

Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

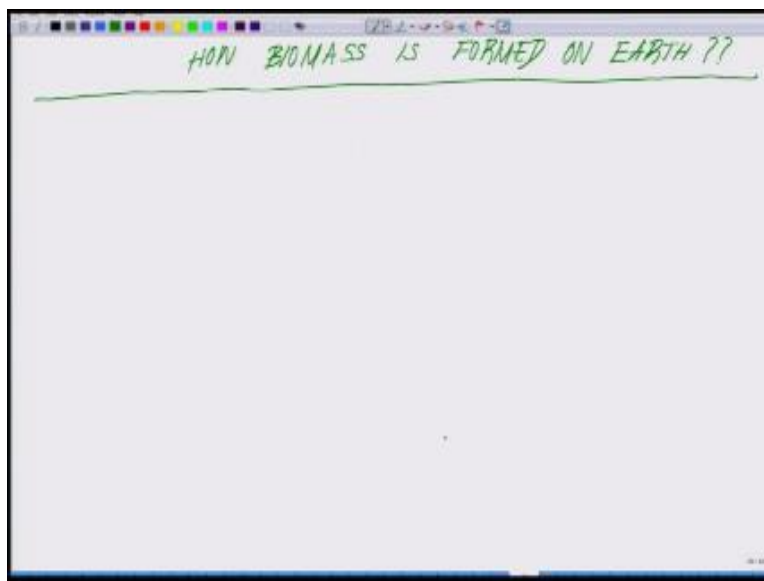
**Course Title
Bioenergy**

**Lecture – 04
How Biomass is Formed on Earth**

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So welcome back.

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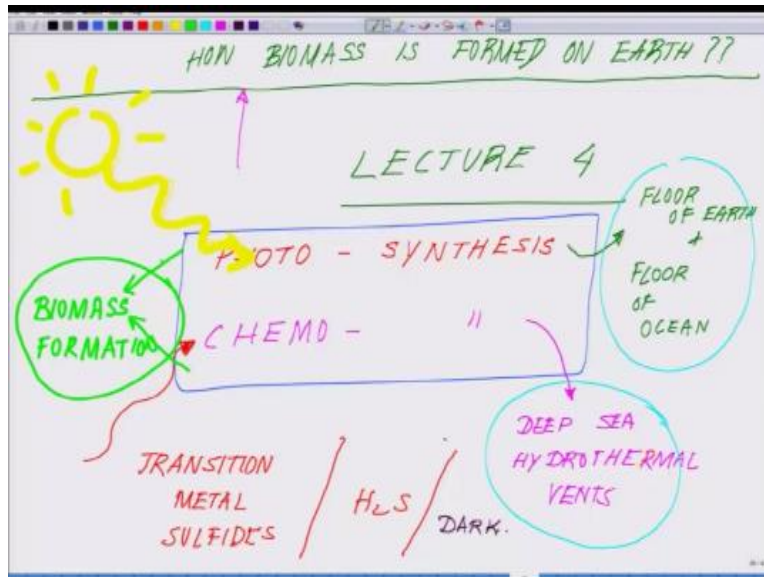
So let us start the lecture four we will be talking about how biomass is formed on earth. So the most fundamental or the most basic source of energy on life for life surviving on earth is sun. So it is the sun energy which is critical in the formation of biomass on the floor or earth, but is that the only route.

So any conversion process involving sun we call it falls under what we call as photosynthesis which essentially if you split the words like photo and synthesis a light dependent synthesis of bio molecules or evolving life forms a light dependent synthesis of life falls under photosynthesis. So it means that essentially means light is falling on the surface of earth and anything which grows on surface of Earth or surface of water bodies are photo synthetically driven.

But is that the only route actually it was believed for a long time that is only route but apparently their discoveries in late 1970's and early 80's of hydrothermal vents which are deep under the sea where no light ever penetrates their life which bubbles there in those vents. And that gives birth to another form of evolving life which is called chemosynthesis. So which are dependent on lot of sulfide rich transition metal sulfides, hydrogen sulfide it is a very, very tough environment.

But yet life survives there and probably a life-form which was very similar to the life which existed when the earth was formed and a life-form which is possibly very similar to the life forms or any form of life if at all exist in mars in the planet mars which is that is why it is also called the Martian form. So let us start this topic with two terminologies and how they lead to the formation of biomass and the whole global spectrum of things.

