Bio-energetics of Life Processes
Prof. Mainak Das
Department of Biological Sciences & Bioengineering & Design Programme
Indian Institute of Technology, Kanpur

Lecture – 12
Photosynthesis-II

Welcome back, to the second lecture of the third week, which is essentially our put it down lecture.

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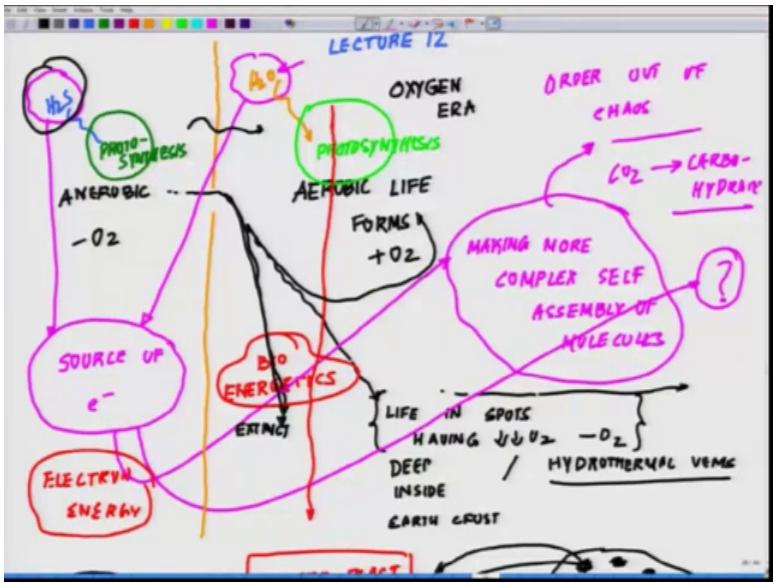

So, this is week 3 lecture 2 and this is our total lecture number wise this is lecture 12 ok. So, in the previous lecture, we talked about the deceptively simple reaction of photosynthesis where, you saw the water molecules react with carbon dioxide leading to the generation of carbohydrate, which is mostly sucrose, glucose and as a byproduct as oxygen .

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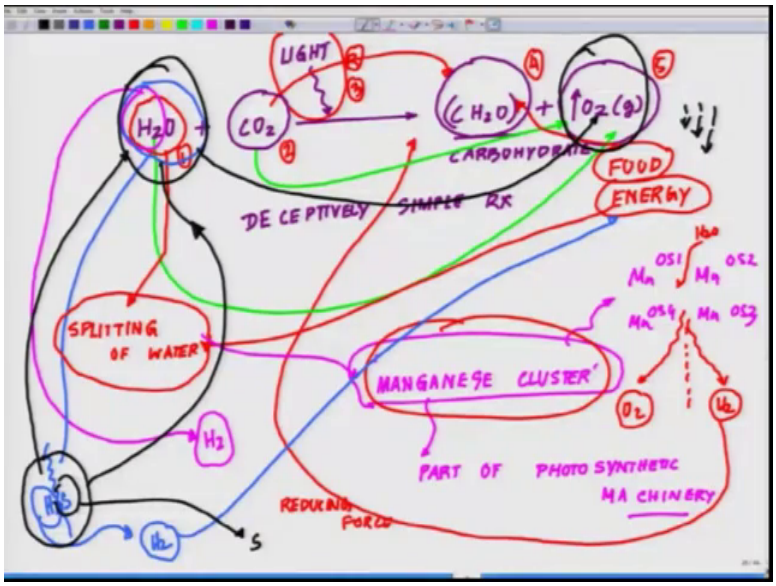

As a matter of fact one thing, I did not mention is the first kind of photosynthesis never used water it was using H2S I have already highlighted, that part in the previous class and it is very interesting you can look at nature in a very interesting way, that nature need it a perennial source of electron or a infinite source of electron to build up an order out of chaos what does that mean is? It needs that electron power all the time to develop more organized molecules like, from carbon dioxide to carbohydrate, which is much more well assembled self assemble stable molecule.

So, in order to generate, that kind of orderly molecules you needed an infinite source of electron and nature always hunted for infinite source of electron, why H2S? In the first place. So, think of the Earth's surface billion of years back it was extremely harsh there was no UV protection lot of sulfur, lot of H2S, lot of obnoxious gases and their nature picked up H2S because, it was in abundance though, water was there maybe nature decided to pick up H2S and nature developed machineries, which could break H2S or which could split H2S.

