Bio-energetics of Life Processes

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Lecture – 06
Biological order and energy – I

Welcome back, to the lecture series in bioenergetics of life processes. So, in the first week we have given overall introduction of the course and certain aspects, what you have dealt what remain the situation in the prebiotic soup, and how possibly the first cell has evolved. So, this week we will kind of further formalize our understanding, we will kind of structure it better just the way through the edges, through billion the self assembly of molecules lead to the formation of what we know as a biological cell, and how this biological cell is capable of making energy rich molecule and generating by burning those molecules generating heat and maintaining an order.

So, essentially if you if one looks into the whole bioenergetics perspective where, the energy is playing the critical role it is basically this energy is trying to create an order out of this chaotic molecular assemblies or molecules all over the place, and in order to create an order a structure like, cell a multicellular organism even a simplest of the simplest unicellular organism like, bacteria you need to invest energy.

So, the whole fundamental concept of bioenergetic comes from the fact that, how energy and matter interact with each other. This is where, it the crux balls down it is basically a interaction of energy and matter and the aspect, what is important to realize it how this energy first of all what is the source of this energy? Is it a chemical source or is it a light source because, or it could be any other source also it could be a some geo sources, some wave sources, some wind sources.

So, there has to be a source of energy, which could be harvested by the molecules present on the cell, and then converting that energy to do some useful work in terms of synthesizing energy rich molecules. So, in other word you are converting the energy into useful materials or you are converting the energy to some form of matter, which could be further burnt to generate energy. So, in other word if I have to put it like this, this week let us, this is our lecture 6 this is week 2 lecture 1 first lecture of the second week. We are

supposed to touch upon the 2 topics here, chemosynthesis and photosynthesis now, as the name indicates chemo and a photo synthesis.

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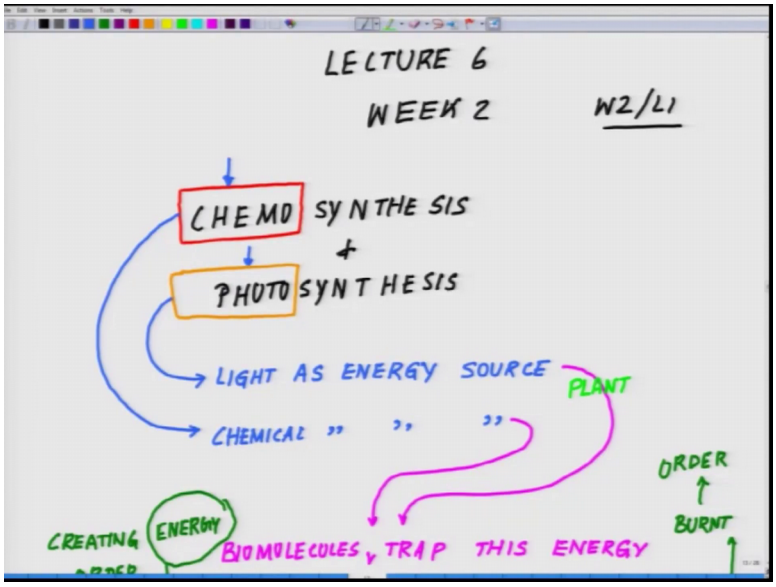

So, if I spread this or split this word into 2 parts chemo and photo. So, these are our source of energy. Either it is an chemical source or is it a light source, light as energy source or chemical as energy source. So, what this energy essentially does it helps. So, just keep this.