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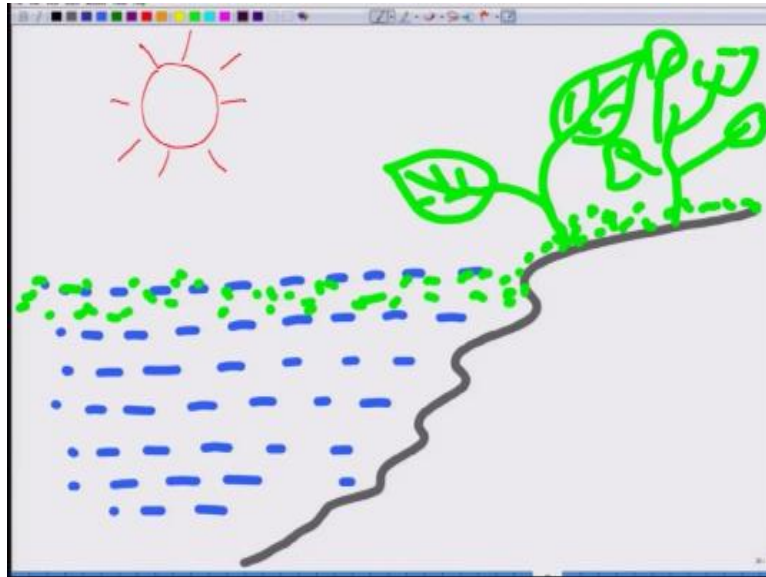


So let us get back to the slide so our central question for this lectures four is how biomass is formed on the planet of earth. And just now I described two words one which is photosynthesis and the second word what I used is chemosynthesis, these are the two words or two processes so one is a light dependent process where sun is involved, the other one is purely, purely chemical dependent processes which includes transition metal sulfides.

And we will talk more on this transition metal sulfide H₂S hydrogen sulfide and the zone where such thing happens. So if you see the location this all these things happen under deep sea hydrothermal vents, whereas when we talk about the life which is going on the floor of earth or ocean floor, so they are on floor of earth and floor of ocean.

So location wise if you look at them this is all on the surface this is all into the very, very dark places underneath the earth and both these processes have one common thing they both lead to biomass formation and of course, they follow very different strategies for biomass formation light-dependent synthesis which is photosynthesis leads to the formation of biomass okay.

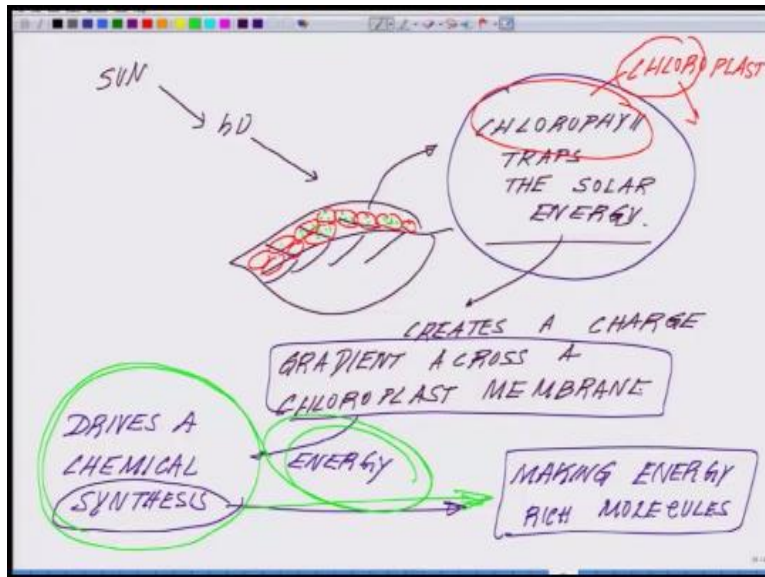
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So coming back to the slide again so here is our perennial source of energy the sun and here we have just okay, so this is the land mass and this represent the water bodies okay, and as we are going down on the depth and this is the whole plants and all other different life forms which are growing on the floor of earth and you have this lot of algal population which is kind of growing close to the surface of the water.

