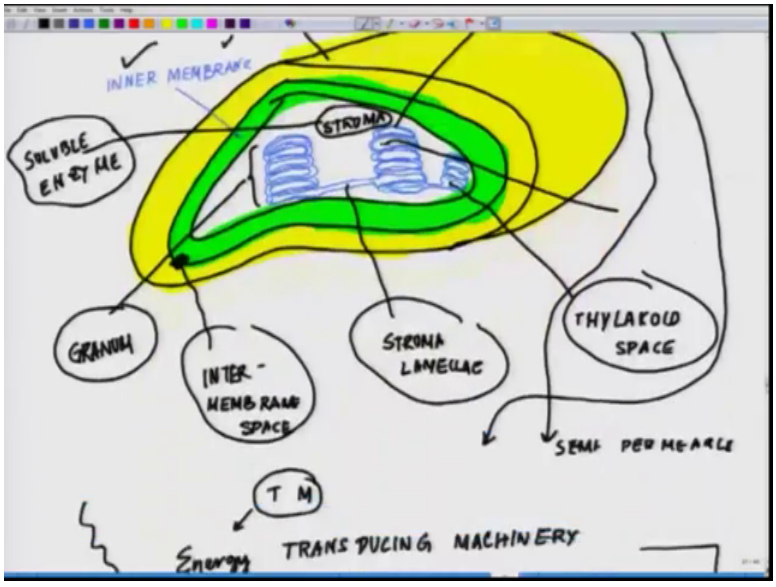
Bio-energetics of Life Processes
Prof. Mainak Das
Department of Biological Sciences & Bioengineering & Design Programme
Indian Institute of Technology, Kanpur

Lecture – 13
Photosynthesis-III

Welcome back to the third lecture of the third week of bioenergetics of life processes. So, in the last class we talked about the structure of the chloroplast knight, told you that where possibly chloroplast may have parasitized the transition from anaerobic to the aerobic world and possibly somewhere out there, those organelle which were getting extinct somewhere or other encapsulated themselves in an surrounding and some way or other we really do not know how that possibly have happened, but that is what at least with the intellectual ability of mankind we as a race contemplate.

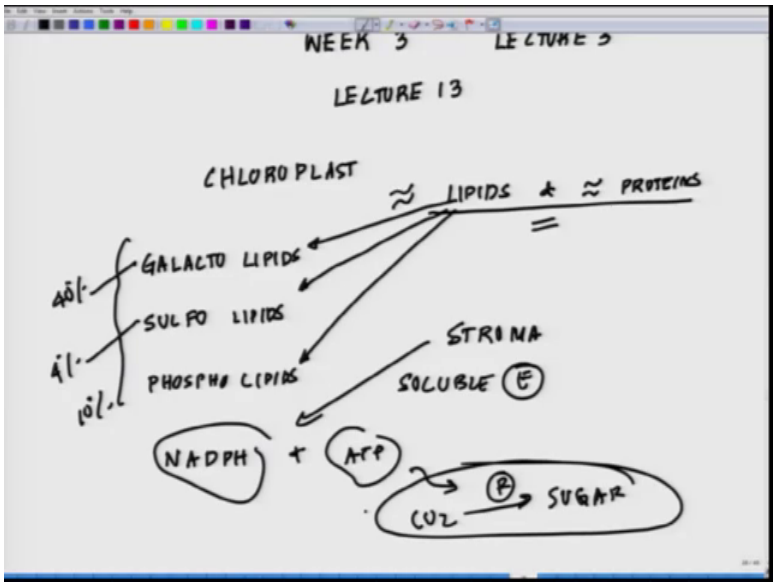
So, coming back to the structure of the chloroplast, so this is what we what we talked about? The chloroplast has 3 different kinds of membranes the inner membranes. So, if you look at it the inner membrane.