So, as earth was cooling down as things were becoming much more close to what life form? What we see today? As things were slowly slowly you know coming down. So, do the source of H2S sulfur dioxide and all these things were slowly you know coming down because, the temperature was now lowering and nature faced a situation of dearth of H2S and possibly it is one such moment in our history or in our evolution of life itself

nature had to search a nature search or discovered, that a very similar molecule like H2S is existing in its own armory, which is water and exactly the same way it is split H2S if it learns to split water then, it can do wonder because this water is abundant in nature.

So, possibly the jump from H2S to water in the story of life as a source of electron energy is one of the most critical step, which changed the scenario of floor of earth, why it changed? Now, let us assume somewhere or other by some mechanism from H2S it will learn to split water ok, which is perfectly fine here the byproduct was sulfur and hydrogen is being used for all the reduction and everything. Now, you switch over to H20, once you switch over to H2O you generate a molecule called oxygen a strong strong oxidant.

So, that brings us to a world where, all the life forms which were used to live in a very reducing environment now, faces a new set of challenge of slowly earth was getting rich in oxygen and those species, which could not handle this new class of oxidant the oxygen were wiped out from the floor of earth they, got extinct or or they started living a life of extremely lack of oxygen environment a reducing environment something like hydrothermal vent, something under the earth crust, somewhere where, this particular molecule oxygen is not really present or maybe present in a very very low concentration.

So, that shift from H2S to water mark the beginning of what we call as aerobic life forms the journey from anerobic, which is minus oxygen environment to a plus oxygen environment and all these anaerobes now, either they got extinct or started having a life in spots having very low oxygen or no oxygen. So, this is where you see places like, hydrothermal, vents or deep inside the earth crust and they are a bacteria, which can do it, which can make food from H2S.

So, if you now fit in the concept of photosynthesis out here. So, there are two kind of photosynthesis a photosynthesis which existed here , and which was dependent on molecules like H2S and another set of photosynthesis, which we see today which is here, which depends on water and this is that, shift from anerobic to aerobic life forms. So, the photosynthesis what we will be dealing? So, what is critical point? What I was trying to make is? If you look at nature carefully these two are common thing what are those? Those are source of electron.

So, nature runs and this is what I am trying to highlight source of electron in making more complex self assembly of molecules, and that essentially brings us to if you remember the last week order out of chaos or this is where, you see molecules like CO2 is making carbohydrates, which are much more organized bigger molecules.

So, it means nature has to run its machinery, it needs to continuously provide the perennial source of electron time to time and we now, live in a world which we do not know? How long how many millions of years are whatsoever? We live in a world where, we are totally dependent on water, but if one day just imagine the water is no more there the another whatever in happens in the universe then, again nature will look for another source of electron, which we do not know what it will be, but nature will continuously look for source of electrons.

So, this is what I was trying to tell you as electron energy, and which is governing our whole energetics or the bioenergetics what we are dealing in this course? Now, coming back the first thing out here, this part of photosynthesis when we are talking about this part of photosynthesis happens in an organelle called chloroplast it is called chloro because, when you look at it inside a cell you will see colorful spots you will see a contrast or black and white suppose, you see the cell under the microscope a plant cell. So, here you have the nucleus which is prominent structure.

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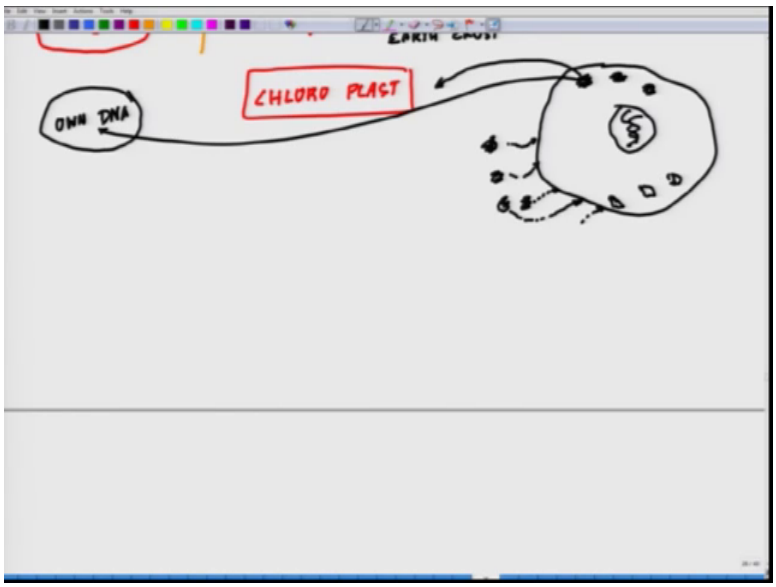

So, you see which are your chloroplast ok. So, now, chloroplasts stand alone as I have told you carries its own DNA and this is where, it is believed that some words at some point or other these chloroplast were independent organelle and possibly these chloroplasts have parasitized the plant cells and possibly, why they have parasitize the plant cell? It is believed again this event has doing something to do as it is being as of now, speculated when we move from in a rope to aerobic lifestyle

Maybe these chloroplasts held a possibility to split H2S, but then as earth was ushering into the oxygen era now, these chloroplasts had two options either they get extinct, which happens to many species or it is somewhere other tricked into the game by getting parasitized into the aerobic life forms, which could withstand a newer kind of environment or those from in anerobic became aerobic something, which we have absolutely no clue and possibly that is where, an independent organelle otherwise independent species like chloroplast, parasitized something like, a plant cell and become part of the plant machinery.