And all this green biomass which is going okay, so what is happening here in all these cases what we are talking about light energy is trapped the sun solar radiation is being trapped by a solar harvester which are the leaves or any green pigment which constitutes of chlorophyll okay. They trap the solar energy, so you are trapping the photons and in that process after trapping the photon there is something called a membrane where a gradient or a kind of a battery is being created through which you drive our chemical reaction.

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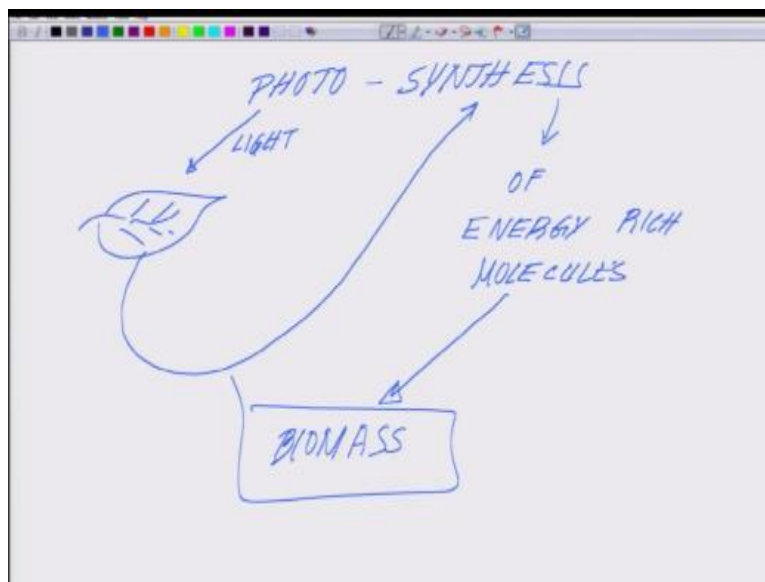
So let us write it down standing so you have sun which is giving you the solar energy so here you have green pigments of chlorophyll which are present on will coming in detail how they are present. So they have chlorophyll, so chlorophyll traps the solar energy we will talk about all the details how they do so and what are the significance of it.

But just at this stage kind of get an idea trap the solar energy and creates charge gradient you can call it across a membrane of chloroplast membrane and we talked about all these things so do not get worried because we will take time to discuss each one of these processes how it is happening, and the energy which is generated because of this chloroplast membrane drives a chemical synthesis.

And as you could see it is a synthesis process so you are making things of making energy rich molecules okay. So solar energy so there is we are a very specialized organ called chloroplast those chloroplasts so let me just get getting back to the slide these chlorophylls are present on chloroplast they are named as chloroplast because they are if you look them under the microscope there is a color pigmentation.

So this chloroplasts are present so if the plant cells are like this if these ones are the ones which are constituting the plant cells. So the chloroplast within the plant cells are present like this will come later about the structure of the chloroplast within the chloroplast you have the chlorophyll molecules and across the chloroplast membrane energy gradient is being created that energy gradient generate sufficient energy to see out here which drives the chemical synthesis to make energy rich molecules.

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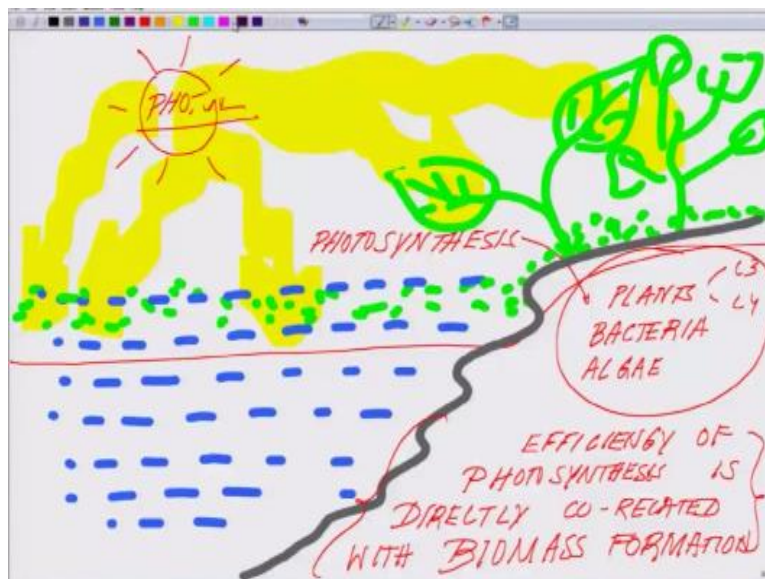


And these energy rich molecules eventually which are produced there once again in the process what we are describing the photosynthesis so let us just split it photo or light through this you are generating, synthesizing synthesis of energy rich molecules and that those energy rich molecules constitute what you call as biomass, so does that make sense.

