Bioinorganic Chemistry

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Lecture No - 38
Non-Metals in Biology-II

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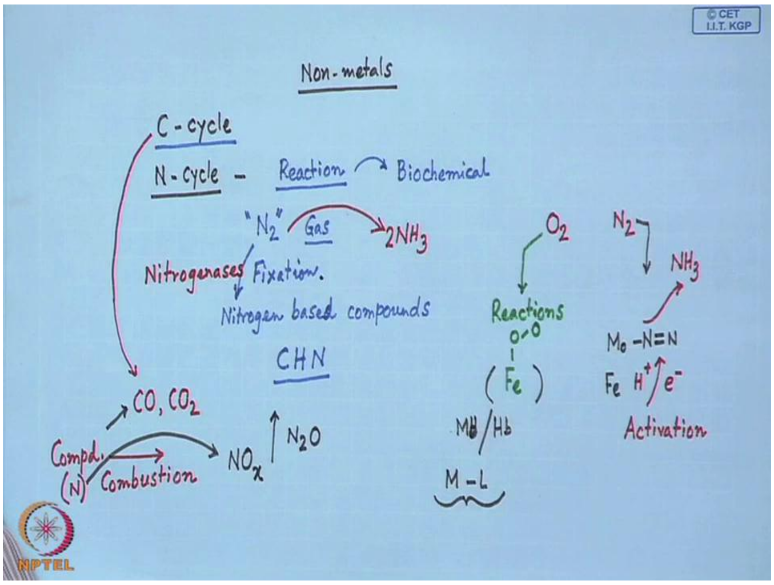

Good morning, once again, welcome to this class what we are dealing with some of the non-metals, and in our last class what we have seen the typical carbon cycle. And how the different carbon based compounds, whether they are typically organic one or the inorganic counterpart like the different carbonates and bicarbonates, how they are getting assimilated and cycle down the different forms. So today, we will see the next one, which is very important after carbon is the, corresponding nitrogen cycle. So, in this cycle, we will see how the nitrogen is getting assimilated into the system. And from the bi inorganic point of view, what we will be looking there that the typical or some basic or important reactions, which are basically can control the different nitrogen based species, what we see.

So therefore, all these reactions, and most of them are basically our biochemical one, and the involvement of the difference species. That means, the corresponding transformations of one nitrogen based compound to the, another is basically coming from the typical one, which is present in our atmosphere, the dinitrogen in the gaseous form. So, high we can fix that particular molecular nitrogen which is a very inert gas molecule also, and which is abundant in the atmosphere. So very, different types of nitrogen based compounds is therefore a challenge to the chemist, is how we can convert this dinitrogen gas to different and important nitrogen based compounds.

So, these are very important, so when we basically go for this type of transformation, we see that, we are basically incorporating the nitrogen atoms, in some well established compounds already we have seen in the case of some of these reactions in carbon cycle. So, the carbon cycle was basically giving us some of these compounds, which are based on carbon and hydrogen. Now, we are basically incorporating nitrogen into the system. So, basically we are getting most of the organic and important other compounds which are composed of carbon, hydrogen and nitrogen. So, basically insertion of the nitrogen, in a typical organic molecule which is based on carbon and hydrogen can be done by fixing the dinitrogen gas, what is available in atmosphere. So, we call this as the fixation of dinitrogen gas.

So, dinitrogen fixation can be done initially, what by the species which are known as nitrogenases. So, we will not discuss in detail of these nitrogenases, but the very important reaction is that how we can convert this dinitrogen and whether we should be able to convert this amount this, N 2 molecule to ammonia. So, basically is a typical reduction reaction, where the dinitrogen which is a typical inert molecule where nitrogen is triple bonded to second nitrogen and going for that. So, we go for the corresponding reduction reaction and this is a 6 electron reduction reactions. And some other metal ions, like molybdenum, vanadium etcetera which are present in nitrogenases along with iron can play some important role to convert the dinitrogen molecule to ammonia.

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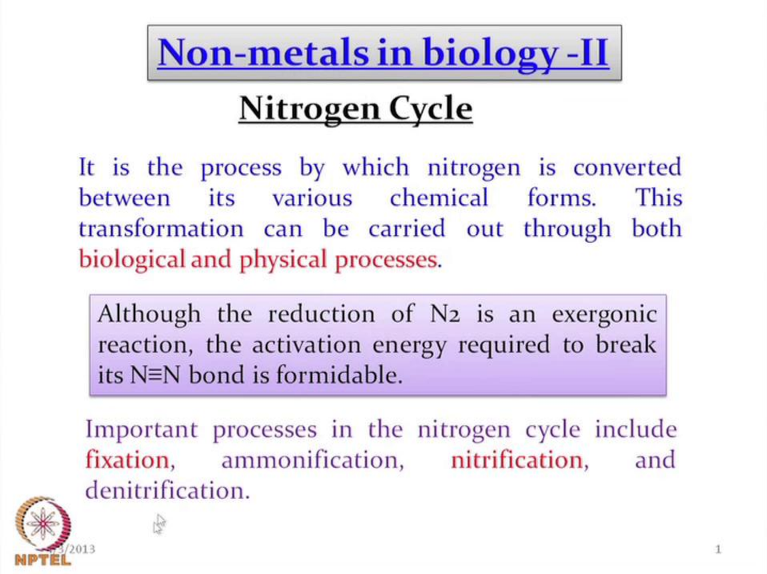

So, what we see that, in this particular case that when we are talking in the non metals in biology and in terms of the typical nitrogen cycle. So, basic definition for the nitrogen cycle is very important that is the process. So, it can be anything that means you can go for the typical reaction in the laboratory; we can go for the typical reaction in the industry. And if we allow this nitrogen to react with some bichemical manner that means, the bichemical reactions can also interact with dinitrogen to convert it into various chemical forms, which are very important.

The different chemical compounds, which having some atoms like carbon, hydrogen, and nitrogen they are very important. And if we can go for these transformations, and if they are carried out by any kind of these reactions that means it can be through the biological processes or some other physical processes or some chemical transformations. So, we basically go for the fixation of nitrogen molecule in some value added compound where we get some very important and interesting molecule based on nitrogen.

