CYCLING OF NITROGEN

* Two things - (1) Circularity of nutrient flow.
  (2) ~~Lin Circularity~~ of Kinds of microorganism required for the basic exchanges between organism and environment.

* The atmosphere, which is approximately 78% nitrogen, is the greatest reservoir and safety valve of the system.

* Nitrogen is continually enering the atmosphere by the action of denitrifying bacteria and continually returning to the cycle through the action of nitrogen fixing micro-organisms (biofixation) and through the action of lighting and other physical fixation.

* The step from proteins, down to nitrates, provide energy for the organisms that accomplish the breakdown, whereas the return steps require energy from other sources such as organic matter or sunlight.

<u>Example</u>: Chemosynthetic bacteria, Nitrosomonas (which converts ammonia to nitrite) and Nitrobacter (which converts nitrites to nitrates) obtains energy from breakdown of organic matter.

NH_3 —Nitrosomas→ Nitrite —Nitrobacter→ Nitrate.

Whereas denitrifying bacteria and nitrogen-fixing ($NO \rightarrow NO_2 \rightarrow NO_3$) bacteria require energy from other sources to accomplish their respective Transformations.

* There is also an important short cycle of nitrogen in the living biosphere, in which heterotrophic organisms breakdown

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proteins enzymatically and excrete the excess nitrogen as urea, uric acid or ammonium. Specialized bacteria gain energy for livlihood by oxidising the ammonium to nitrite and the nitrite to nitrate.

* All the three — ammonium, nitrite and nitrate — may be used as basic nitrogen sources by plants. Plants that use nitrate must produce enzymes to convert it back to ammonium, so nitrate is a more energy-expensive source of nitrogen than ammonium from a plant's point of view, the most plants will preferentially use ammonium when it is available.

Following micro-organisms are involved in nitrogen fixation.

Till 1950:

(1) Free living bacteria : (a) Azotobacter (aerobic)
(b) Clostridium (anaerobic)

(2) Symbiotic nodule bacteria : Rhizobium (on legume plants).

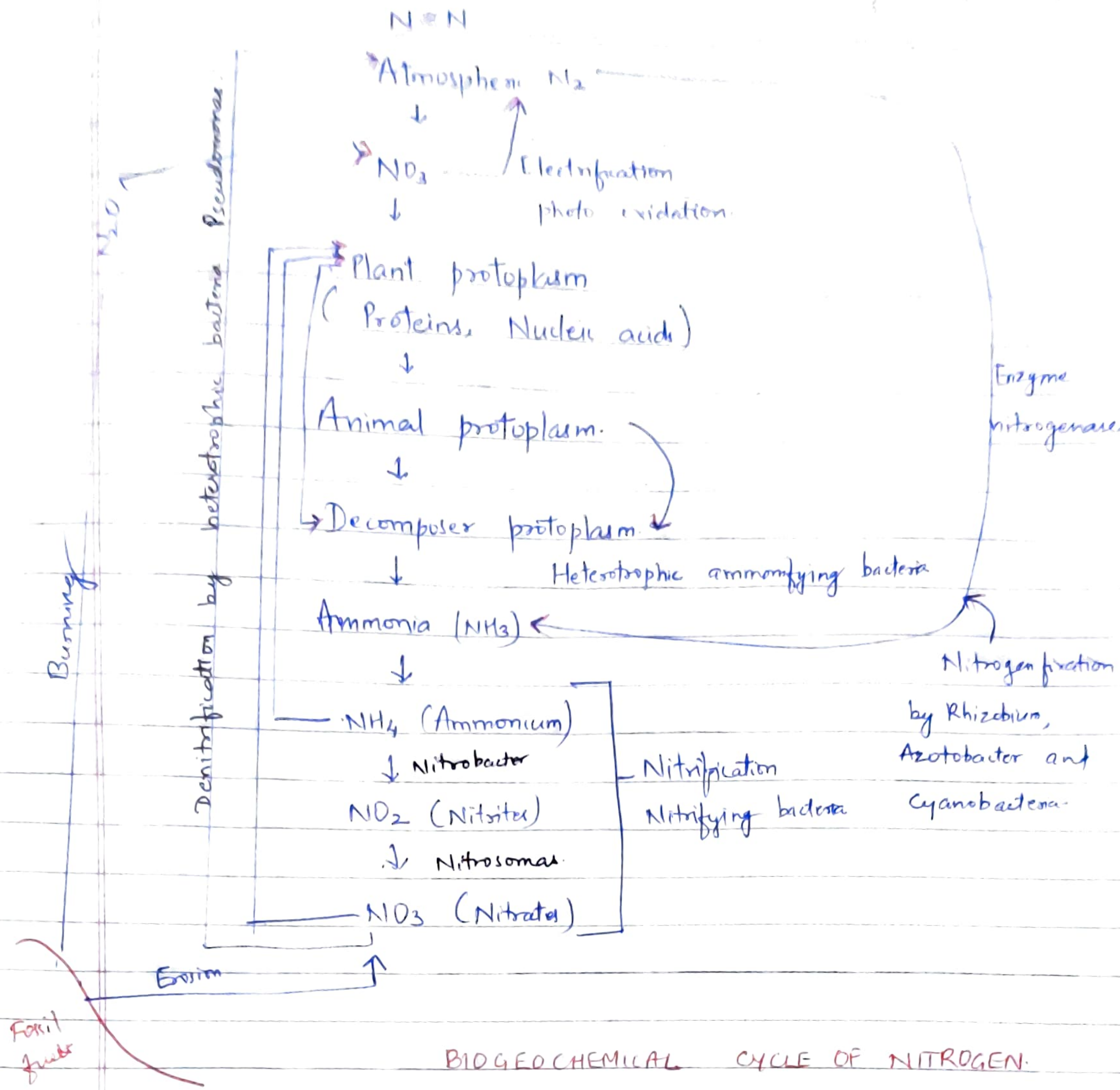
(3) Cyanobacteria : Anabaena, Nostoc and several other genera from blue-green algae (gree-bacteria).

