Nanotechnology in Agriculture
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Lecture-26
Antioxidant Nanomaterial in Animal Production-I

Welcome back to the lecture series the application of nanomaterials in agriculture. So now we are moving to the section where we are talking about the application of nanotechnology in animal production. So if we recollect back we talked about some of these areas what we enumerated in the dairy sector for milk from the cows and buffalos yeah camel, goat and sheep.

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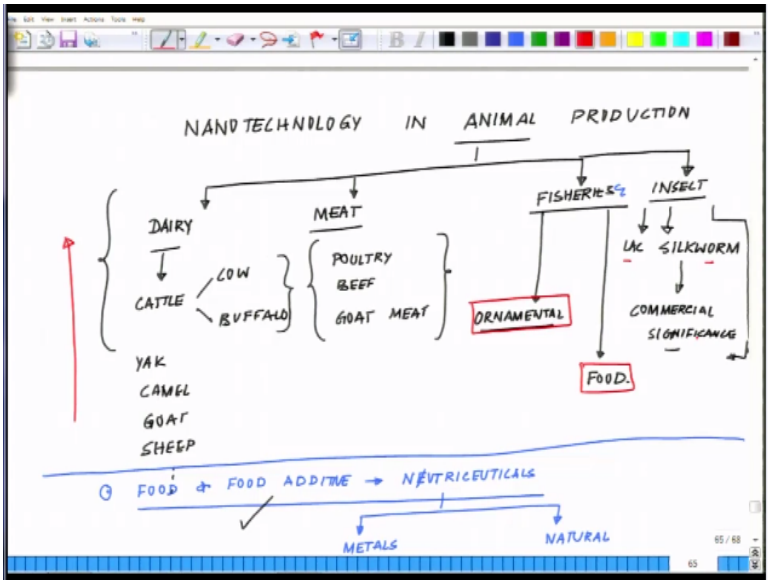

These needs to you know in order to feed you need to increase the milk production and when we talk about the milk production essentially formation of milk from the blood when it happens in the mammary gland of the female part of the species, it consumes a lot, lot of macro and micronutrients and milking mother needs to be supplied with these different micronutrient in sufficient amount and on the way if it supplemented is through food.

And not only milk production in terms of the body rate, in terms of the milk production that is equally important. So if we talk about the other sector which is the meat which includes your poultry, beef, goat and several other animals. Then you talk about the fisheries which is the 2

section one is the fish as the food, other one is the ornamental and then in insect sector we talk about lac, silkworm and their commercial significance.

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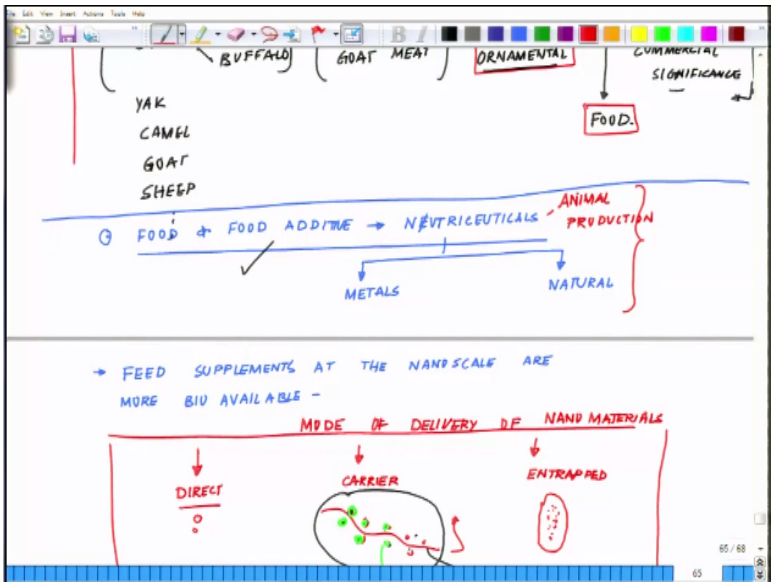

The areas where major chunk of investments are happening is this area food and food additives nutraceuticals for the animal production ok this is for animal production. So the nutraceuticals could be used for human too for here we are specifically concern with the animal ok.