Because we know that our protein structure in the biological origin of everything; that means the proteins and polypeptides all also having some nitrogen backbone into it. So, we all know is a typical from the thermodynamic point of view that how the dinitrogen reduction is taking place. It is a exergonic reaction and the activation energy required to break the nitrogen, nitrogen bond is very high is a very stable molecule unlike the dioxygen molecule. Because the dioxygen molecule is the men molecule, which can go for the corresponding, all sorts of oxidation reactions, but in this particular case the nitrogen, nitrogen triple bond is present.

So, this activation of this dinitrogen molecule is very important. So, if we compare these 2 molecules what we know from our childhood that these 2 molecules are present in the atmosphere, one is the oxygen molecule and another is the nitrogen molecule. And we see that this is been carried out by our blood for the oxidation, or for the food material and all these things. So, this dioxygen molecule can go for some important reactions, and one such interaction is the interaction in the corresponding hemoglobin and myoglobin molecule.

Where the iron centre is reacting with the dioxygen molecule that means, what we are seeing through that particular reaction is that, this dioxygen molecule is binding to that particular iron centre of the hemoglobin or the myoglobin molecule, hemoglobin or myoglobin molecule. So, this dioxygen is interacting through this particular one and we can go for the iron oxygen bond and the oxygen, oxygen bond cleavage is also possible. And we can go for the corresponding oxidizing equivalent, which can be transferred to some other substrate or the food material like burning of carbohydrate molecule or the glucose molecule that means the interaction of this iron with this O 2 molecule is important, where the metal is your iron, and our ligand is dioxygen molecule. So, this is in very typical form is the corresponding interaction of the metal with that of our ligand. So, in a same fashion, if we just consider the di oxy nitrogen can also be interacted with some metal centre, say molybdenum or iron, which are the metallic part present in the nitrogenases molecule.

So, if they can go for some kind of similar binding with that of the dinitrogen molecule, And if we can go for some reaction where we can consider like that of our dioxygen molecule that if we are available to activate the dinitrogen molecule. So, the first step for that is the corresponding activation, and if we can go for the activation if we can reduce the bond order between the 2 nitrogen atoms. And if some available or vitals are there, where we can feed electrons that means, this is a typical reduction reaction to convert it this particular dinitrogen to ammonia molecule.

So, we just have provide both h plus and e minus that means, is a reduction reaction will take place your nitrogen, nitrogen bond order will be reduced. And we can go ultimately for the conversion of the ammonia molecule, but this is not so easy. So, this bare has to be broken for this activation of this nitrogen, nitrogen triple bond and the corresponding process, which we can consider during this nitrogen cycle, because day by day, depending upon the corresponding input of the different nitrogen based compounds is changing, how we interacting the corresponding nitrogen cycle?

So, this is very contemporary interest for knowing this particular nitrogen cycle in the form, that how it can go for the fixation. So, when we take the help of the different nitrogenases, we can go for the fixation of nitrogen, at least in the form of ammonia formation, if we are not going for any other type of molecule formation. But at least, we can go for the corresponding formation of ammonia molecule from the nitrogen gas then in some cases ammonification can take place and there is some process which you consider as the nitrification.

So, nitrifying bacteria is also there. So, is a typical bichemical reaction, what bacteria can do which we cannot donor in the laboratory, for the fixation of nitrogen. So, nitrogen can be activated for nitride and nitrate formation, and in some other cases, the reverse reaction that means the de nitrification reaction. So, all these typical reactions these are some steps that means, if we consider that it is the fixation, we consider it as a nitrogen fixation, if it is considering the corresponding ammonia formation. So, it is ammonification, and then the corresponding nitride and nitrate formation we call it as a nitrification reaction, and the reverse of that the nitrates. And nitrides can be reduced back to nitrogen or ammonia can also be considered as a corresponding reaction in terms of it is denitrification reaction.

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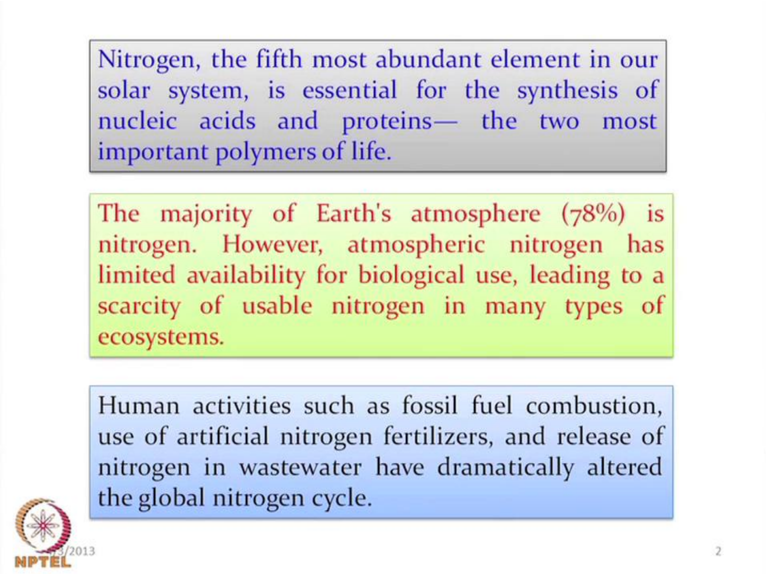

So, if we just simply consider that nitrogen, which is very much abundant in the atmosphere, and it is the fifth most abundant element in our solar system, wherever we go we get the oxygen; we get the silicates; we get the other important elements. But nitrogen is everywhere, and it is therefore, essential for some basic component, why nitrogen is so important and why we should all know at least some of the basic reactions where the bioinorganic chemistry can take some important role to play that means how we can convert the gas, which is available which is plenty in the atmosphere. How we can convert this nitrogen to say urea, which is a very useful fertilizer for our agriculture, and this nitrogen if we are able to fix in the form of ammonia. So, we can have some agricultural revolution in that form, and also if we can go for the synthesis of different nucleic acids.

So, different DNA and RNA, we can have the nitrogen based hetero cycles and the different proteins. So, proteins are forming from the different polypeptides, and within the polypeptide, we have the basic ingredients for the formation of this polypeptides are corresponding amino acids. So, if we have the synthesis of those amino acids, the very simple amino acid what we know as the glyasine. So, synthesis of the glyasine also depended on the fixation of nitrogen, if that nitrogen is coming from the atmosphere. So, for our life these two are the very important polymers and they are nitrogen bearing and they are very much depended on the nitrogen cycle.

