Basics of Biology
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Lecture – 06
Origin of Life (Part 1)

Hello everyone. This is Doctor Vishal Trivedi from Department of Biosciences and Bioengineering IIT Guwahati. And what we were discussing? We were discussing about the living organisms. So far what we have discussed? In the previous module we have discussed about the classification of the different organisms. And while we were discussing about the classifications we have discussed about the invertebrate animals. And we have also discussed about the vertebrate animals.

Apart from that while we were discussing about classification we have discussed about the different way in which the organisms are being classified. And we have seen that the animals are being classified as the within the five different kingdoms. These kingdoms are the protista monera, fungi, animalia and plants. And to understand how the people are doing the classification we have discussed in detail about the invertebrate classification as well as the vertebrate classifications. And ultimately in the previous lecture we have also discussed about the plant classifications.

And why we were discussing these classifications? We were discussing these classifications only to understand that how the different organisms are interrelated to each other, how they are being evolved from the lower organisms? So you might have seen that there are many organisms which were gradually acquiring the new and new characters. And that is how they wear actually developing the new features.

For example when we were discussing about the different types of mammals. We discussed that how the mammals have actually evolved their heart. Like, so initially heart was one chambered heart, and then it has become two chambered heart and then it became the four chambered heart which is actually the fully developed Heart which is present in the very very high mammals like the humans.

So why we were discussing about the classifications? We were discussing the classifications to understand how these living organisms are interrelated to each other and how they are forming a

relationship. And how these relationships could be exploited in terms of understanding many features.

So in today's lecture we are going to discuss about the Evolutions or how these organisms are being evolved. So to understand these aspects first we have to understand that how the life actually originated on to the earth, because you have to first understand how the life originated on the earth, and then you can actually be able to understand how these life containing organisms are actually being acquired the characters, acquired the features so that they will be able to adopt more nicely and they will be able to run their life cycle in a smooth way. So the first question which we would like to ask or which we would like to raise today is what is life and how you define the life.

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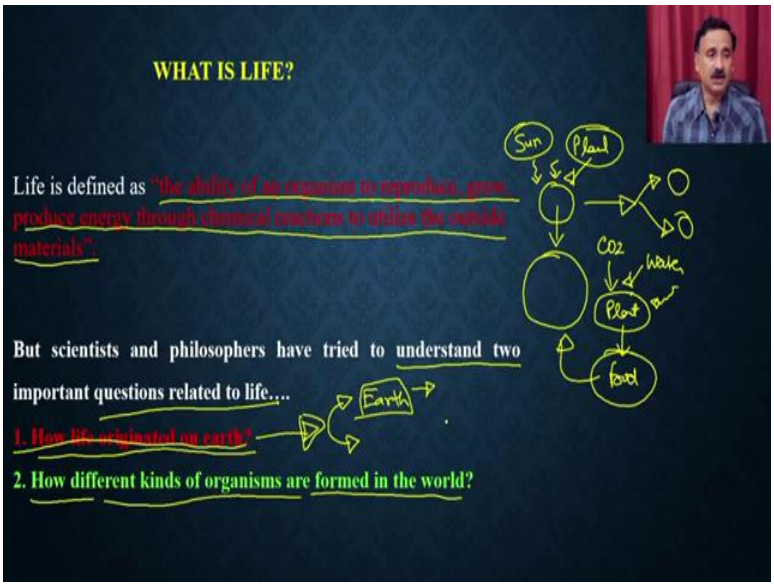

So what is life? So life is defined as the ability of an organism to reproduce energy through chemical reactions to utilize the outside material. so what it means is that you can say that a organism is having a life if the organism would be able to reproduce, which means it can be able to give you the offsprings, it could be able to utilize the raw material, whether the raw material would be in the case of plants, for example it would be sunlight or if it could be the other organisms like the plant itself could be a raw material for the other organisms. Like as we discussed in the previous lecture or previous module that some plants some organisms are the herbivorous and some organisms are the carnivorous.

But irrespective of that life is going to be defined as the ability of an organism to reproduce, which means it can be able to give rise to the offsprings. Then it can also be able to grow which means it can be actually be able to grow in size. Like for example when we born we are born as a child. Then slowly, slowly, slowly we grow in terms of height, in terms of our hands are big so we become adult. So that also should be there. And then it should be able to produce energy. So it should be able to run the metabolic reactions so that it can be able to utilize the raw material what is available in the system.

So if it is a plant the plant will actually be able to utilize the two raw material it can utilize the carbon dioxide and the water. So the carbon dioxide and water are actually going to be utilized by the plant along with the sunlight. And that is how the planets are actually going to generate the food which is going to be consumed by the other organisms.

So before we get into the details of how life is originated on to the earth the scientists as well as the philosophers have tried to understand the two important questions related to life. First is how the life originated on to the earth? Because this which looks very simple with the easy way that okay you have an organism. It is utilizing and all that. But the first question is that how the organism has evolved an ability to do that? And that we should be able to understand.