(Refer Slide Time: 01:17)



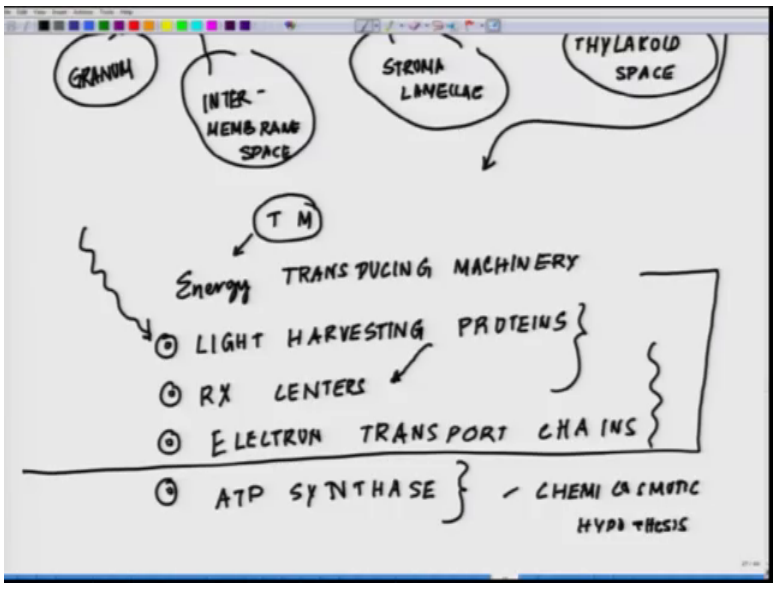
The outer membrane and the thylakoid membrane and we talked about 3 different kind of spaces; the space between the inner and the outer membrane between this green and the yellow, then you have a space the stroma, which is the space and then you have the thylakoid space which is between the thylakoid membrane

(Refer Slide Time: 01:45)



So, today let us let us resume our week 3; lecture 3 and in sum total this is lecture 13. So, if you look at the chloroplast, so chloroplast acid; the thylakoid membrane contains the look the energy transducing machinery. So, it is out here the thylakoid membrane which has the TM or thylakoid membrane.

(Refer Slide Time: 02:30)



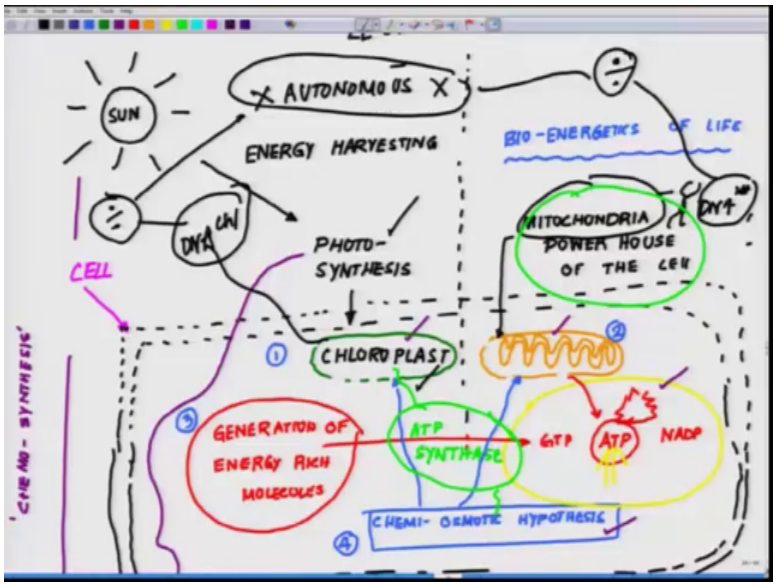
This contains the energy transducing machine machinery energy transducing machinery and which is essentially these are the point which light harvesting proteins light harvesting proteins, then you have the reaction centers or x is the reaction reaction

centers then you have electron transport chain electron transport chains and you have atp synthase.

So, now if I have to put it together, so this is where light harvesting we talked about, this is where how this is translated into the reaction center and this is where the whole flow of electron is happening and then the synthesis atp synthase. So, which is and this is governed by again there chemi os smotic hypothcsis.

So, if you look back where we started the show for this week.