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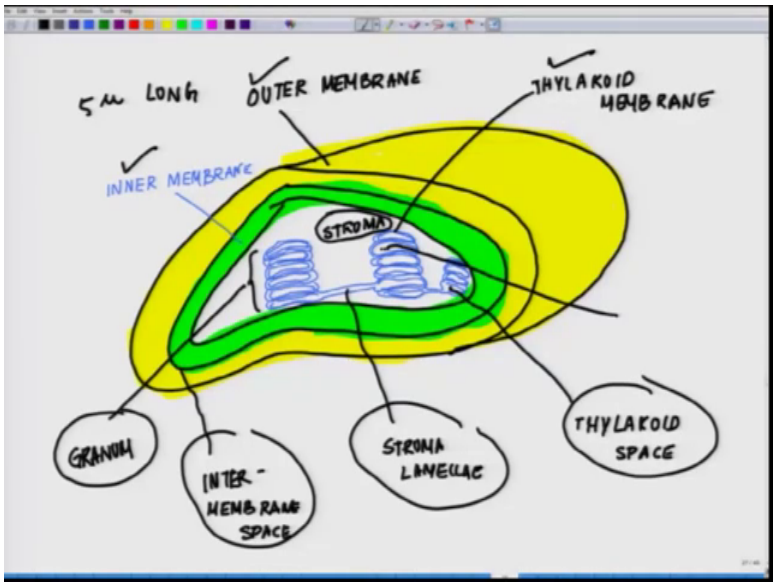

Now, how this looks like if you look at the structure of the chloroplast in nature. So, the chloroplast is something like, it is a double membrane structure and something like, this this is the cross section I am drawing of chloroplast ok. So, this has inner membrane, which is out once again ok. So, this is the inner membrane of the chloroplast. So, this is

and this membranes the structure is very important as we as we I will move through you will realize it and then, you have an outer membrane which is something like this .

So, just like any other cell which has a double membranous structure chloroplast is no different. So, this is how a cross section of the chloroplast looks like. Now, inside the chloroplast if you look at it you have very interesting cross sectional structures, which are something like this , something like this a very stacked structure and these this stacked structures are also double membranous something like this ok.

Now, if we look at these structures they are also as I told you they are also double membranous like this, and these double membrane repeatedly I am telling you this is one of the central common theme of energy production as we will talk about these double membranous structure holds our series of proteins on its on its matrix as we will see through, which are involved in several energy transaction processes ok.

Now, let us put in. So, this is our inner membrane then, you have a outer membrane further this part is called the stroma and this whole thing is called the granum, this is the inter membranous space somewhere, in between inter membrane space this is called stroma lamellae and this is called thylakoid space the space in between you see those blue dotted blue lines thylakoid space and this is called thylakoid membrane and if you look at it chloroplast.

The organelle of photosynthesis are typically 5 micron long ok, this is the kind of dimension and it is very similar to mitochondria it has an outer membrane and an inner membrane with an intervening inter membrane space the inner membrane surrounds a stroma containing a soluble enzymes and membranous structure called thylakoids ok, which are flattened sacs a pile of these sacs are called the granum as you could see this is the pile of those sacs, which is called the granum and the different greena are connected by region of thylakoid membrane called stroma lamellae, which is connecting these different greena and the thylakoid membranes separate the thylakoid space from stroma space ok. So, if you look at it the thylakoid membrane separate the thylakoid space from the stroma space thus, chloroplasts have three different membranes it has an outer membrane, it has an inner membrane and it has a thylakoid membrane ok.

So, outer membrane, inner membrane and a thylakoid membrane and three separate spaces; one of the space is the inter membranous space, which is between the two

membrane outer membrane then with stroma, which is this is space and then, you have a thylakoid space which is out here thylakoid space ok.

So, in developing chloroplast the thylakoid arise from invagination of the inner membrane and so they are analogous to the mitochondrial structure where, you see structures like cristae in the mitochondria. So, this is the overall architecture of the chloroplast.

So, I will close it here, in the next class we will talk about the initial reactions of photosynthesis.

Thank you.