So you have the solar energy falling on a solar panel biological solar panels are leaves, on the leaves there are specific solar energy trappers called chloroplasts present inside the plant cells there are numerous chloroplast those chloroplasts consists of a membrane and a light trapping molecule called chlorophyll will come in depth into each one of those how they look like and how they function.

Those chlorophylls which are present across the membrane of the chloroplast converts that light energy into a form of a charge gradient and that charge gradient generate sufficient energy for the synthesis of the biomass.

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So now if I go back to the very first slide where I was talking about this situation so this is what is happening. Now this light energy which is falling on these is the one which is governing the formation of biomass okay. And this whole thing falls under the whole area where so here is the source of photon or photo sources which are governing the process of photo in phases okay is it clear.

And further we will talk about how this photosynthesis process what are the mechanism thought but that gives you an idea that if the photosynthesis efficiency is more then there will be more and more conversion of light into biomass and that will bring us two different kind of life form whether it is, so photosynthesis get light so different kind of plants, bacteria and algae.

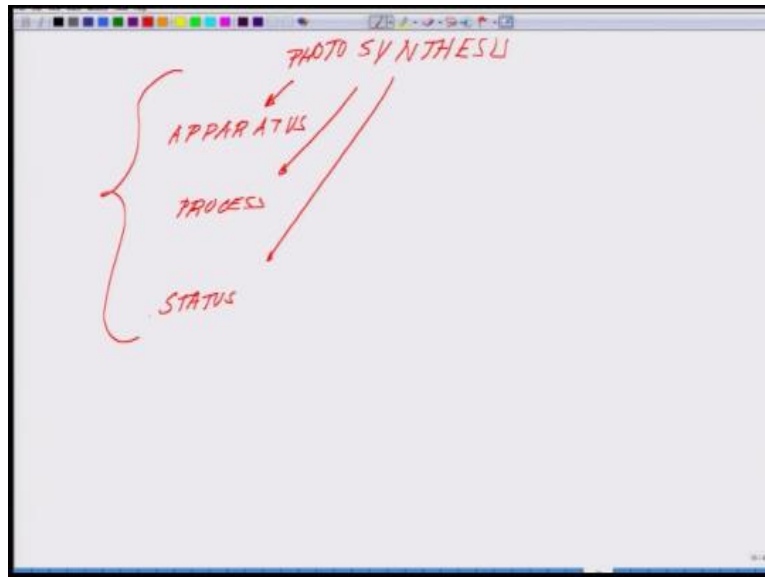
And within plants will talk about C3 C4 so what is the take home message is very important here the efficiency of photosynthesis is directly correlated with biomass formation. This basic concept is very important for all of you to understand whenever we talk about bio energy why it is so multi-dimensional you have to understand photosynthesis what are the new answers of it, what is the significance of it and where it matters the most.

So if you have efficient plants which consumes less water and it are exceptionally good for the synthetic apparatus then and have a higher efficiency than they are better off say for example, just for an example think of it take your imagination stretch it those who have travel in the desert say in Thar desert in Rajasthan or any other design as a matter of fact across the world you will see there are specific vegetation which grew thorny bushes.

So think of it for a minute there is hardly any water and yet those bushes are functional there we are working, they are tracking solar energy in spite so it means these are the plant which could be a very good source of biomass, because they could efficiently convert a lot of solar energy even in the absence of water or scarcity of water in the absence of water we will be wrong with you in the scarcity of water.