(Refer Slide Time: 04:35)



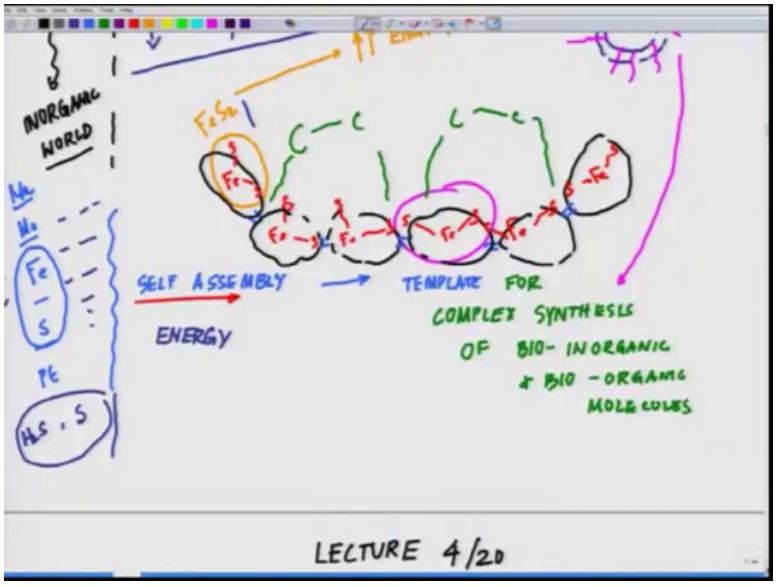
We talked about the photosynthesis talked about the chloroplast and the generation of energy rich molecule out here, which is now let us fit in atp synthase governed by chemi os smotic hypothcsis and another system which is mitochondria which is non light dependent and it does it in a different way and we will talk about it. So, this is when in the global scheme of things false. So, that is why I did not introduce slowly I wanted to come and now 80 percentage when you talk about in the chloroplast it is in that thylakoid membrane where it is located. So, it is in the thylakoid membrane where atp synthase is present ok.

So, and if you really look at the chloroplast they have nearly equal amount of lipids and protein and the lipid composition is highly distinctive, about 40 percent of the total lipids are galacto lipids and 4 percent are sulpho lipids and what are the significance we really

do not know. So, very well and 10 percent are phospholipids and which has nearly equal amount of almost equal amount of lipids and proteins, that is what makes up the thylakoid membrane and thylakoid membrane like the inner mitochondrial membrane is impermeable to most of the molecules.

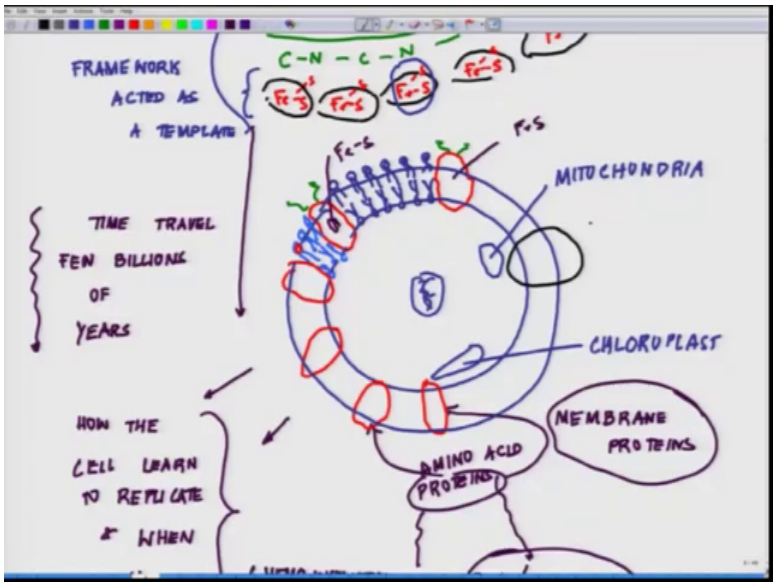
So, if you look at this thylakoid membrane this is very similar to the cell membrane which is semi permeable. So, if you go back to the first week lectures, when we talked about like let me see if I could really take you back there when I talked about.