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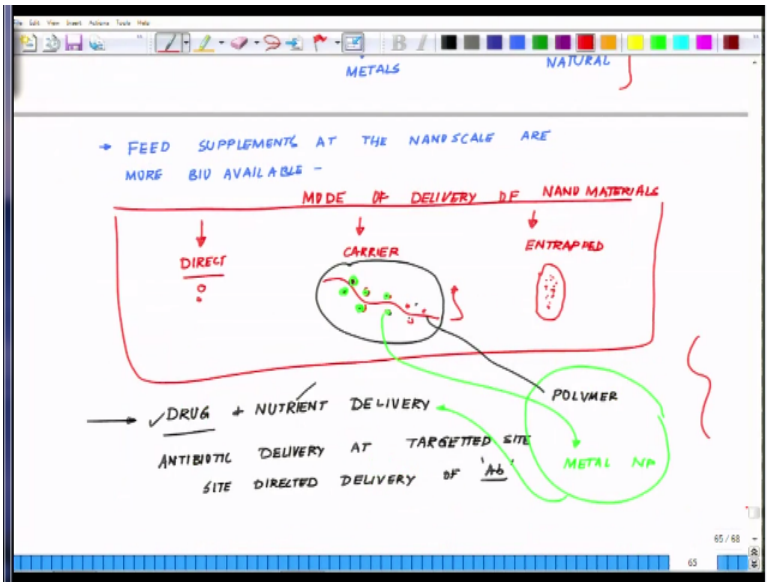

So now there are different modes of delivering these nanomaterials either you deliver them direct or you deliver them as a carrier or you deliver them as entrapped something like a capsule like

delivery ok. And there are lot of polymers, polymeric nanomaterials, polymer coating, polymer gels and several such a carrier modes have been used to deliver these particles.

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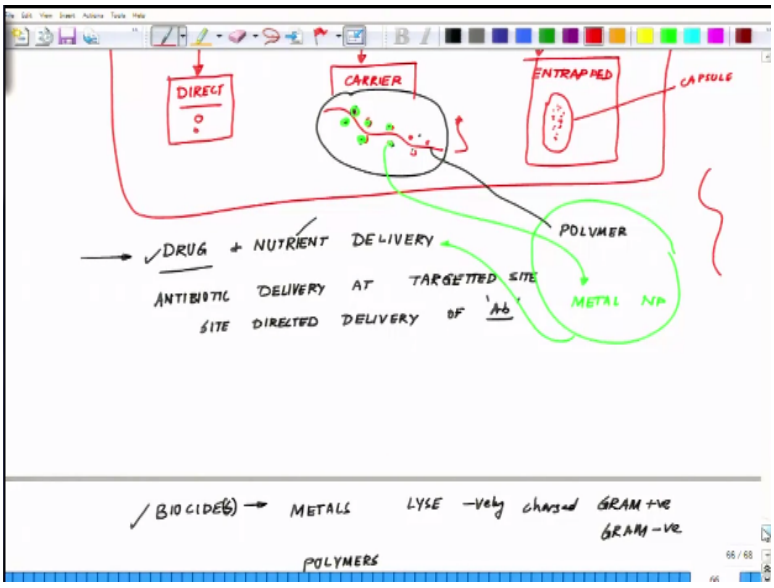

So, what we will do from here is at apart from it we talked about the drug and nutrient delivery which is antibiotic delivery to the targeted sites.