So the first question is that how life originated on to the earth. And the second question is once the life originated on to the earth how it has actually acquired the different types of features? Like so how different kinds of organisms are being formed. You know that it we have many types of invertebrate organisms. We have different types of vertebrate organisms. We have plants. We have the fungi. We have different types of bacteria. We have viruses. We have viriods. We have micro plasma.

So how these different types of organisms which we have discussed in the previous module are being developed on to the earth? How these different organisms are being developed? So these are the two different important questions which we are going to discuss in this particular module.

So let us start how the life originated on to earth. and if we want to understand the life we have to first understand how the earth is being formed on to the, how the earth is formed and why the life is only present on to the earth. If you recall and if you go through with the different types of newspapers and all those kinds of sources what you will find is that the earth is the only planet in

the solar system where you have the life. There are other planets which are bigger than earth but they do not have the life.

So we first have to understand how the life is originate? What is the unique about the earth so that life is only originated on to the earth? And what are the different conditions which are actually allowing the life to be originated on to earth?

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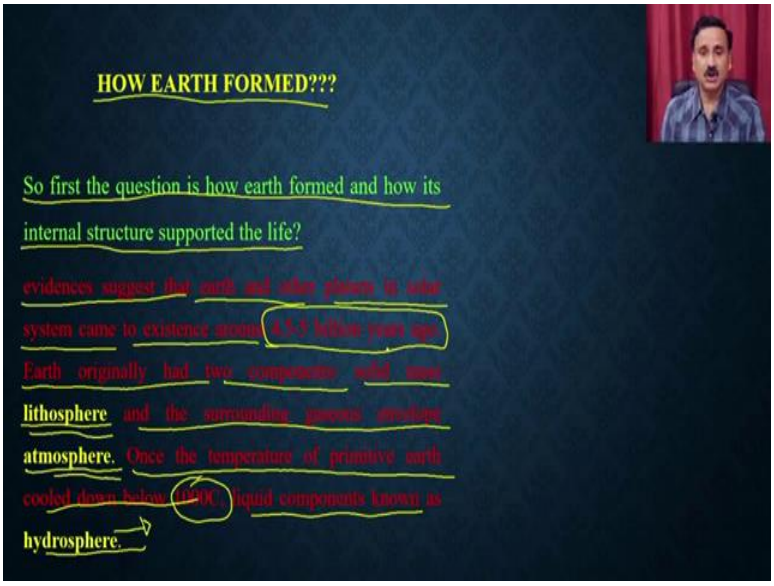

So to understand these questions we are going to ask how the earth is formed and why there is a life on to the earth. So first question is how the earth is formed and how its internal structures are supporting the life. Evidences suggest that the earth and other planets in the solar system came into existence about 4.5 to 5 billion years ago.

And earth originally had two components. One is the solid mass like the earth which is also called as the lithosphere and the surrounding gaseous envelope which is called as the atmosphere. You all know all these. You have the two major components. One is the solid mass which is called as the lithosphere and commonly says it as the surface. And the atmosphere the air around that.

So once temperature of the primitive earth cooled down below to 1000 degrees Celsius then the liquid component also came which is also so called as the hydrosphere. So you have the three components. One is the lithosphere which is actually the solid mass. You have the air part which is called as the atmosphere. And then you have the water part which is called as the hydrosphere.

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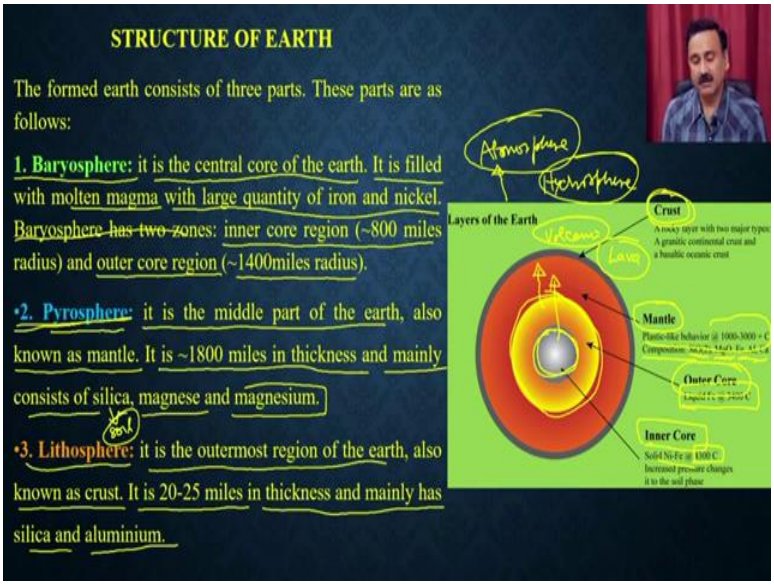

Now if you see the structure of earth what you will see is that the earth has different layers. And these layers are as follows. You have the baryosphere. You have the pyrosphere and you have the lithosphere. So this is I am talking about the solid mass which you are talking about. So you have the baryosphere. So it is the central core on the earth. So this is the baryosphere which is the central core score of the earth and it is filled with a molten magna with a large quantity of iron and nickel.

