Nanotechnology in Agriculture
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Lecture-27
Antioxidant Nanomaterial in Animal Production Part-II

So welcome back to the lecture series in nanomaterials in agriculture, so we are into the section of role of nanomaterials in animal production. So in the last class we started talking about one of the very early work I should say it is almost now 18 years back or near about 16 years I would say of one of the rare earth what they call us lanthanide series cerium Ce and I introduce you in which part of the periodic table you could see this.

And I highlighted one of the reactions of nano ceria where we highlighted upon 3 properties that ceria is autocatalytic follows an autocatalytic process.

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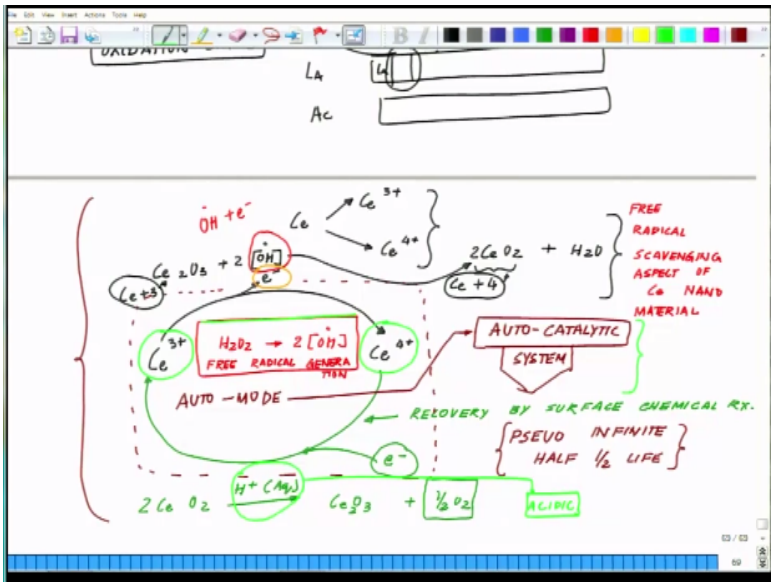

By virtue of which cerium 3 in oxidation state 3 gets oxidized to oxidation state 4 and it again travels back to oxidation state 3 by surface reaction or surface chemical reaction. And this of course need little bit of a H+ or in other word this needs slightly acidic milieu to make this happen. Now as I showed you it is generating free radical generation it does like this, so in other word when we talk about different antioxidant system natural antioxidant system.

So, just recollect back when I told you that there are people who started this and the pioneering people I would say if I have to highlight 2 to 3 names I would highlight (()) (02:03) so these are some of the very very pioneering people who started this whole area of you know (()) (02:16) around with cerium oxide nanoparticles.

And as I told you in the last class the autocatalytic mechanism or autocatalysis this terminology with the pseudo half-life. This whole concept was proposed by Heckman at that time which is almost 16, 17 years back now around 2000 I would say around 2004 when he propose this interesting idea. So what does that mean, what is the biological significant and where this could be utilize for therapy as well as it is annual production application and other biomaterial applications.

So in order to understand one has to first of all see what all antioxidant enzymes are there in our body. So let us enumerate the antioxidant enzymes which are present in nature ok.

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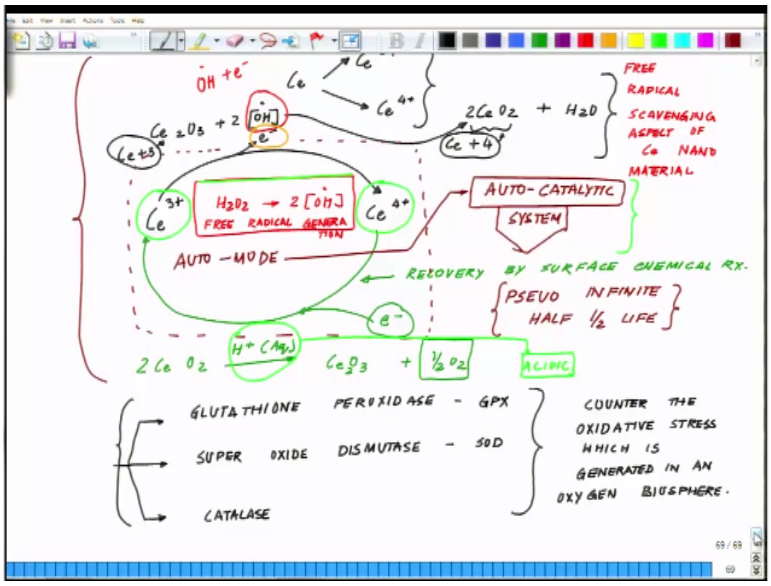

So, our body we are gifted with 3 antioxidant enzyme system glutathione peroxidase, superoxide dismutase which is in short they call it SOD glutathione peroxidase is GPX in short in the third one is catalase. These 3 enzyme systems evolve in order to counter the oxidative stress which is generated in an oxygen biosphere. So, from the time life system has move from anaerobic to the aerobic world, it is started depending on oxygen.