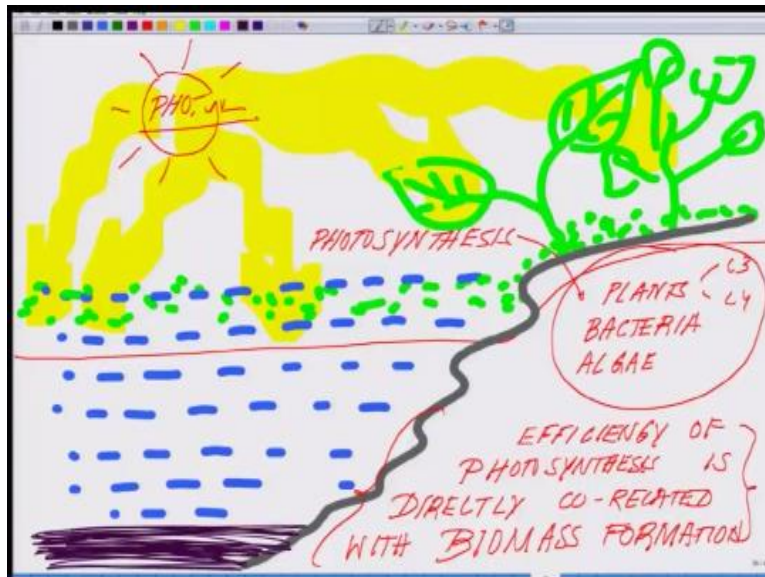
So if we know how hardy those plants are and you see could really you know bring some of those qualities in producing biomass, in producing plants over a large area then we can produce more biomass with higher efficiencies and we will talk about all those things. So in this part of photosynthesis which will be phase two of the part 2 of the course will be dealing with we will talk about the photosynthetic apparatus.

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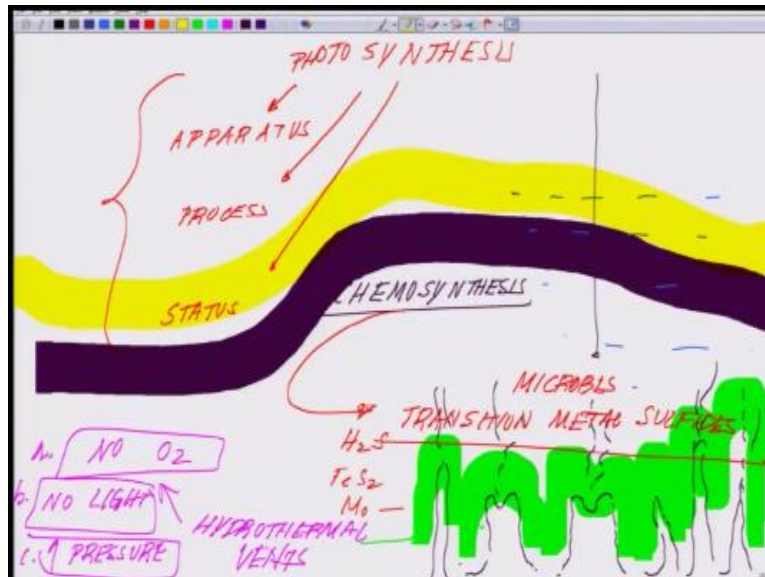
So this is what we will talk about once again yeah, so we will talk about photosynthesis we will talk about the apparatus, we will talk about the process and we will talk about the current status photosynthesis. This is what we will be dealing with.

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But having said this in the beginning I told you something else there is another life-form which survives somewhere out here where no light energy reaches that some kind of drawing it in dark okay, this is out here deep inside the hydrothermal vents.