Recent discoveries:-

① Rhodospirillum (purple bacterium) and other representative of the photosynthetic bacteria are also nitrogen fixer.

② A variety of Pseudomonas like soil bacteria also have capacity of nitrogen fixation.

③ Actinomycetes (a kind of filamentous bacteria) in the root nodule of



BIOGEOCHEMICAL CYCLE OF NITROGEN.

alders (Alnus) and certain other non-leguminous woody plants fix nitrogen as efficiently as do Rhizobium bacteria in legume nodules

④ Nitrogen fixation also occurs in ocean.
e.g. Trichodesmium (Blue-Green-Algae bacterium) in the Ocean is limited by iron, otherwise very efficient.

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(5) So far, 160 species in eight genera in five families of dicotyledons have been shown to possess actinomycetes-induced nodules

- Bacteria – Legume = Largely tropical in origin
- Actinomycetes fixer : Originate in north-temperate zone

(6) Nitrogen fixation by cyanobacteria may be
- free living form
- form symbiotic with fungi

<u>Symbiotic</u> : Fronds of the small floating aquatic ferns <u>Azolla</u> contain small pores filled with symbiotic <u>Anabaena</u> that actively fix nitrogen.

Azolla – Anabaena
(fern) (bacteria)
↓
Symbiosis.

] Play important role in paddy rice-culture. Provides Nitrogen fixation function as fertilizer.

Enzyme Nitrogenase, catalyses the splitting of N_2

* Micro-organisms growing on leaves and epiphytes in humid tropical forests, fix appreciable quantities of atmospheric nitrogen, some of which may be used by trees themselves.

* It appears that biological nitrogen fixation goes on in both the autotrophic and heterotrophic strata of ecosystems and in both aerobic and anaerobic zones of soils and aquatic sediments.

* Nitrogen fixation is especially energy expensive because much energy is required to break triple bond of molecular N_2 ($N \equiv N$).

About 40 Kcal (≡ 10g of glucose) is required to fix 1 g of nitrogen. (Efficiency 10%).

- Free living nitrogen fixer are less efficient (1%)
- Industrial fixation need, lot of fossil fuel energy, that's why nitrogen fertilizers are more expensive than others

Detrimental effects of too much nitrogen.-

Most of the natural ecosystems, and most native species are adapted to low nutrient environment. More of nitrogen may provide opportunity for high nutrient adapted weedy species which may be exotic, resulting ultimately in reduced biodiversity. It may also increase number of pests and diseases globally, and is also beginning to adversely affect human health.