So this is the central part which is called as the baryosphere. And it is actually being filled with the minerals like the iron as well as the iron as well as nickel. And this is the only portion which actually comes out from the earth in the form of when there will be volcano eruption. So then this portion comes out from the earth in the form of the lava and that is how it actually, it is very hot and because this is the portion which is very hot, having a molten metals. So these metals when they come out in the form of the fountain or in the form of the lava it becomes, they destroy the regions.

The baryosphere has two zones the inner core zone. So this is the inner core zone where you have actually the iron and the nickel. And that is what is called as the inner core. So you have the inner core. And then you also have the outer core. In the inner core you have the solid nickel and the iron. So in the inner core you have the solid metals like the iron and the nickel whereas in the outer core you have the liquid metals like liquid iron.

Why it is so? Because the inner core has the very high, is a high temperature at 3400 degrees Celsius whereas the inner core has the temperature at 4300 degrees Celsius. And it also increase the pressure changes into the solid space. So inner core has radius of the 800 miles whereas the outer core has radius of the 1400 miles radius.

And apart from that then you have this middle layer which is middle layer is also called as the pyrosphere. So it is the middle part of the earth also known as the mantle. So this is called as the mantle. So this is like a plastic-like behavior because it has at the temperature of 1000 to 3000 degrees Celsius. And it mostly contains the silica, magnesium and iron aluminium and calcium.

And it is 1800 miles in thickness and mainly consists of silica, manganese and magnesium. So this is also the place which is filled up with the different types of metals. And mostly these metals are the silica, manganese and magnesium. So you know that the silica is actually a main component which is forming soil.

And then you have the lithosphere. Lithosphere is the outermost region of the earth also known as the crust. So this is the lithosphere which is also called as the crust. And it is 20 to 25 miles in thickness and mainly has silica and the aluminium.

So if you recall these are the three layers. You have the baryosphere which is the innermost layer. Baryosphere has two regions. One is called as the inner core where you have the solid metals like the iron and the nickel. Then you have the outer core which contains the liquid iron. And that liquid iron only comes out in the form of the lava when there will be volcano eruptions.

And then you have the middle layer which is also called as pyrosphere. And this middle layer is also consist of the silica, manganese, iron, aluminium and calcium. And then you have the outer layer which is called as the crust or the lithosphere. And that is also containing the silica and aluminium.

So this is the structure of the earth. Outside you have the atmosphere. So outside you also have the atmosphere, and you also have the hydrosphere. So this is what you have which actually be present around the earth. Now how this actually can make earth as a suitable planet for developing the earth, developing the life.

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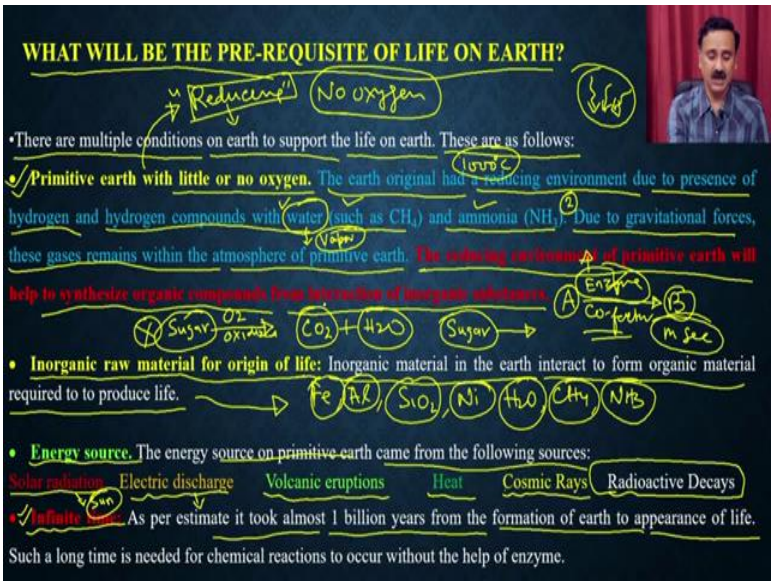

So what will be the requirement of a planet to give the life? So that is what you have to understand and these are the prerequisites which are present on the earth. So there are multiple conditions which were existing on the earth to support the life on the earth. These are as follows.