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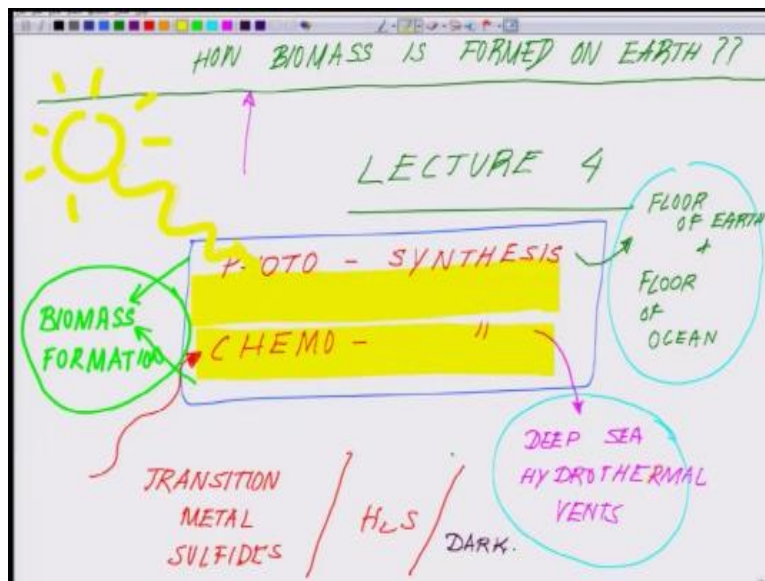
So that is what we talk about that chemosynthesis, so what happened in that situation is deep inside the ocean floor in the bed of the ocean floor you will see these kind of structures from where lot of there are these are called brown and white smokers. So lot of magma, lot of sulfide rich gases which comes out deep inside so this is we are talking about many, many miles underneath into the ocean floor okay.

So that is where you will see lot of life-forms are growing around it like this in the hydrothermal vents. So these are the hydrothermal vents where you have no oxygen no O₂ you have no light no oxygen no light you have high pressure yet life thrives in this region out here life is thriving. And this could be a big inspiration and I will dedicate one of the current operations by the way just to rehash there is a lot of H₂S, FeS₂ molybdenum there are a lot of transition metal sulfides.

And there are very specific microbes which are grows here and this is the whole world of the dark world off. So this is the dark world of chemosynthesis and upper one is the bright world of photosynthesis. So these two are the processes which will be discussing and especially with the chemosynthesis in the later half are we talking about some of the molecules which could promote the biomass formation okay.

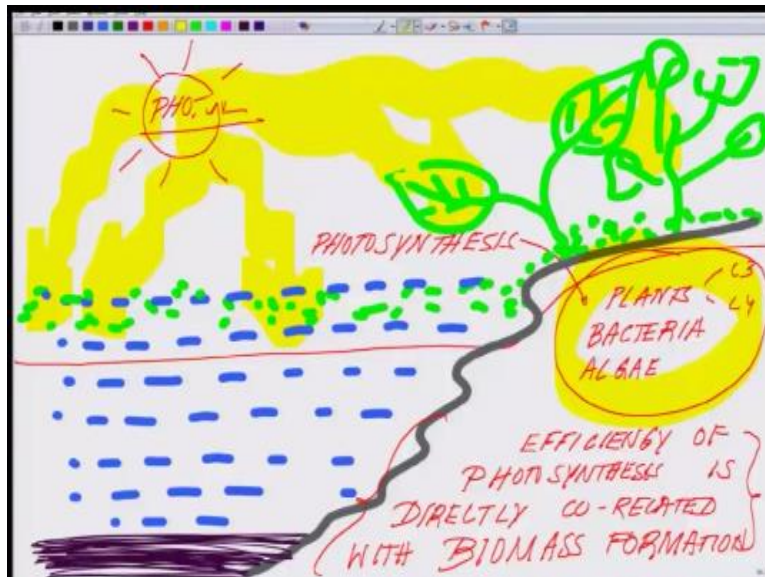
So this is the overall architecture of chemosynthesis and photosynthesis which are helpful in the production of biomass across the floor of earth okay. So this is where I will be concluding my this lecture where we talked about let us summarize what we talked about.

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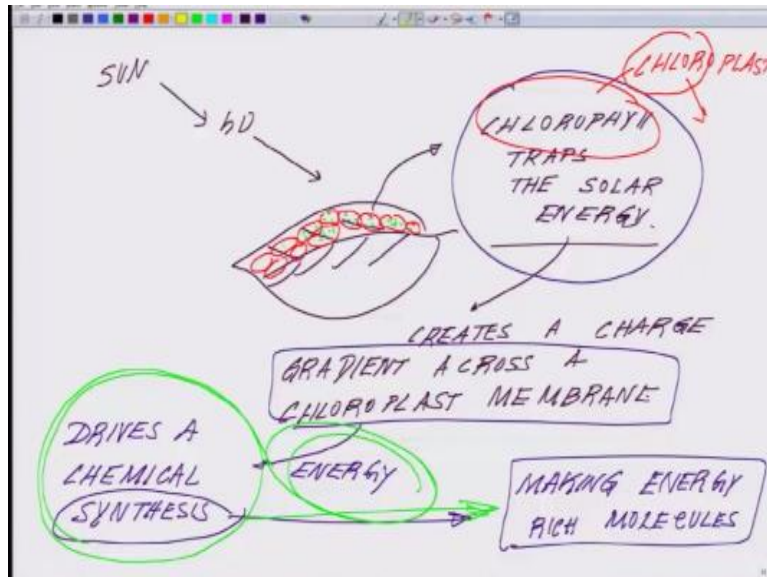
We talked about one second we started our lecture how the biomass is formed. So we talked about photosynthesis we talked about chemosynthesis okay. So the floor of earth which is filled with and the deep sea hydrothermal vents where we talk about chemosynthesis and photosynthesis which happens on the floor of earth and floor of ocean.