So, how the available nitrogen molecules are there, and how that molecule can be converted to the synthesis rather bio synthesis of these nucleic acids and proteins. So, next will see that, the environment what we have about 78 percent of the atmosphere that means, the earth atmosphere belongs to nitrogen. So, atmospheric nitrogen it has unlimited source and if we can use that particular source for biological conversion and we can use the corresponding scarcity of some important molecules.

So, in the ecosystem the usable nitrogen that means, that particular nitrogen which can be converted or which can be inserted very easily to that of our some useful molecules that we can see through this nitrogen cycle. But in the reverse side our activity the human activities such as during the fossil fuel combustion, we have seen that for some part of this carbon cycle, what we have seen that the corresponding degraded form from this carbon cycle. The degraded form what we are burning this carbon compounds, the useful carbon compounds in the form of its corresponding carbon monoxide and carbon dioxide.

And both of them are the typical green house gases and when we burn our fossil fuels that means, the coal the oil the natural gases all the time we also contribute the corresponding carbon monoxide and carbon dioxide. So, it is not that all the time we will have only carbon based compounds, which are responsible for the burning process. So, any combustion reaction, if we can have that a typical combustion reaction from any compound bearing nitrogen, and we all know that this particular oxidation reaction, when we have this nitrogen.

So, when we have the carbon based compounds, we get the carbon monoxide and carbon dioxide, and when we have the nitrogen based compound, we get the corresponding nitrogen oxides. So, there are different forms and different types of nitrogen oxides, we know when we typically know from our school days, that when we react nitric acid with copper. So, reduction of nitric acid can lead to different sorts of nitrogen oxides it can be nitric oxide, it can be nitrous oxide, it can be nitrogen dioxide. So, all these things, we can consider in channel form as the NOX molecule that the different nitrogen based oxides.

So, these nitrogen based oxides basically go for towards the, our upper atmosphere, and they also can contribute to the corresponding environmental pollution. And in some cases, if we can able to generate the nitrous oxide at the same time from the reduction of some other oxides, we get that this is one of the component of those green house gases. So, during the fossil fuel combustion that means, whether it is the corresponding that gas molecule that means, the natural gas molecule the fossil carbon that means in terms of the corresponding coke or coal or the corresponding fuel in terms of the petroleum and the diesel products. And the use of the different types of different artificial fertilizers, like that of our urea.

So, in he will, urea is also consumed, we produce large amount of this nitrogen based oxides. So, we release some amount of nitrogen also in the form of some useful compound of this nitrogen in waste water. And basically we can interval or we can contribute something and we have chance to alter the corresponding global nitrogen cycle. So, we should also be able to contribute to the nitrogen cycle which is present over there, excuse me.

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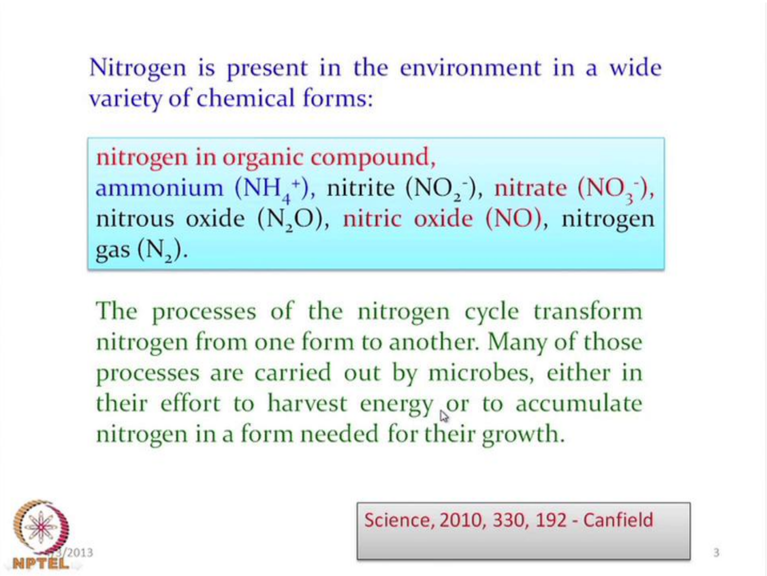

So, this particular case, so when we have nitrogen which is present in the environment, in a wide variety of chemical forms. So so far, we were just talking about the corresponding fixation of this nitrogen that means, when we have this nitrogen, we basically, when we consider this nitrogen. And if we just simply consider the simple reaction of it as the corresponding conversion of is as ammonia.

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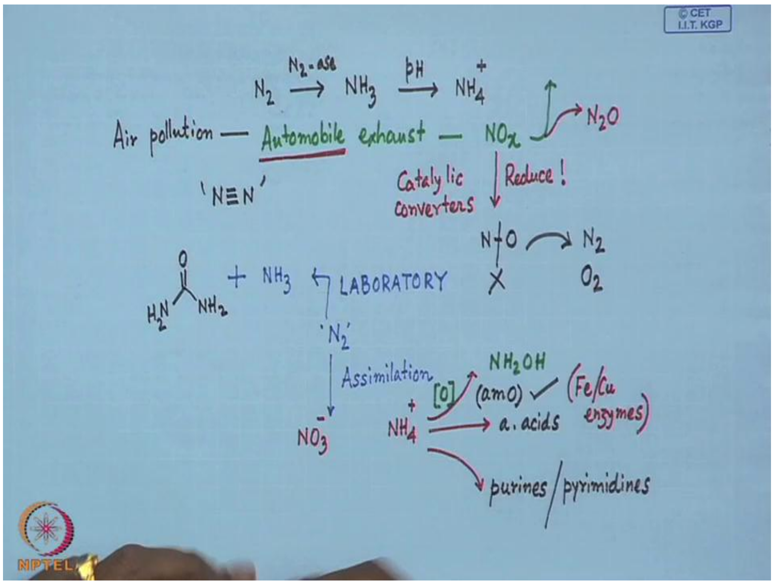

So, this is the corresponding use of the corresponding nitrogenases. So, use of nitrogenases you can have and depending upon the corresponding soil P H. So, in soil also we should be able to produce the corresponding ammonium, the ammonium ion can be formed. So, different compounds which we get so, very initially, we should have the nitrogen in the different forms of the organic compounds. So, nitrogen if it is present in the form of the urea. So, that is one form. So, urea can also be converted to some other organic form also.