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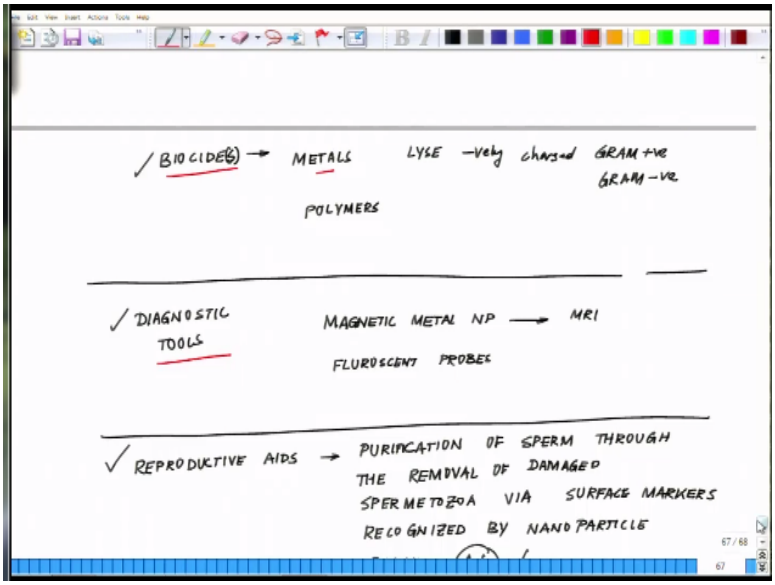

And site directed delivery of antibiotics or antibodies and the biocides in terms of the metals, diagnostic tools, using different kind of fluorescent probe.

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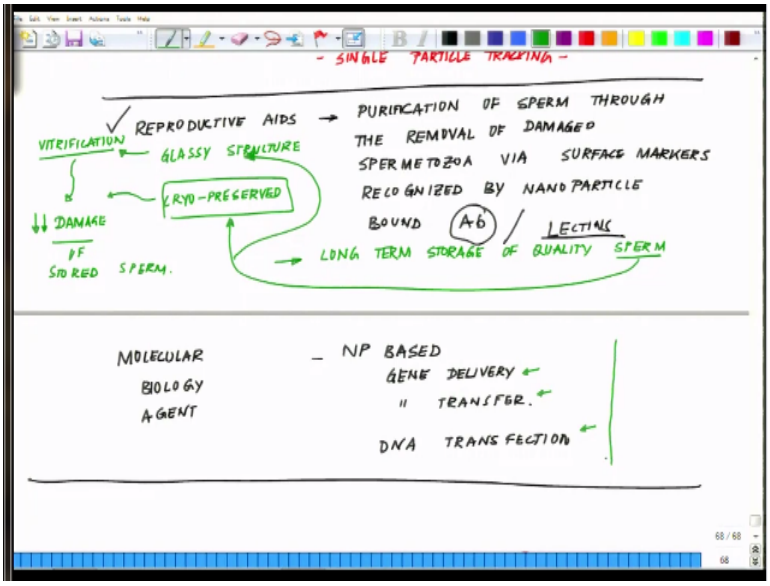

And there is lot of work which is going on in terms of single particle tracking ok. Then you have lot of reproductive aids, purification of the sperm through the removal of damages spermatozoa via surface marker recognized by nanoparticle. Similarly there is another area which is exceptionally important especially in modern animal production is long term storage of sperm, long term storage of you should say quality sperm.

Because these sperms are stored in cryo-preserved chambers and during this storage there are significant amount of damage which occurs. Now how you can cryo-preserve them are there is another technique which is you are converting them into glassious structure which is you are making them, you are shifting the cooling curve in such a way that ice secures our crystals are not forming which is called vitrification.

So, how one can but the whole idea is how to reduce the damage of stored sperm, so this is very essential because whenever animal breedings are being done, if you find a good male for the sperm to be fairly effective to increase the production of the offspring it will generate. The common practice is that you preserve those sperms for posterity and this is happening all over the world you have amazingly good animal sperm banks where these are being preserved.

But in order to preserve these kind of sperms it undergoes of lot, lot of damage. So this is one area where there is tremendous amount of research goes on in places especially in places like a

national dairy research institute in India at Cornell, in Indian veterinary research institute at Izatnagar and several other veterinary and agriculture and dairy universities and industries across the countries in Gujarat and other places where lot of efforts are being made to preserve these sperms in a way.

