DISSIMILATORY AND ASSIMILATORY NITRATE REDUCTION-

THE PROCESS OF NITRATE REDUCTION TAKES PLACE IN 2 WAYS-

1. Dissimilatory nitrate reduction.
2. Assimilatory nitrate reduction.

The process of dissimilatory nitrate reduction is also called Nitrate Respiration because here, the organism uses nitrate only as a terminal electron acceptor which means, nitrate will accept or gain the electrons in the process, it will get reduced and when there are electron donors that are donating the electron, the electrons flow through a series of electron carriers and are finally accepted by nitrate. In this process during the electron flow, there is an energy synthesis/ATP synthesis. So, this process is performed by organisms as a sole production of energy.

Whereas, in assimilatory nitrate reduction the organism utilizes the nitrogen in the environment in the form of nitrate and assimilates it or incorporates it into its own cell in the form of amino group which is found in the amino acids.

The dissimilatory nitrate reduction is of 2 types-

1. Dissimilatory nitrate reduction to Ammonium (DNRA).
2. Denitrification.

\*In both the cases the nitrate is used as a terminal electron acceptor.

\*In case of denitrification, the end product is dinitrogen which is the atmospheric form whereas, Ammonium is the soluble form that can be found in soil or in the marine sediments.

1. DNRA –This process is performed by *Beggiatoa, Thioploca, Shewanella* etc. In nitrogen cycle or in the environment we may not study about this process because quantitatively it is not very significant. Not a large percentage of organisms perform it as compared to denitrification which is an important part of nitrogen cycle. But, DNRA is very important process ecologically because the nitrate which is a usable form is converted into NH4+ which also is a usable form so, plants or microorganisms can readily utilize NO3- and NH4+ from the soil .

This is seen mostly in anaerobic environments such as sewage sludge.

THE PROCESS OF DNRA-

In this process the formation of ammonium ions takes place-

NO3NO2- NH4+ → present in the environment that can be utilized by these organisms.

* + Nitrate reductase enzyme participates in the conversion of nitrate to nitrite.
  + Nitrite reductase enzyme participates in the conversion of nitrite to ammonium
  + Nitrate reductase is found in periplasmic space of a cell and, nitrite reductase is found in the surface of periplasmic membrane.
  + This Nitrite reductase is Cytochrome C nitrite reductase.

1. DENITRIFICATION : This is a very important process. In this process, the nitrate acts as a terminal electron acceptor and NO3- gets reduced to NO2- NO, N2O, and then finally to N2 .

Nitrate is a less efficient electron acceptor in comparison to oxygen so, most of the denitrifiers show denitrification only when oxygen is unavailable that means they are facultative anaerobes. They can survive in the soil. They can use oxygen and show aerobic respiration and when oxygen gets over they can immediately switch to nitrate respiration or denitrification where they use NO3- as a terminal electron acceptor instead of O2 .

This process can be observed in soil, in groundwater, in wetlands, or even in anoxic environments such as marine sediments.

The organisms that show denitrification are-

*Paracoccus denitrificans, Thiobacillus denitrificans, Micrococcus denitrificans,Pseudomonas, Serratia, Bradyrhizobium japonicum, Agrobacterium, Flavobacterium, Rhodospirillum, Halophiles* etc.

PROCESS-

The general equation goes like-

2NO3-  + 10 e-  + 12 H+  → N2 + 6 H2O.

Stepwise process-

NO3-  → NO2-  → NO → N2O → N2

Nitrate Nitrite Nitric Nitrous Dinitrogen

Oxide Oxide

The series of enzymes involved are :

1. Nitrate reductase.
2. Nitrite reductase.
3. Nitric oxide reductase.
4. Nitrous oxide reductase.

THE IMPORTANCE OF DISSIMILATORY NITRATE REDUCTION-

In both the cases the significance is mainly in the sewage treatment plants. The sewage sludge and water are rich in nitrates and to remove the nitrates from there the denitrification is utilized as one of the step. On adding denitrifiers, they convert the NO3- into N2 and the water becomes cleaner. Also, in groundwater systems if there is an excess of agricultural runoff and water coming from fields , in such cases to clean up the groundwater the denitrifiers are used.

THE ASSIMILATORY NITRATE REDUCTION-

This process is carried out by plants, fungi, and different bacteria and all organisms which are growing in the soil are capable of taking up the nitrogen from the environment by assimilatory nitrate reduction. Eg., *Azotobacter, Anabaena, Acinetobacter, Yeasts, Chlorella* and all plants are able to assimilate and convert the nitrate that is present in the environment into an amino group in their own body or cell.

NO3- → NO2-  → NH4+  → is incorporated or converted into an amino acid by GS-GOGAT pathway.

* The nitrite reductase enzyme here is ferredoxin-dependent nitrite reductase.

GS-GOGAT pathway-

Glutamine synthetase- Glutamine synthase pathway, through this pathway, all the organisms assimilate the NH4+ that has been formed. They convert NO3- into NO2- , NO2- into NH4+ and then convert NH4+ into an amino acid through this GS-GOGAT pathway.

Assimilatory nitrate reduction does not require any anoxic conditions. So, any organism can carry it out.