So, different types of organic compounds which contains nitrogen then in the form of the formation of ammonia, we get the ammonium ion, then we can have the nitride. So, immediate conversion of nitrogen and ammonium ion to the corresponding nitride ion, which is getting oxidized to nitride ion that means, we have plenty of oxygen in the atmosphere, plenty of oxygen in the air. And that oxygen, if it is utilized for the oxidation of the nitride an ion we get the equivalent amount of nitrides.

Then through the reduction of these gases, we get some case the corresponding nitrous oxide, then nitric oxide. And ultimately if we are able to get back from these oxides, were corresponding reduction can give rise to the nitrogen gas itself. So, in one cycle, we want to fix this nitrogen in some useful compounds like that of our up to the protein synthesis. And in another case the degradation the biochemical degradation, also to break the proteins, and the polypeptides molecules to back to the nitrogen and oxygen, which is also true, when we have the different NOX type of molecule.

So, what we are polluting that means, for air pollution, we have a serious concern from the corresponding automobile exhaust. So, if we have the automobile exhaust, we produce huge amount of NOX molecule, NOX molecules. So, NOX molecules are there and which is going up to mix up with that of our corresponding atmosphere above us, and along with nitrogen oxygen and carbon dioxide and monoxide, this NOX molecules are mixing up. And if some of these through some activities, through some biochemical reactions through some environmental reactions also, because in upper atmosphere in the stratosphere, some photochemical reactions are also taking place based on the nitrogen, oxygen and the available nitrogen oxides.

So, they can produce the most formidable green house gas, nitrous oxide, but the challenge for a clean environment or the clean atmosphere, that how we reduce. That means, we have to reduce the corresponding concentration of NOX in the environment, because the burning of fossil fuel, we cannot stop we have to burn the corresponding fossil fuels in any form and along with all other gases the NOX is coming. So, how we reduce the corresponding concentration of the NOX? So, that is why all these automobiles that mean, the cars, buses, trucks, and all these thing they are now a day fitted with some converter, which are known as catalytic converters.

So, catalytic converters are there with the idea that in this NOX molecule, what we have here that means, initially we are facing the problem that how we convert the nitrogen, nitrogen triple bonded molecule to some useful products like ammonia. Then here also, we have this NOX type of molecule, how we can break this particular nitrogen, oxygen bond, such that the catalytic converter can produce.

So, after breaking, so the thermodynamic driving forces are always there and if we can break that thing it immediately convert some active nitrogen radicals and nitrogen species. Similarly, some active oxygen species, and both of them are ultimately converted to some harmless gases like what present in our atmosphere is the formation of the corresponding nitrogen and oxygen gases. So, all the time if we just can have even the nitric oxide is present, how we can break this nitric oxide between nitrogen and oxygen. So, within this nitrogen cycle we transform nitrogen from one form to the other.

So, that is the, basic idea behind this knowing this particular nitrogen cycle that how we convert one particular form to the other form. And many of these processes they are basically the human activity is very less, because we cannot have large amount of the enzymes like nitrogenases, but different microbes, different bacteria's they have some important and useful mechanism. They basically get the harvest energy, or they basically get nitrogen, for their survival also, and when they are needed for their growth like the plant materials. So, if we the plant, which is depended on some bacteria or microbes and these bacteria and microbes can fix efficiently the atmospheric nitrogen that means, the nitrogen present in the gaseous atmosphere. So, that can be converted to some useful molecule, and that molecule can be stored in the plant.

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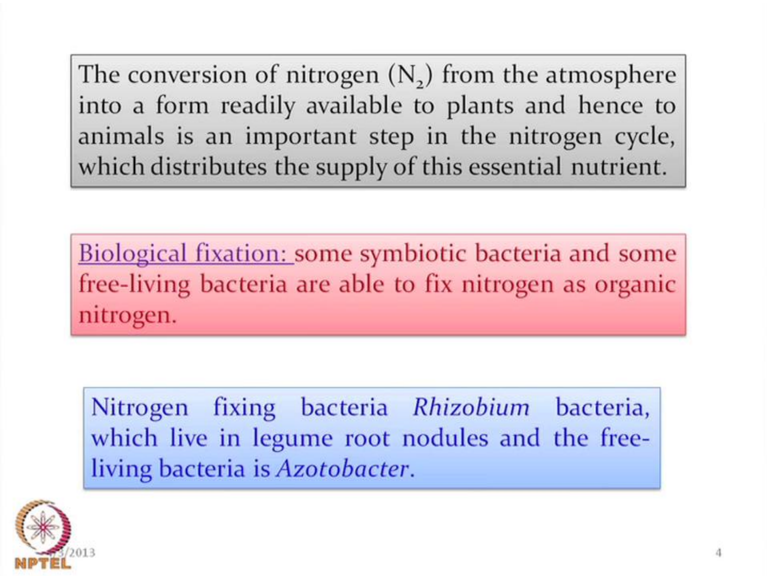

So, what we see that, what are the corresponding conversions? So, if we are able to convert, so this nitrogen into the form, which is readily available to plants. Hence the animals which are depended on those animals, they will also get the corresponding nitrogen as their useful source. So, plants will provide this nitrogen, depending upon the bacteria, and this nitrogen can go to the animals. And these are basically some important steps, because they are also controlling the formation of different useful biological molecules like all the different proteins and polypeptides and nucleic acids.

So, they basically contribute nicely towards the nitrogen cycle, which basically responsible and distribute the supply of their essential nutrients. So, when we think about some supply of some essential nutrients, we should always think about the corresponding nitrogen, because the nitrogen is the very basic component for the protein molecules. So, whenever we need some protein molecule, we should always think about nitrogen, and we should always think about the corresponding nitrogen cycle. So, it should be dependent on some biological fixation. So, biological fixation is the most important fixation, and which can be easily available, and which we can get very nicely. So, there are some bacteria, which we call as say biotic bacteria is so. And there are some also some free living bacteria which can able to fix nitrogen into some useful organic compound that means, useful organic nitrogen compounds can be formed directly from the nitrogen available in the atmosphere.