And I will come to that where all some of these nanomaterials could come very handy, ok then we talked about little bit about molecular biology techniques and nanoparticles based gene delivering, gene transfer and DNA transaction. So these are the areas where lot of concentrations happen. So today I will take a case study of one of the nanoparticle the way we did for the plants, so enumerate much of it the white grain and then you took 1 or 2 examples where we kind of in a highlighted the whole journey.

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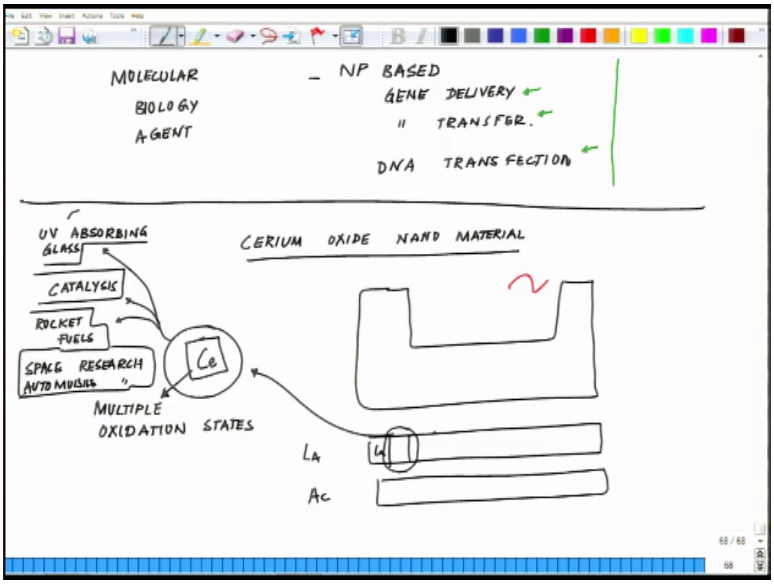

The one which I am going to take up today is cerium oxide, so cerium oxide nanoparticles or nanomaterials ok. So cerium those of you are well verse to the periodic table or we knowing are those who were not well verse will all remember that if you look at the periodic table carefully, so something like this ok. And then you see there are 2 lines underneath like this, this all of you remember and one we used to called as lanthanide La series, other one is actinide series.

So, if you look at the lanthanide series, if you look at the second element this reads as Ce cerium and do not please do not confused with Cs cesium many people does confuse it cesium, this is

Cerium okay. And much of these elements which are there they stay or they survive at multiple oxidation states, the first one is lanthanum, then you have cerium. So cerium is commonly used in the industry for multiple applications which has nothing to do with living systems.

The area where cerium is used is in catalysis, in rocket fuels, in UV absorbing glass, so which is defined application in space research in automobile research and some of those heavy engineering areas. Now just on set of today we are into 2018, little early like around 2000 I would say 2000, 2004 sometime around 2002, there was one idea which was tinkered back in university of central Florida Orlando by one Indian individual processed with the seal along with one of his collaborator.

That Virgil Ensky could we use, it is used for catalysis, it is an antioxidant that is a inorganic antioxidant could we use this as an antioxidant for biological systems, it is at that time this kind of crazy idea was taking shape, but how?. So initial study shows something very unique about this material, so when it goes in the nano domain it does some very interesting reactions. So I am going to first of all share the reactions with you ok, how it act?

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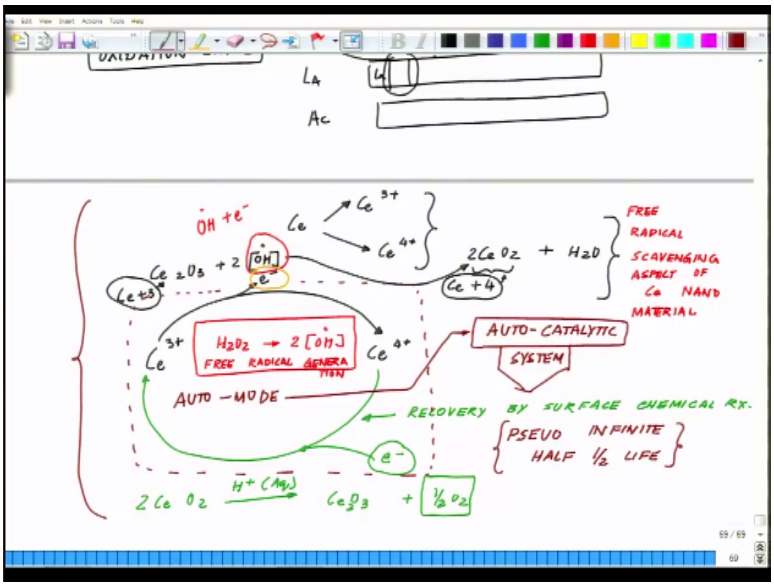