(Refer Slide Time: 07:00)



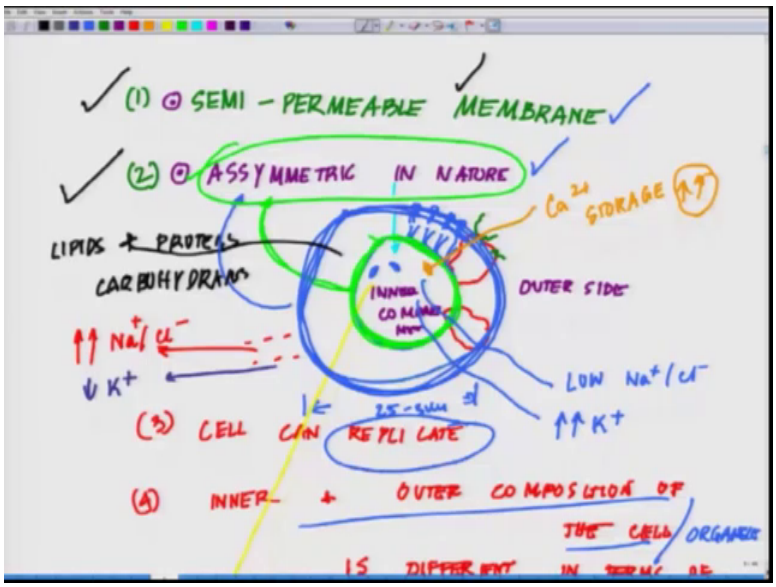
Making of the membrane template for complex synthesis and self assembly of making these kinds of membranes which are formed, so possibly these membranes now this is where it was.

(Refer Slide Time: 07:14)



These kind of membranes have learnt to be semi permeable or selectively permeable. So, how they learn this is another very interesting story ok, but this fundamental concept.

(Refer Slide Time: 07:30)



If you recollect when I told you that all these membranes are semi permeable in nature and they are asymmetric in nature, and now I am adding 1 more thing; they are made up of lipids and proteins and with some form of carbohydrates.

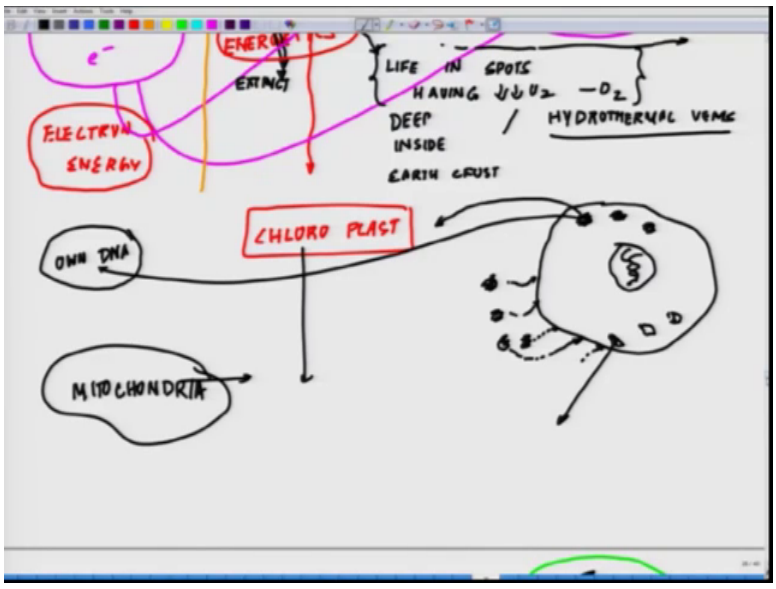
So, now talking about thylakoid membrane, now let us come back and again start where we were. So, it consists of equal amount of lipids and proteins and the lipids are either

galacto lipids, salpho lipids and phospho lipids, at different composition where you have 40 percent of the lipids are galactolipids , salpholipids are around 4 percent and 10 percent are phosphor lipids. thylakoid membrane the inner mitochondria marine is impermeable to most of the molecules and iron; the outer membrane of the chloroplast like that of mitochondria is highly permeable to small molecules, which is we are talking about this outer membrane is permeable to small molecules and ions; the stroma contains soluble enzymes; this is the stroma, this is a region which contain all sorts of soluble; and when we talk about soluble we are talking about water soluble, soluble enzymes ok.