So, this we can consider as biological fixation. So, biological fixation, is also depended on some form of nitrogenases, and these nitrogenases what we are unable to make for some laboratory use or some industry use. But the bacteria can have these nitrogenases, and these nitrogenases are useful to store the nitrogen in some useful compound. So, one such bacteria is the rhizobium bacteria from our very early school days, we are studying from early school levels that this rhizobium is present and this rhizobium bacteria is responsible for nitrogen fixing.

So, this nitrogenases are available very easily with these rhizobium based bacteria, which are available in the legume root nodules of the different pena trees and all other. And they are basically the free living bacteria and also known as azotobacter. Azo is the corresponding nitrogen part, the azo is the corresponding term for the nitrogen use. So, the bacterium, which is responsible for handling the azo function, the azo group that means, the nitrogen group in the form of the rhizobium which can directly fix. The nitrogen from the environment in the form of some useful organic compound or ammonia molecule, we get very easily the corresponding fixation of nitrogen in some useful compound.

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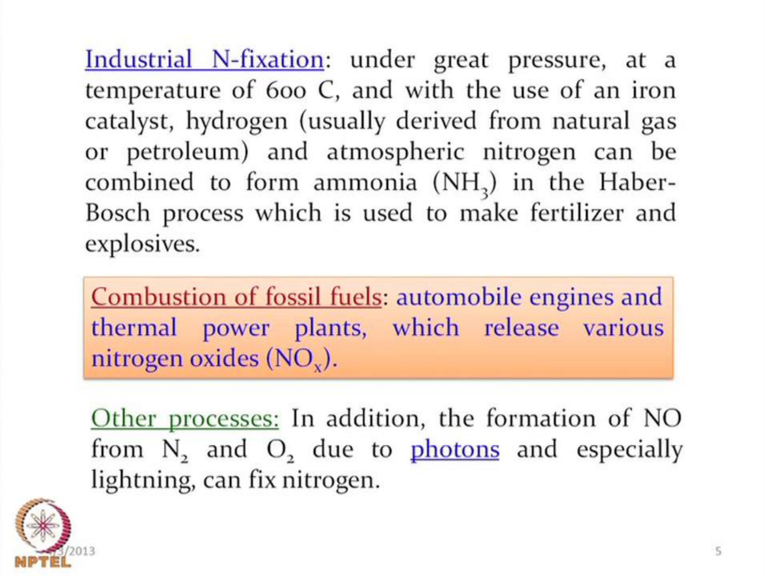

But the other one, what the human activity always want to do that how we make the urea in the laboratory. So, that is not a very easy task, and long back these 2 persons Haber and Bosch developed a particular process which we known as the corresponding industrial nitrogen fixation. So, if we are not able to go for some bacterial fixation, we have to produce chemically. So, the corresponding chemical compound, what we make in our laboratory that is the typical urea molecule. So, how we get the corresponding urea, which can be used for the useful fertilizer and that fertilizer what we get basically from the corresponding, ammonia molecule.

So, both these two, that means the urea and ammonia, how we get this too basically, from the dinitrogen molecule, and in a typical laboratory. So, if we have some very easy and useful laboratory technique, what bacteria’s are doing that means, they are doing in typical atmospheric conditions that means, one atmospheric pressure of nitrogen is available, and at the room temperature that means, the temperature what is available in the agriculture field. So, at that particular temperature in pressure, which we call also the autogenic temperature and pressure we can able to convert this nitrogen to ammonia and to urea.

But when we talk in terms of the corresponding fixation that means, the breaking of the nitrogen, nitrogen triple bond, the reduction of this nitrogen centre’s and insertion of the hydrogen as proton. We take the help of only the Haber and Bosch process which is giving us the useful industrial fixation under very high pressure, that means, the nitrogen pressure should be very high and at very high temperature. So, not only very high pressure and high temperature, which bacteria does not need we use some also some catalyst, the iron based catalyst is also required, and the hydrogen gas. So, which sometimes derived from the natural gas or the petroleum product and the petroleum that means, which is basically carbon based some hydro carbon. So, hydro carbons, if those hydro carbons can be useful for giving, or generating the hydrogen that hydrogen can be utilized for attaching to this nitrogen to get ammonia.

So, this nitrogen can attach with that of the hydrogen available, we get ammonia, and we can get some of these fertilizers, and some of these very deadly molecules like those of the explosives. Because we all know now a days there is ammonium nitrate, which is a very useful explosive, and in some bad purposes. Basically people are using these particular things, because these are highly exothermic reaction for burning of these ammonia nitrate.

So, making all these molecules, we can use this particular industrial fixation of this particular nitrogen. So, when we make this that means, when you make urea, when you make ammonia, but on the reference direction when we burn them as I already told you that the different nitrogen oxides how we get. So, if we can go for the burning of the fossil fuels. So, the different automobile engines the thermal power plants, they all will release the nitrogen oxides. And they can increase the corresponding concentration of nitrogen based oxides in the upper atmosphere. And there are also other processes, which can have the corresponding formation of nitrogen oxides form the N 2 and O 2 present in the air and atmosphere, particularly in the upper atmosphere, when plenty of photo molecules are available from the sunlight.

And if this particular reaction that means, the reaction between nitrogen and oxygen if they are all photo chemical hydrogen that means, we can go for the corresponding photo chemical reaction between these nitrogen and oxygen we get the different forms of nitrogen oxides. And when we make this nitrogen oxides we basically convert this nitrogen whether this nitrogen oxides are harmful or beneficial, we should not consider at that particular point. But whether we are able to convert the gaseous nitrogen the triple bonded nitrogen, the nitrogen gas to some useful or other compound that will considered as the corresponding fixing of the dinitrogen molecule.