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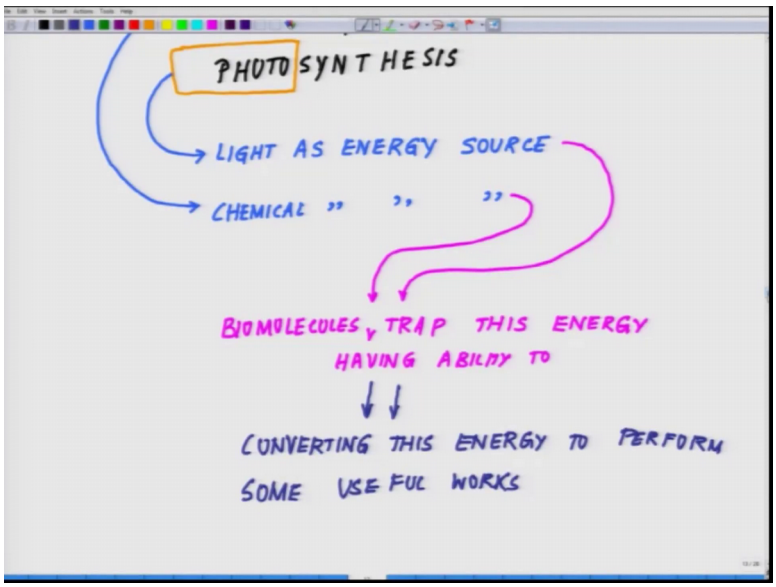

So, first of all this energy is being, there should be bio molecules having ability to trap this energy and the next thing is converting this energy to perform some useful work.

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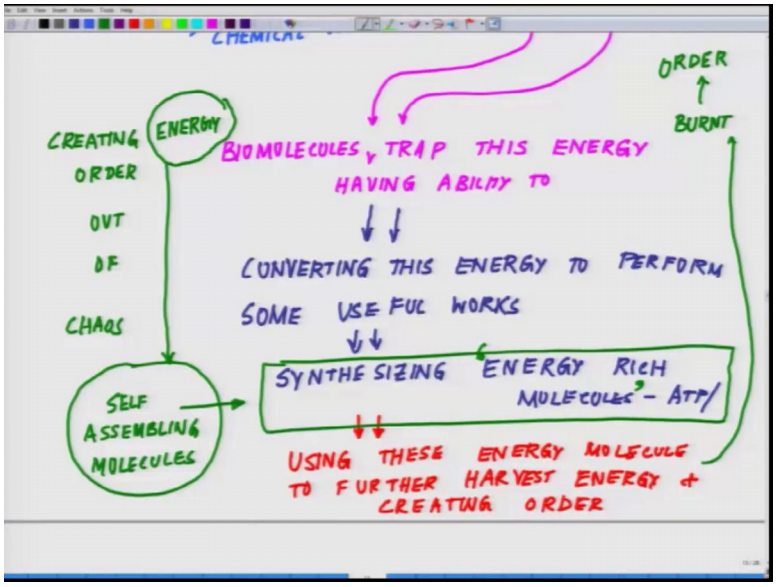

In terms of when we talk about useful work here, what we essentially mean is synthesizing energy rich molecules, which in the biological platform we talk about ATP and other Nadpnadph and all those kind of molecules and followed by, using these energy rich molecule to further harvest energy and creating order.

So, in other word if you look at this whole process in a both side view, if you get an both side view what you will observe is this is a process where, essentially what we are doing we are creating order out of chaos, why cubes? So, whenever we talk about synthesizing energy rich molecules in other word what we are talking about is a process, whether using enzymes, using some other form of supporting molecules we are self assemble molecules a particular kind of molecules it could be Atpnadph, it could be anything it does not matter. What is important for you to realize is you need energy you need to supply some form of energy to execute this self assembling of molecule to create those energy rich molecules out here, and using these energy rich molecule further they are being burned.

So, essentially these are being further burnt to create an order and this is if you look at this whole thing this is where, our whole food chain works essentially. So, you can fit in

your story this is where, the plant kingdom is working and this is where, most of the animal kingdom or who we are working.