That utilized NADPH and that utilize the NADPH and ATP synthesized by the thylakoid membrane. So, what these enzymes are doing is that these solubilized enzymes. So, the stroma contains soluble enzymes that utilize the NADPH and ATP at the stroma, the soluble enzymes are utilizing this NADPH and the ATP in order to convert the CO 2 into sugar, this is where the conversion of CO 2 to sugar is happening which is the reduction reaction and the chloroplasts contain it is own DNA and it is own machinery for applicating and expressing it.

However chloroplast like mitochondria are autonomous are not autonomous they also contain many protein encoded by the nuclear DNA. So, somewhere or at some point or other after getting parasitized these organelle chloroplast or mitochondria.

(Refer Slide Time: 10:30)

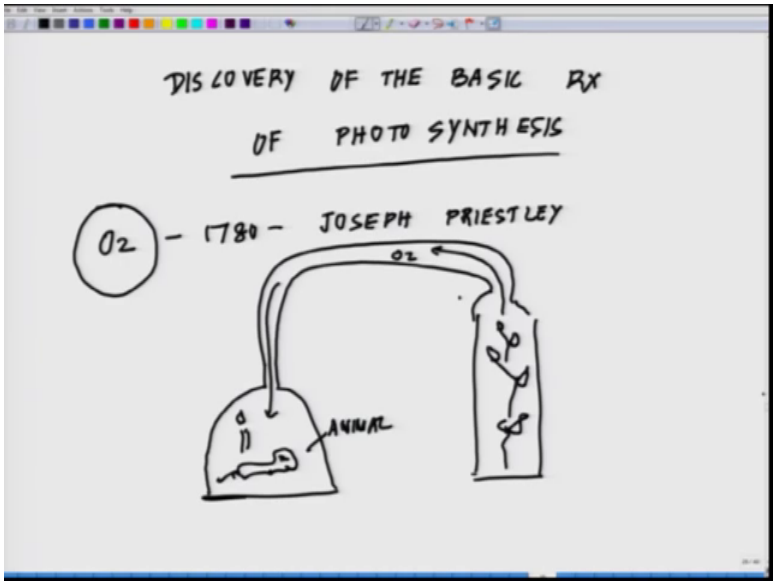


So, this is again other organelle what we will be dealing with about I mentioned once again mitochondria, these 2 are believed to have parasitized the bigger or some other cell.

So, now though they have their own DNA or own genetic material, both mitochondria and the chloroplasts ; it is once again this is empty DNA which is the mitochondrial DNA and chl DNA is the chloroplast DNA though they have their own DNA, but interestingly and the code they code us and it is that their DNA which is responsible for the replications and everything, all their division is carried out by their own DNA. Yet they are not competent enough to have a autonomous existence, they cannot survive independently that is the cost they have paid by parasitizing themselves into another host.

So, they lost their ability to have an independent existence unlike possibly they used to have at some point in distant past ok. So, now having said this about the chloroplast now let us move on to the basic reactions of discovery of the basic reactions of photosynthesis ok.

(Refer Slide Time: 12:34)



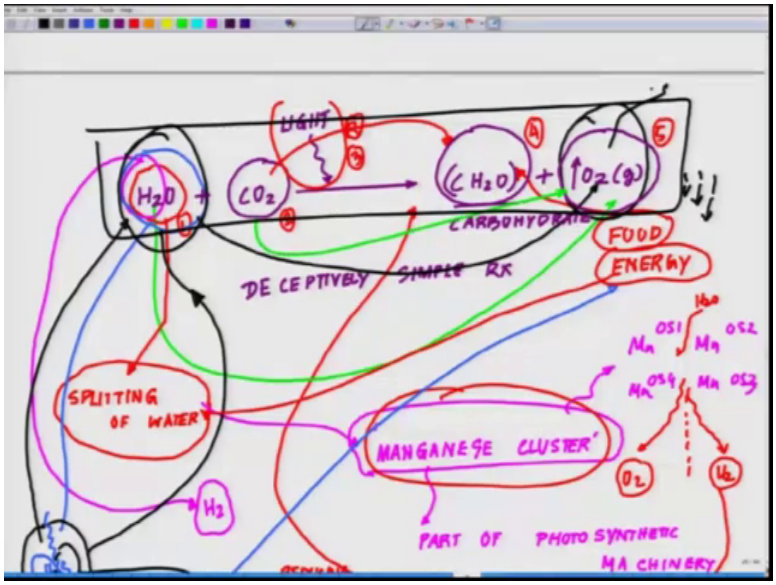
Discovery of the basic reactions of photosynthesis, so if you look at most of the basic equations of photosynthesis could have been written at the end of 18th century, the production of oxygen in photosynthesis was discovered in 780 by Joseph Priestley.