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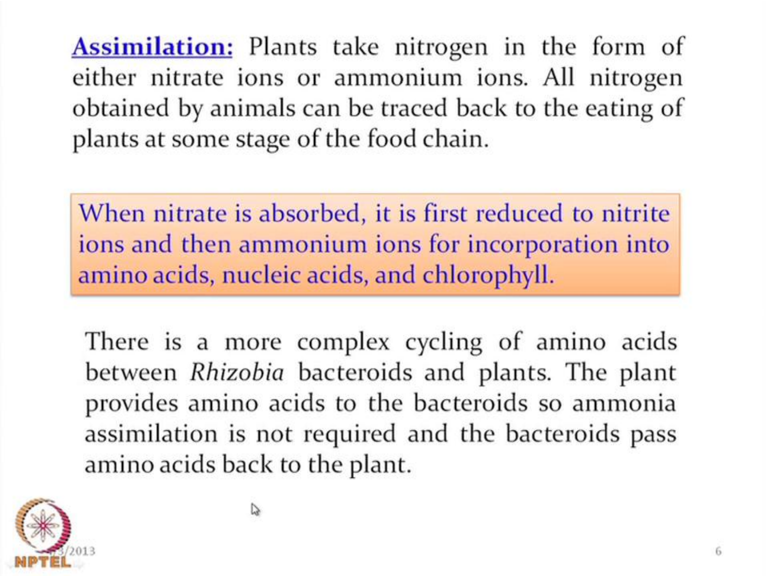

So, if we can consider from the bacterial point of view and the plants are present. So, some of these things, we can considered at the corresponding assimilation reaction. So, when we have the plant, we basically get the corresponding ammonium ion in the form of the nitrate ion or the ammonium ion. So, typical assimilation so this we can consider as the fixation, and when we have the corresponding assimilation reaction based on these nitrogen.

So, what we get there that means, we are forming the corresponding species as one of the important species is N O 3 minus and another species is the corresponding ammonia, and through protenation, the corresponding ammonium ion. So, when an ammonium ion is forming and the nitrates are forming. So, the plants are getting both this 2 species, so, these are in the ionic form. So, when we are able to make these ions immediately from the dinitrogen, and if plant can take up these 2 ions in their body?

So, they can be stored in the plant molecules, in some useable nitrogen based compounds some nitrogen bearing molecules can be stored in the plants. So, protein type of molecules can be so, the vegetable proteins, the organic protein molecules, which are the source from the plant system is basically coming from this nitrates and ammonium ions which are coming from the nitrogen molecule. So, this nitrogen obtained by animals can be traced back, to the eating of the plants by at some stage of the food chain. So, along with the nitrogen cycle, the food chain is also coming. So, animal like ours, the human being is also dependent; we are also dependent on some plant molecules. So, plants we are consuming, and by consuming the plants are different, food materials and all other thing we basically get the corresponding nitrogen source as the corresponding organic protein source.

So, these basically are coming from directly through the assimilation process. So, when this assimilation, that means, the dinitrogen is forming, and forming the ammonium ions. So, they can have in the corresponding cycle in the nitrogen cycle they can all be converted in some useful molecule that means, one most important molecule apart from the corresponding oxide based anions or the corresponding, oxide based or the oxygen based, or the corresponding nitrogen oxides. We can have one important species, which we can get is the N H 2 O H from the ammonium ion. So, hydroxyl amine can also be formed from the ammonium ion. So, this particular one, which is basically controlled by the reaction with some enzymes and this is basically some oxidation reaction, and this oxidation reaction is basically controlled by ammonium mono oxygenize.

So, A M O, so, if the, ammonium mono oxygenase so, which will be working on the ammonium ion, and since it is a oxygenase reaction, it will insert some amount of oxygen into the molecule and the ammonia or the ammonium ion can be very easily converted to the hydroxyl amine molecule. So, we can have some important information, once we can track this particular pathway for the formation of ammonium ion to the hydroxyl amine. We can think above the corresponding ammonium mono oxygenase reaction on the ammonium ion. Similarly, this can also be useful for the formation of different amino acids. So, amino acids are forming from there and these amino acids are also very much useful for our system, and there are some purin based corresponding nucleic acids.

So, what these nucleic acids, we are just talking about they are basically responsible for the synthesis, initially of that of our purines, and pyrimidines. So, these purines and pyrimidine molecules, which are also coming from this ammonium molecules. So, this particular ammonium mono oxygenase, so these basically depend on some metal ions also, that is why the bio inorganic part of these cycles are also dependent on some other system, because they are basically based on iron copper enzymes.

So, these iron copper enzymes are responsible for a very simple reaction, but we are not able to do this simple reactions so easily or quiet often in the laboratory for the conversion of the ammonium ion to hydroxyl amine. So, these are some part basically within the nitrogen cycle, when we think of the corresponding assimilation of the dinitrogen molecule, in the form of these 2 ions. Because, whenever we get these an anions that means, the nitrate anion or the ammonium ion cation so these 2 ions when they are formed.

So, if they are form at all, the soil system, the soil on which the plants are there, the soil system cannot return very much of these nitrate ions, or the ammonium ions into it. They basically percolate through the soil system and them; basically reach ultimately to the ground water. So, what we get then plants require these ions for their survival, for their production, of the corresponding important molecule, but instead of that these ions basically, percolating through the soil, depending upon the nature of the soil.

It basically ultimately, reaching to the ground water, and if the concentration is pretty high, and which is above some recommended level, we basically get a corresponding quantum terminated ground water. So, assimilation can also have some risk factor related to that of our corresponding pollution of air, it can also pollute the ground water. So, water pollution is also dependent on this sort of nitrogen cycle part. So, when we have nitrate, if the nitrate is forming over there, nitrate is absorbed in the medium and when it is absorbed, they basically in some cases they are reduced to nitrate ions.

So, some redox enzymes, some oxydo reductases are there. So, these oxydo reductases, when present they basically first go for the corresponding reduced thing and the reverse reaction is also true. When, we get the corresponding oxidation of the nitrite to nitrate. So, what we see that, when we are able to make these particular anions, as the corresponding nitrate, which is very useful and the soil should also have some enrichment of the nitrate anion, which can be reduced to nitrate ion.