And because of the presence of oxygen it result in lot of oxidative stress and that is where nature develop series of antioxidant enzyme and these 3 are the key antioxidant enzymes which nature develops over period of time glutathione peroxidase, superoxide dismutase and catalase to counter the oxidative stress. Now there are several molecules what we used as food additives as they call it very frequently as antioxidants ok.

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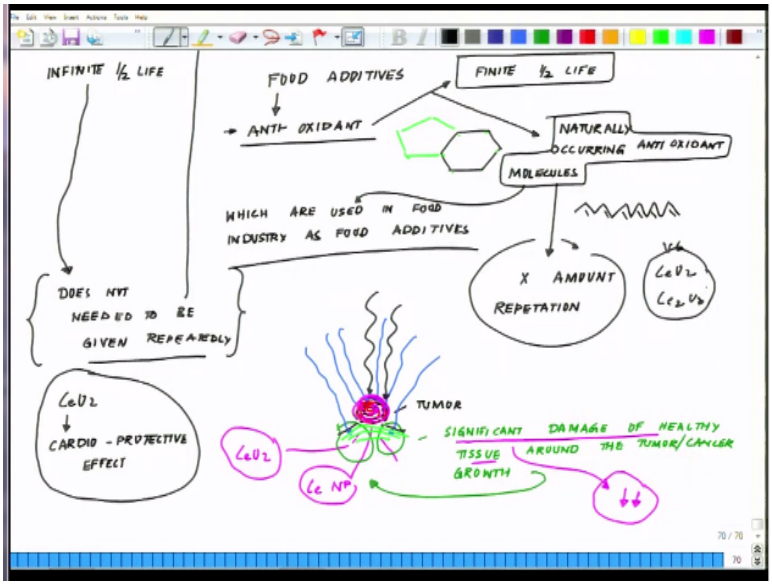

So, there are several you will come across food additives which are antioxidants and they are added in food, they are added in nutraceuticals all other things. But the problem with much of these molecules if you look at these molecules this will be bulky molecules like you know they will be organic molecule with bulky chains and everything, these are fairly bulky molecules which exactly does the same thing what you observe here in this reaction.

They takes away the pulls up or scavenge the free radical by getting oxidized, but now the problem with these kind of molecules are they have a finite half-life. Because once much of these molecules and we are not (()) (06:52) enzymes here ok. We are talking about the naturally occurring antioxidant which are used as food additives, naturally occurring antioxidant molecules which are used in food industry as food additives.

Now much of these molecules gets broken down over a period of time, and a very short period of time because they have a finite half-life, they cannot regenerate back most of them. So whenever we consume such things that you ensure that we are continuously taking back and of course they are continuously taking them what is the quantity, what is the amount it needs a lot of fine tuning.

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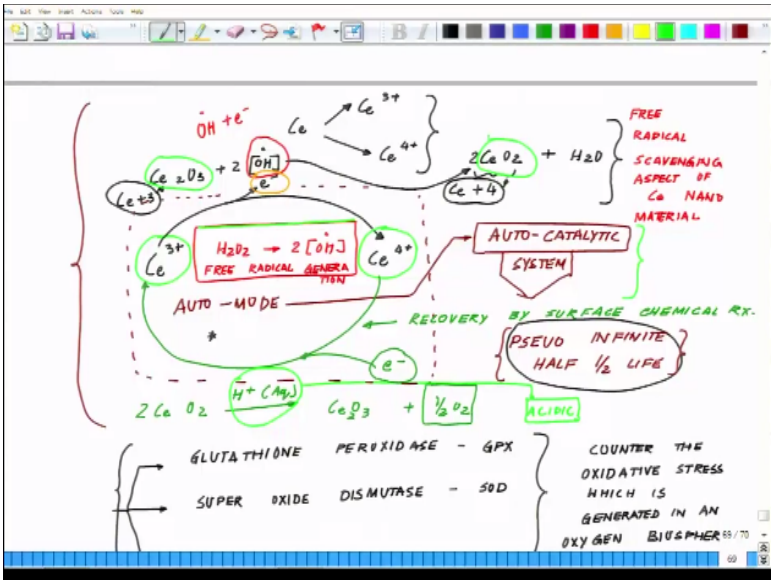

Now I propose a situation, situation something like this say for example we talk about something here, something which has infinite pseudo infinite half-life a molecule like this. So what is happening say for example for these kind of naturally occurring molecules if you are taking in your as a food additive say every time you are taking food if you are taking some X amount ok and this X amount is like you are continuously doing it in a circular fashion like you know you are repeating it or reputation.