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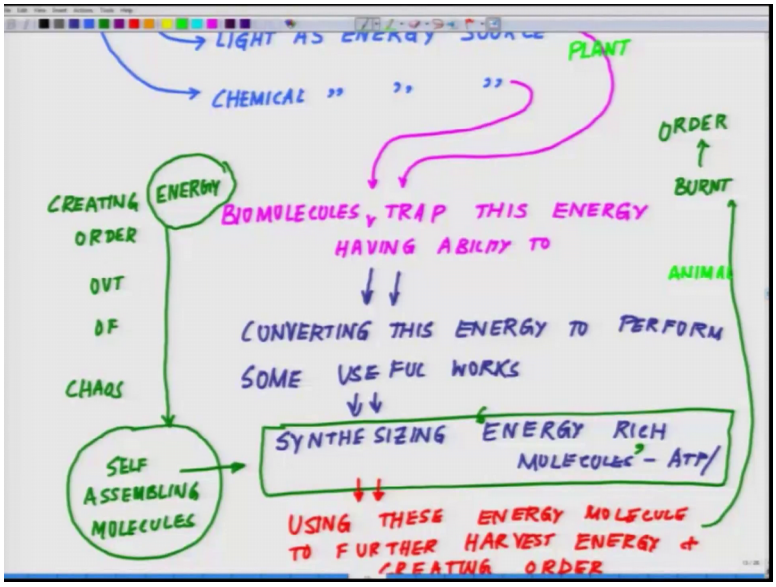

So, if we look back the first week, what we talked about the first thing, what we essentially talked about was simple biological molecules can form under prebiotic conditions. This is one of the concepts what we essentially underlined. So, under the broad heading what we talked about in the last week was from molecules to the first cell, right?

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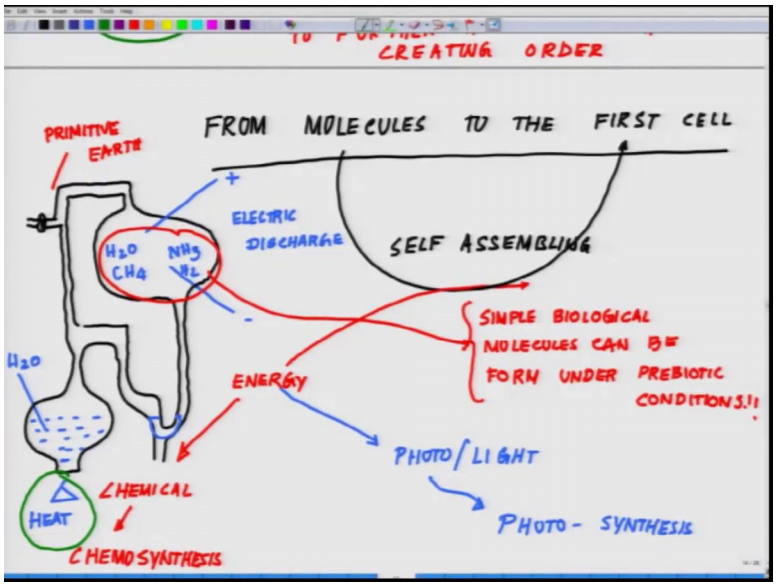

From molecules to the just a recap to the first cell, this is what we have highlighted, how the molecules make a first cell? So, in other word a process of self assembling and any self assembling process is executed by, energy input you need some form of energy.

Now, when this energy is chemical energy then, this is called chemosynthesis. You are synthesizing energy rich molecule using this energy, and when it is photo or light we call it photo synthesis. And if you remember or recollect in the very first point I highlighted this, chemo and photosynthesis but, before we get into the fundamentals of chemosynthesis and photosynthesis, we needed to have a slightly better understanding of the events or some of the prerequisite thermo dynamical aspects, which govern this extraordinarily beautifully evolved systems on the floor of earth we are very fortunate to have see such, a wonderfully evolved structures which could be an inspiration for generations to come what will be our future of solar cell?

What will be our future of energetic? How we can really resolve energy problems? So, that is where slowly this course will be kind of you know will be catering you to realize that, you know if someday the engineers and the scientists can really emulate some of these processes by which, nature is harvesting light nature is harvesting energy by burning chemicals by using different kind of enzymes and it is all in the basics, it is not something out of the world the things are happening. So, that is where, I am taking this opportunity to tell, that this is where slowly the course will be going where, bienergetics will kind of merge with some of the futuristic energy requirement phenomena or what all we needed to really you know work upon.