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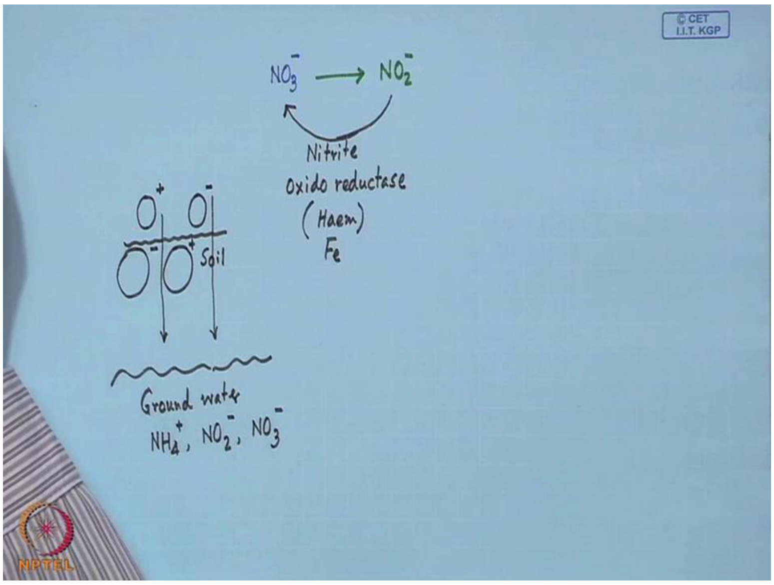

And this particular thing is the corresponding reduction reaction, and in this particular case when we go back from nitrate to nitrite, this is present in some bacteria again. And this particular one when it is acting on nitrite ion, when it is basically reacting on the nitrate converting to nitrite that means the insertion of one oxygen. So, this is basically some oxidation reaction. So, nitrite oxydo reductases is present. So, if nitrate oxido reductases, is present which is iron based, haem enzyme.

So, it is iron based haem enzyme so, that haem enzyme. So, we have iron there, which can convert this thing. So, both these two that means the reduction of nitrate to nitrite, and it is corresponding oxidation to nitrite, can basically control the amount of this particular anions in the medium. And then we have the ammonium ions and all these that means, the nitrite, the nitrate, and the ammonium ions. They are responsible for their typical incorporation, into all nitrogen bearing important molecules, we have the nitrogen bearing amino acids, so for the bio synthesis path.

So, the bio synthetic pathways for the amino acids for the nucleic acid, bio synthesis and for the chlorophyll also, because the chlorophyll also have the typical micro cyclic structure. The backbone for the binding of the metal ions, this is the micro cyclic ligand is forming, apart from the carbon and hydrogen it also have some nitrogen, in the form of the hydro cyclic ring payroll is basically the corresponding tetra payroll unit.

So, for the formation of all these important bio molecules, which nature can synthesize for us and the bio synthetic pathways are all dependent on the typical nitrogen cycle. So, nitrogen cycle can influence the corresponding production of these important molecules like amino acids, nucleic acids and chlorophyll. So, the rhizobium bacteriods, we have seen therefore, and therefore, we can have the corresponding complex cycling of amino acids.

So, if we bring amino acids into the picture, related to the simple nitrogen cycle what we have been studying from our earlier school days. But never, we have studied that, how amino acid can come into the picture, and how the oxidized form of the different nitrogen's which can go for the corresponding air pollution as well as water pollution that these bacteria that means the rhizobia bacteriods are coming into the picture, and also the plants.

So, when plants through the fixation of these nitrogen from air can produce amino acids and they basically responsible for the providing these amino acids to these bacteriods. So, ammonia assimilation is not required, and because they are directly getting this particular amino acids and bacteriods in return pass this amino acids back to the plant. So, that is we have the corresponding synergetic affect, that how we fix one thing to the other, and how one bacteria is passing something to the plant and plant is getting from the bacteria.

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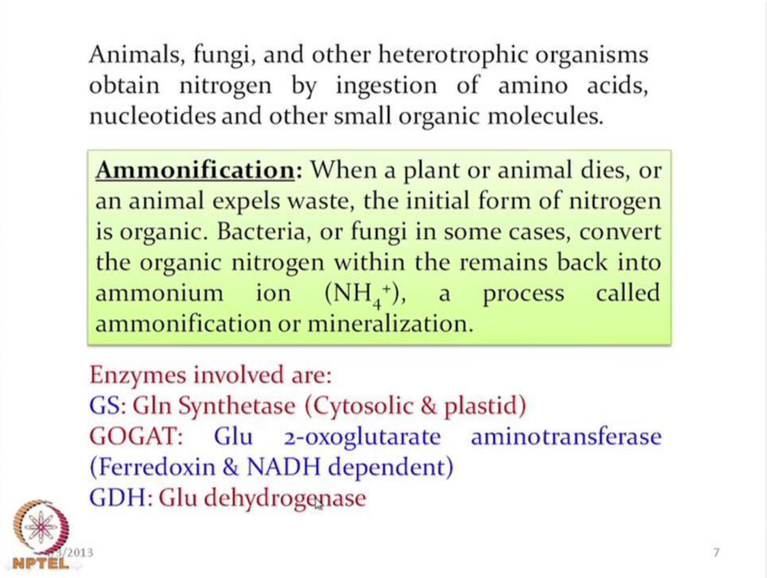

So, basically, not only the bacteria so, we the human being; the different animals; the fungi, and other heterotrophic organisms, how they get the corresponding nitrogen, which is very important, how we get our amino acid? If we have the shortage of amino acids, how the amino acid supplementation can be done, and the nucleotides and another small molecule corresponding protein molecules are corresponding small molecule peptides are there which are basically the nitrogen based and all are dependent on this. And when formation of ammonium ion, like the nitrogenases, we call this particular terminology for this is the ammonification. Ammonification is when a plant or animal basically dying out that means, the death is taking place and all the animal we just go for the corresponding expansion of waste material, and initial form of the nitrogen in the organic part.

So, bacteria or fungi in some cases convert all the nitrogen bearing compounds remains back into the ammonium ion. And when we convert all the nitrogen bearing compound like that of our fixation of dinitrogen to ammonium, we call this particular part of the system, as the ammonification or mineralization. That means, if we have some waste material that means, we just to in from getting from the dead material, this nitrogen available from the burning of the amino acids, the polypeptides, the nucleotides. So, all these burning of the chlorophyll the breakdown of the chlorophyll molecule, the breakdown of the other porphyring ring, present in the bloods, the hemoglobin and the myoglobin.