Now I say for example something has infinite half-life as long as it is in the body, then this molecule which is infinite half-life does not needed to be given repeatedly. So in other word if the role of these antioxidant molecules which are we are using as nutraceuticals, we are using for healthy development, growth and so and so forth. We may not need them to be given so much in amount.

And giving a very small amount once or maybe twice over a period of time those particles will remain there and they will continuously they will be circulating in your body or those sit in different places and they will perform their antioxidant activity over a period of time, is it possible?. That is where the paradigm are slowly calling for a change will there be some kind of impact into the system which we have in throughout, well as of now they have not seen anything and will unfold the story.

So, what we are talking about is could we use these kind of a small molecule, extremely small with if you look at it this is like you know. This is out there 5 atoms, 3 oxygen, 2 cerium or if it is a state 4 and we are talking about 1 cerium and 2 oxygen like 3, 5 and 3 atoms. We are talking about something the way smaller then something which has lot of these you know benzene ring and like you know performing all sorts of antioxidant activity.

I mean even if you look at it there will be carbon, carbon, carbon, carbon, carbon, carbon, 6 carbon and another 5 carbon out there. So I mean those are huge molecules or you can even look for carotene which has like something like molecule like something like this with bunch of you know single and double bonds you know stuck together as compared to that if you look if you verses if you look at CeO_2, Ce_2O_3 likewise if you look at it, there is no comparison these are way way too small ok.

So now that was one of the very very early thought which tinkled around that is it possible to have these kind of molecules.

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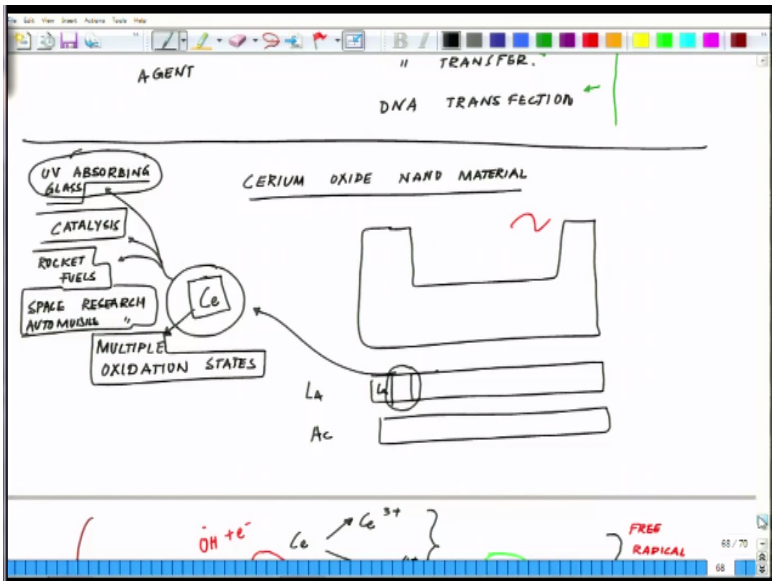

So, having said this I will add one more thing when I talked about Cerium I told you this is used as a UV absorbing. So the very first study which call the tension was it was used, so all of you were aware of the fact that cerium is being used for a sorry radiation is being used for cancer therapy ok. So say for example there is a tumor growth here. So, there is a tumor growth, so this is irradiated with strong radiation in order to you know destroy this tissue.

So now when you are irradiating that spot what is happening is that, so they help this part, if I show the red is the tumor growth then I am using the green color I am showing the healthy tissue and I am showing the radiation in say blue. So, what is happening is that how much so were localized you put the beam there will be beam which will be coming here and there will be significant damage of healthy tissues all around ok, significant damage of healthy tissue around the tumor or the cancerous growth or cancer growth ok.

So, this is fairly common, so one of the experiment very early experiment there is a wonderful paper and all as the paper for you guys read was. If you fortify these with cerium, it was observed that the death of the healthy tissue that significant damage of healthy tissue is significantly reduced. And you could really get rid of this tumor tissue without causing a lot of harm to the healthy tissue because of it is one property if you remember it UV absorbing.

So, this was one of the paper came from (()) (15:33) and so that to seal back in say 2005 or 2006 is a very very first paper in the field, thus people are tinkering at that time ok, very very first paper. So here is one compound which find the application in of course which is not mention here something like in the diagnostic tools and therapy.