So, let us move on where we are. So, so if we see this from molecules to the first cell. So, one of the experiment, which I have partly talked about and there are certain questions, which were asked is you remembers experiment if you most of you have probably seen but, in case you have not let me just draw the and minded when you re miller presented that their work there are so much scepticism.

I am just trying to draw the a whole apparatus. So, as we have always mentioned that, our life has evolved in water. So, this is where, heat is coming into plain. So, this is the apparatus and this is water and here, you are having electric discharge electric discharge and this leads to the formation of simple molecules as being shown here. And this is a kind of a trap here, where you are trapping these molecules and evaluating them.

So, a typical experiment simulating the conditions on the primitive earth this is essentially a situation of primitive earth where, simple biological molecules can form under prebiotic conditions. So, this is where highlighting the fact that simple current a biological molecules can be formed under prebiotic conditions. So now, whenever we talked about this the condition that, exist in existed and on earth. So, if you look at it very carefully.

So, this needs a source of energy. So, you realizing that what, so ever may be the situation whether it is a experiment, whether it is a chemical evolution, whether it is a photosynthesis the critical aspect is, that you need some form of energy it could be heat energy coming from the deep sea geysers or a hot water spring or geothermal energy or solar energy some form of energy has to be put into the system in order to create an order among the molecules. So, this fundamental concept has to come very clear in your understanding of bioenergetics, it is a interaction of energy input of energy, which is self assembling the molecules to form a structure.

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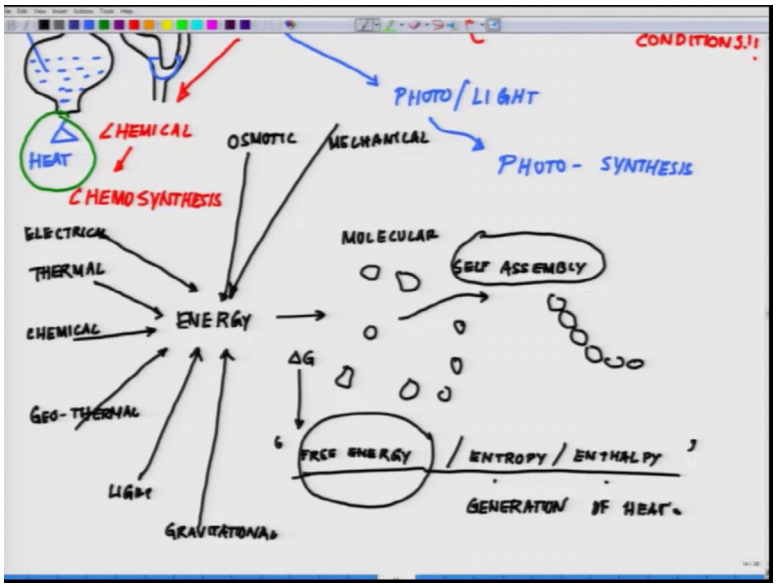

So, this is the crux and in this whole process there is one parameter, which continuously tells you a story called free energy delta G will come to this that, free energy, entropy, enthalpy these parameters will come very, very handy as we will walk through this journey of understanding and this energy as I told you could come from multitude of sources, it could be thermal of course, we will be dealing with a chemical only it will be

thermal, it could be chemical, it could be geo thermal, it could be light, it could be gravitational, it could be electric electrical, it could be gravitational light, it could be osmotic.

So, it could be even in a mechanical energy could have n number of sources, or n number of roots route by which, it could govern the self assembly of molecules and this whole process thermodynamically we can define by seeing the change in the entropy or chios enthalpy and most importantly the free energy and the generation of heat, and they are all linked to heat.

So, with this background I will close in this class and I will move on to the next class where, we will talk little bit more about the simple biological molecules and how they are self assembling and where, on the evolutionary chart our most limited organism stands and where, we are and then we will follow up little bit more on the free energy entropy and enthalpy.

Thank you.