So, when they are coming back and all of them, if they can be converted to the ammonium ion through the formation of ammonia. We are happy to have this particular, because the nitrogen can be fixed in this particular form, we are not wasting out this particular nitrogen. And we call this has the corresponding ammonification or mineralization. As if the nitrogen store house is being kept nicely, and as mineral, we are considering this nitrogen in the form of its corresponding fixation. So, this particular reaction, because since we have some delicate reactions in this particular case. So, several enzymes are involved; one is the corresponding G S, which is gel and synthetase, the GOGAT that Glu 2 oxoglutarate aminotransferase. So, this is the amino group transfer reaction, which is definitely dependent on ferredoxin and N A D H, these are the biological reduction equivalents.

So, when we have to transfer the electron, as we know most of these cases we have to go for the corresponding electron transfer as well as proton transfer simultaneously. So, the activity of these enzymes are very much dependent on the corresponding activity of ferridoxin and N A D H. Then G D H is also there, which is another form of dehydrogenases. So, like the hydrogenases where we fix the hydrogen, as the corresponding proton or some other useful hydrogen bearing compound. Similarly, here also during the formation of ammonium ion, we should dependent on some form of the dehydrogenase, class of enzyme for this reaction.

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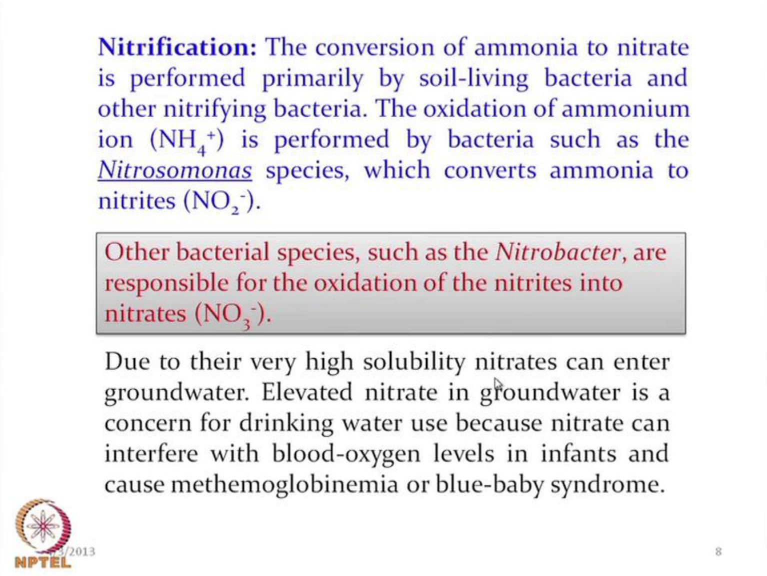

So, what is there that the ammonification after ammonification, we can talk about the corresponding nitrification? So, this nitrification reaction is the corresponding again inter relation between the corresponding ammonia and nitrate ion, which is performed primarily by the soil living bacteria other nitrifying bacteria. So, we know that the nitrification is taking place directly and the corresponding formation of this nitrites and nitrates, are taking place.

Similarly, it can also happen that the oxidation of ammonium ion by all these bacteria which are known as nitrosomonas. So, nitrosomonas type of bacteria are also responsible for the oxidation of ammonium ion and they all convert this ammonia to the nitrites. So, very easily we get the corresponding conversions to the nitrites, and the nitrites and nitrates, are all we know, that they are also the typical form or another form of the corresponding fertilizers, what soil is required for the useful plant growth.

Then, after nitrosomonas, so when nitrosomonas is acting on ammonium ion, we get the nitrites, but some other bacterial species, which we call as nitrobacter, which is talking about the corresponding nitrate formation. So, that is why it is the nitrobacter are also there and the responsible for the oxidation of nitrite into nitrates. So, this particular one so, conversion of ammonium to nitrate, and nitrate to nitrite, when they are all dependent on some bacteria, we get different types of bio chemical reactions.

So, these bio chemical reactions are pretty important, and which are also very important that the way we talk that it is very difficult to get the corresponding urea molecule, or the ammonia molecule directly from the dinitrogen molecule in the same way is very difficult to get the nitrate or nitrite directly from the ammonium ion. So, when we see that when these nitrates are forming so, ions are forming so, whether we have the corresponding cation or the corresponding anion, the ammonium ion or the nitrate or nitrites.

So, if they are basically sitting over the soil material. So, they cannot be returned until and unless the soil also have some bigger or some counteracting anions, as well as some counteracting cations, which can take part this anion, and this cation nicely. If this is not there, these particular ions, the cations and anions basically, percolate through the soil material and it can go ultimately to the ground water.

So, if we have the ground water. So, we have some elevated level of concentration for ammonium ion for the nitrate ion, and for the nitrite ion, in the ground water. So, what we are basically looking for, we are looking for the formation of this thing, and their corresponding conversion into some useful organic molecule. But instead of that, we get due to high solubility of this nitrates and nitrite, particularly. If we have the sodium nitrate, that sodium nitrate can go for direct solubilization in water, because it has very high solubility in the water bed, and it can go and percolate to the ground water, and it is entering to the ground water.

So, when we consume that particular ground water, we should be affected by the high level of the nitrate present in the ground water. So, basically or indirectly, the nitrogen cycle, what we are talking about, which should be helpful for getting some useful molecules like the protein, polypeptides and nucleic acids in our system. But instead if it is going in some wrong direction, we should get the corresponding nitrogen from the atmosphere to the ground water.

So, what we have the elevated nitrate in the ground water definitely therefore, a typical concern for drinking water, we cannot use that particular water as a very good source of drinking water. And these nitrates if we can conceiving they can go to the corresponding blood and the blood oxygen level can be interacted and the babies. And the infants can go for some typical methemoglobinemia disease or the blue baby syndrome where the baby is not getting sufficient amount of oxygen, which is required for their respiration, because the hemoglobin is not sufficient to get this particular oxygen for their survival.

So, these nitrate and nitrites, basically interacting the corresponding blood oxygen level, because the hemoglobin and myoglobin molecule, having the iron centre which can take out that particular oxygen. And that taking up this particular oxygen depending on the partial pressure of oxygen can control the corresponding blood oxygen level. So, when the water is present having some nitrite and nitrate ion that will definitely interfere the corresponding oxygen level in the blood particularly for the babies.

Thank you very much.