So, cerium in it is nano domain if you look at it, so cerium as I told you if you look at this part of the game where I said you they remain in multiple oxidation state. So let us start what are the oxidation state of cerium you see, the cerium remains in Ce 3+ and Ce 4+, these are the

oxidation state of cerium okay 3 and 4. And when we talk about a 10 nanometer or a 2 nanometer particle we are talking about typically calculate how many atoms will be there keeping carbon radius in mind.

There will be I do not know, I have to 10 and 1 nanometer we are talking about something in the 17, 18 or maybe 20 odd atoms are there. At that structure at that geometry the it does some very interesting surface chemical reactions, it behaves like a auto catalytic molecule as a matter of fact this was one of the very first time auto catalytic ceria was proposed or this word was coined by professor (()) (13:14) in university of central Florida.

In one of his discussion highlighted over it seems there is an autocatalytic means I will show you the reaction what does that mean. It is changing it is oxidation state all by itself auto ok auto mode ok. So list for the reaction in front of you that will kind of make more sense Ce 3+ ok, now Ce 3+ does something very interesting, Ce 3+ has to get oxidized to become Ce 4+ but if it has to get oxidize essentially what it will have to do, it will have to give a way an electron.

If it gives a way an electron what it does in that process is Ce_2O_3 which is oxidation state 3+2 you have OH free radical setting there, now that OH free radical transform into CeO_2 ok balancing it. So this is oxidation state 4+4 of Cerium of course ok and here you have cerium in +3 state, +4 state + water H_2O ok. So this action is essentially so here you have the free radical sitting there, so this free radical OH.+electron but in electron and become H_2O.

Now this process is the free radical scavenging part of cerium, free radical scavenging aspects of cerium nanomaterial ok. Now there is another set of surface reaction which happens and that what provokes who is a Hackman to suggest the other way around it, there was so if it is doing these free radical scavenging let us highlight that part. So H_2O_2 which is remaining in 2, so this is how there is the free radical generation which happens in hydrogen peroxide free radical generation ok.

Now this Ce 4 state of ceria reverts back or it gets reduced in that process it will pick up an electron from the surface and by picking up an electron. So this is the reducing electron and this

is the electron which is helping the Ceria to get oxidized. So this electron which it picks up it is a basically a recovery why surface chemical reaction, this kind of recovery is called recovery by surface chemical reaction or X is strands for the reaction.

So what is happening is 2CeO2 which is oxidation state 4, so it has to be slightly aqueous system ok, it forms Ce2O3+ 1/2O2 it is generating oxygen here. So realize in this whole process the recovery by surface chemical reaction. So this whole thing what I have put across here this whole reaction is in a auto mode or this is what Hackman seal highlighted upon like this is autocatalytic system ok.

And specifically this autocatalytic process has its own tremendous implications, what are the implications, will talk about it now. So this process what you are observing lead us to a situation where you have a finite amount of this material and it is just you know what we are talking about 3 or 4 atoms to ceria couple of oxygen hanging out, dangling out there, this gives us a situation where a very finite amount of material could continuously auto regenerate itself and reserves in performing antioxidant activity.

In other word what we are talking about is it has a pseudo infinite half-life, in other word because pseudo infinite half life. So, we will continue this discussion from here what are the physiological implications in animal body for a material which has a pseudo infinite half life, thank you.