and nitric oxide (N_2O) is called denitrification. This is by the action of denitrifying bacteria such as Pseudomonas, Thiobacilliis and Micrococca etc.

The cyclic flow of nitrogen in the ecosystem requires balanced action of bacteria involving many species, so that sufficient levels of plant nutrients are maintained without excess in accumulation of decomposition products like ammonia.

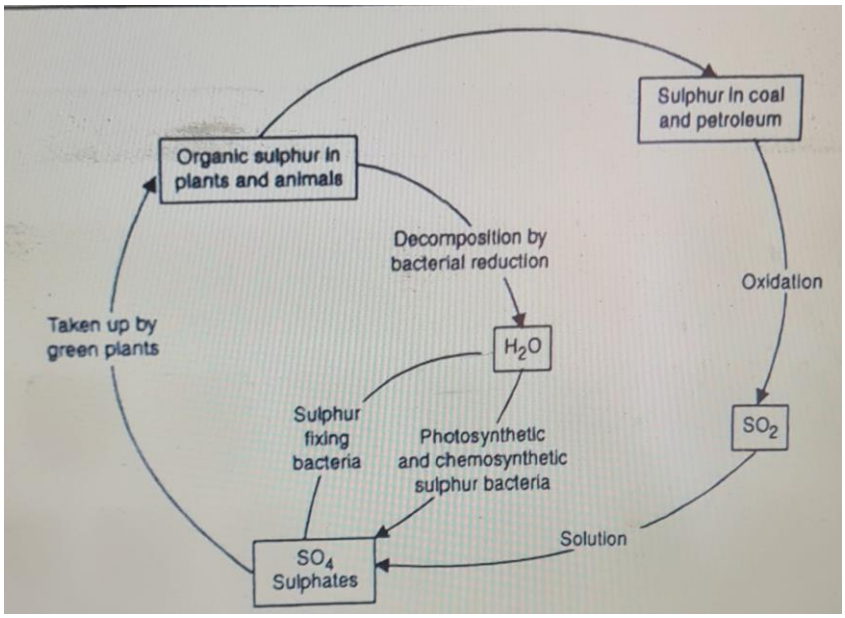
SULPHUR CYCLE

In nature, sulphur exists in elemental form and in several states, including hydrogen sulphide (H_2S), sulphites (SO_2) and sulphates (SO_4).

- Usually Sulphur obtained from the combustion of coal and petroleum in its oxidized (SO_2) and reduced (H_2S) form. However plants can use it only in the form of sulphates.
- The sulphates enters into food chain through plant and then into animals. In living body it is converted into organic Sulphur.
- Organic sulphur in plants and animals is decomposed to H_2S by bacterial action. Under aerobic conditions, Aspergillus and Neurospora, and undes

anaerobic conditions bacteria like Escherichia and Proteus play a key role in the decomposition.

- The organic Sulphur can also be converted into sulphate (SO_4) in presence of water and bacteria like chemosynthetic, photosynthetic and sulhur fixing bacteria.
- Some part of the organic Sulphur locked into coal and petroleum and return to environment as Sulphur dioxide when these product are burnt to maintain the cycle.



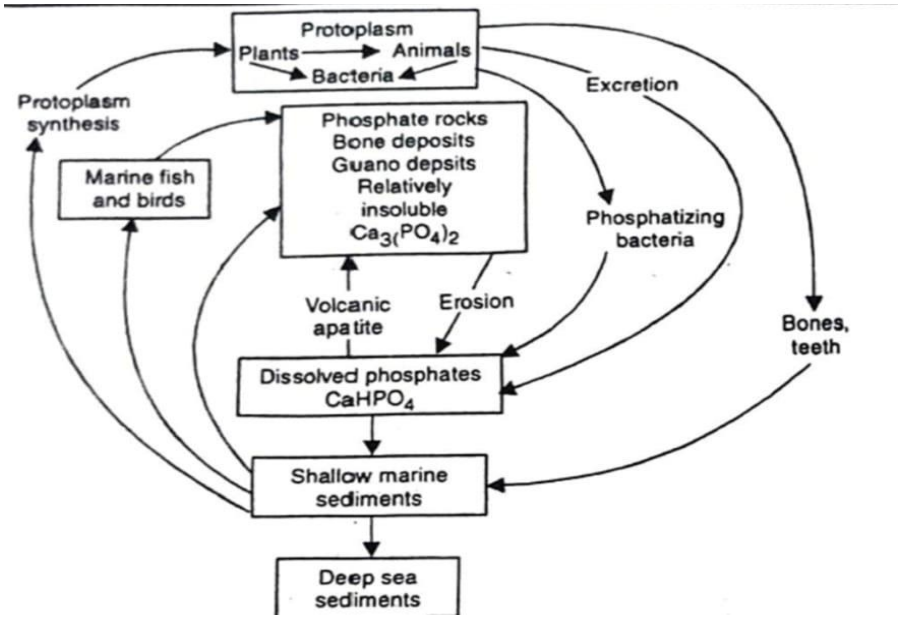
(Fig.3 SULPHUR CYCLE)

PHOPHRUS CYCLE

Phosphorus cycle is an example of sedimentary type of cycle having its main reservoir in rocks and other natural deposits formed during geological ages.

- Phosphorus, like nitrogen, is key element in all living organisms but much less abundant in abiotic environment. It is relatively more abundant in plants and animals.
- Phosphorus in the protoplasm is broken down by phosphatising bacteria to dissolved phosphates ($CaHPO_4$) which may be utilized directly in protein synthesis in plants or it may enter in marine deposits and become fixed in relatively insoluble form.

- Bone,teeth and guano deposits may also lock up phosphates for considerable period unless artificially recovered.
- The phosphorus may be released from these rocks slowly to soluble forms by the action of dilute nitric acid formed during nitrification and is released from the reservoir by bleaching, erosion and mining for agricultural use.



(Fig.4 PHOSPHORUS CYCLE)

As with other biogeochemical cycles, man's activities have altered the phosphorus cycle. High concentrations of phosphate in natural water cause eutrophication and pollution. The household detergents that enter waste water systems and then find way into lakes and streams are major sources of pollution.

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REFERENCE:

1. BOOK: Essential of Environmental science

2. WIKIPEDIA