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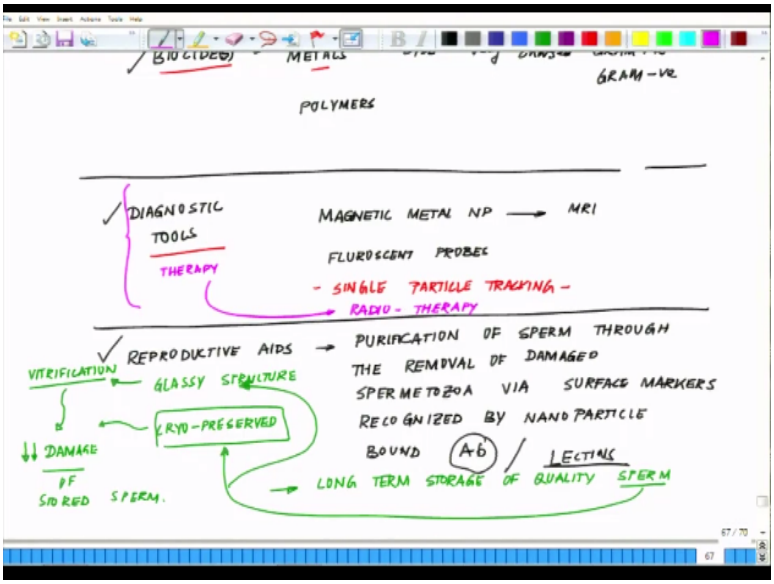

I am adding one more here especially in radio therapy ok and this is a huge problem across the world those patients where suffering from radiation related damage because of removing their cancer, removing their tumor, it is kind of a very tough story out there the amount of damage it causes. So that was the very very first paper in the field. The next paper which in that aspect came or that came from another gentleman (()) (16:43) much of this work happen in university of central Florida.

It is pretty much you can say that this molecule to gets rebirth in an around the area of the cave, canal overall and all that place where NASA has it is whole launching systems and sitting by the Atlantic in Orlando. So the next was came from (()) (17:11) grand old man what he found out that it has a cardio protective effect ok. The next study in that line CeO2 has a cardio protective effect, this was another very very interesting study which really called a hypertension.

Same time there were 2 studies which really put a firm footing above the mechanism of action of cerium.

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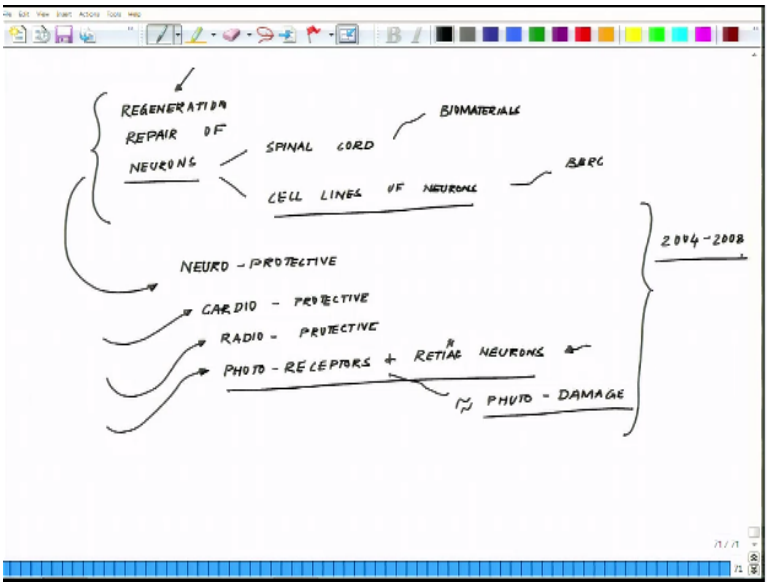

One was on regenerating neurons both of them are regeneration or repair of neurons of 2 places spinal cord neurons, adverse spinal cord neuron and this other one was for neuronal cell lines, cell lines of neurons. So, in other word, so the first time it was evolving that it has a cardio protective, neuro-protective and this all was except this cell line work which is published in BBRC and this was publish in biomaterials.

So cardio protective it has a role as a radio protective and simultaneously it was saying it was being highlighted that it has a interesting role in protecting the retinal cells will goes through lot of photo damage ok. The photoreceptors of the retina and not only the photoreceptors and retinal neuron where this tremendous amount of photo damage which is happening everyday ok.

So some of these studies laid the foundation stone during early I would say 2004 to 2008 that this molecule could be used for white array of applications. So will continue our story that how these thing shaped up, some of the very unique applications in animal world, thank you.