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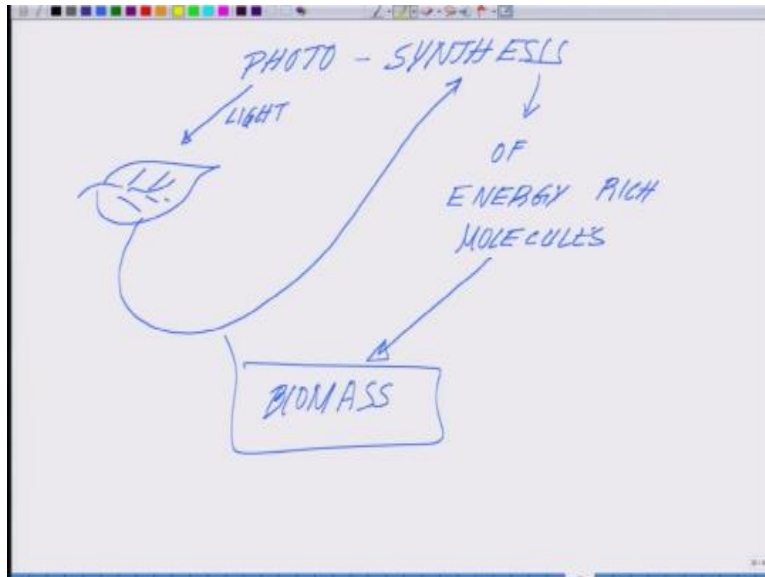
But the whole idea was biomass formation and then we talked about all the different life forms which are involved in it plants bacteria algae microbes and so many other things.

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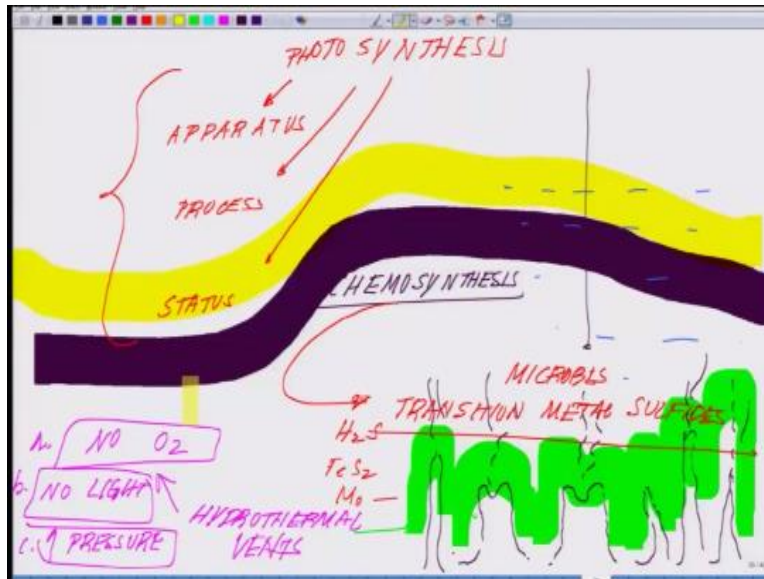
Then we talked about the process the overall process how photosynthesis happens.

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From there we talked about how we kind of split the word photo and synthesis of the energy-rich molecules.

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And then we talked about the life form at the darker zones of the earth okay. So I will close in here moving on to the lecture 5 thank you.

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