So, Joseph Priestley basically he found that the plants could restore air which has not been injured by the burning of candles, basically a simple experiment they did that whatever is coming out from the plant and he basically could help the life to survive ok. So, priestle has this classic experiment where you have say for example, you have a plant in a chamber where you have a green plant growing and this is connected to that is bell jar where you have an animal surviving ok

So, essentially the plant is giving every oxygen and this oxygen is helping this animal to survive, now if you burn this so basically he found that the plants could restore here, which has been injured by the burning of candles he placed a sprig of mint in an invert inverted glass jar in a vessel of water and found several days later that, the air wound either extinguish a candle nor was it all inconvenient to a mouse which was put there ok. So, similarly you can in a burn a candle out there and it would not get extinguished.

So, this was the first discovery in the photosynthesis that oxygen is evolved in photosynthesis, now going by going back to that deceptively simple reaction where it all started.

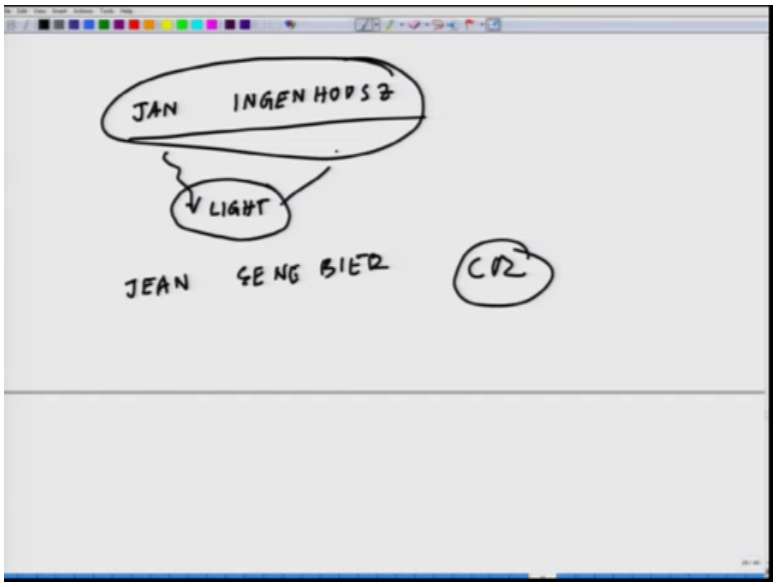
(Refer Slide Time: 15:02)



In the light of this if you look at this reaction everything will make sense that oxygen evolution ok.

So, this was the first of the very foremost discovery of photosynthesis the evolution of oxygen ok. The next major contribution to the elucidation of photosynthesis was made by Jean Ingen House who was a Dutchman.

(Refer Slide Time: 15:25)



So, basically based on priestley experiment he went further and what it did is that he figured out. So, according to his own language he discovered that the role of light in photosynthesis. So, basically the person who discovered that for synthesis can only happen in the presence of light. So, this was Jean Ingen House discovery that it is not only that it is producing oxygen for this process to happen you need light.

So, this was the second distinct contribution and followed by that there was another guy called Jean Seng Bier his distinctive contribution was to show that the fixed air namely CO2 is taken up in photosynthesis. So, basically the third name which comes into play is Jean Seng Bier, who showed that CO2 is used in the process of a carbon dioxide fixation or in photosynthesis.

So, now we have dealt with 3 different things, so this gentleman showed the role of light priestley showed devolution of oxygen Jean Seng Bier states, that it is the carbon dioxide which is involved in it these are the 3 major contribution which was made in the very early between 1700 and 1800 centuries.

So, I will close in here in the next class we will move on to the role of the chlorophyll molecules ok.

Thank you.