So in the primitive earth there was low or the little oxygen present, which means the earth's primitive environment was the reducing environment, which means it was not containing the oxygen. So there was no oxygen in the primitive earth. The earth originally had a reducing environment due to the presence of hydrogen as well as the hydrogen compounds such as the methane and the ammonia. Even if it contains the water that does not contain the oxygen. It is a compound where oxygen is called with the hydrogen.

So due to gravitational forces these gases remain within the atmosphere of the primitive earth. So that is the second point. Why there is a atmosphere in the earth? Because it has the gravitational forces and because of the gravitational forces it actually pulls all these gases or it actually keeps a pressure on these gases and because of that, these gases are always being remained within the atmosphere. And because they will remain in the atmosphere they will be able to interact with each other. And that is how they are actually going to give rise two different types of compounds.

So the reducing environment of the primitive earth will help to synthesize the organic compound from the interaction of the inorganic substances. So because it has the gravitational forces because it has the reducing environment; you know the advantage of reducing environment. If you have a reducing environment, reducing environment actually reduce the chances of spoiling of substances.

For example if you have a sugar molecule and if you keep the sugar molecule as such the sugar is actually going to get oxidized spontaneously. Even if you keep a sugar molecule and you do not do anything it is actually going to get oxidized because there is oxygen in the environment. And that is how it is actually going to form the carbon dioxide and water.

Maybe there are microorganisms which are actually going to do this because if the microorganisms are going to do this, this process is going to be very fast. And that is how what will happen is that the sugar which is a complex organic molecule is going to be broken down into the carbon dioxide and water. And that is how you are actually going to destroy the formed organic molecule.

Whereas if it is a reducing environment you cannot break the sugar molecule. It will remain as such and that is how you can be able to utilize this sugar molecule. or you can be able to then build the bigger molecule based on this sugar molecule. So that is why that was the major reason why the life is originated on to the earth because it has reducing environment. And then it also has the gravitational forces to hold the gases within the atmosphere of the primitive earth.

So what are the organic materials what you have? You have water. You have methane. You have ammonia. And you have all these molecules. All these are present in the gases because the temperature of the earth or the temperature of the primitive earth is approximately around 1000 degrees Celsius.

So that it always keeps water not in the liquidified form, that always keeps the water in the vapor form. And that is how the water actually can interact with the methane ammonia and that is how it can actually be able to give you the organic compounds. Then it also has the essential inorganic material. So in inorganic material in the earth interact to form the organic material required to produce the life.

For example we have just discussed in the previous slide that we have we have the iron. We have the aluminium. We have the silica. We have the nickel. And all these metals. Apart from these metals we also have the water which is very, very important for the life. You might have seen if you keep water in a bucket or somewhere and if you leave it like that undisturbed you will see that the algae and all other kinds of life organisms originates. So that is actually the power of the water because it allows the growth. It allows the growth of the living organisms. Then you also have the methane. You have the ammonia. And all these are very very essential for generation of the complex organic molecules.

Then it also requires the energy source. So the energy source on the primitive earth comes from the multiple sources. You have the solar radiations. So we are very lucky and we are very blessed that we have a very big source of energy in the form of sun. Then we have electric discharge. So these are the electric discharge will come when there will be a lightning.

Then we have the volcanic eruptions. So volcanic eruption I think in the previous slide only we have discussed that if there is a volcanic eruption it gives rise to it allows the coming out of the magna and coming out of the lava. So along with the lava it also gives the energy. Then it also has the heat. So heat also comes from the solar power.

And then you also have the cosmic rays and then you also have the radioactive material which actually going to decay and that is how we are actually also going to provide the energy into the system, because you cannot catalyze this reactions under normal circumstances or at a very, very low temperature. So you always require the energy if you want to form the complex molecules.

And then there was a no, the last point is the infinite time. As per the estimate it took approximately 1 billion years from the formation of earth to appearance of the life. Such a long time is needed for the chemical reactions. Why it is so? Because currently if you try to do the chemical reaction what you are going to do? Suppose I want to convert a A into B. so what I will do is I will just put an enzyme and I will put the cofactors. I will put some, and when I put the enzyme the A is going to get converted in a range of milliseconds or seconds actually.

But since the enzyme was not present onto the primitive earth because enzymes are biological catalysts. They can actually be able to enhance rate of reactions. And that is how the A will get

converted at a rapid rate. But since the enzymes were not present on to the primitive earth these reactions are going to be very, very slow.

They will take minutes seconds and hours for completing even the single condensation reaction of hydrogen and oxygen to give you the water. And that is why it took a very, very long time even for formation of earth. And on the other hand it also took very long time for these chemical reactions to give rise to the simpler organic molecules like sugar and the carbohydrates. So these are the prerequisites of the life on the earth.

But there was still we have the original question left that how the life originated on to earth. To understand that question the people in the different eras actually proposed the different types of hypothesis or different types of theories to explain that.

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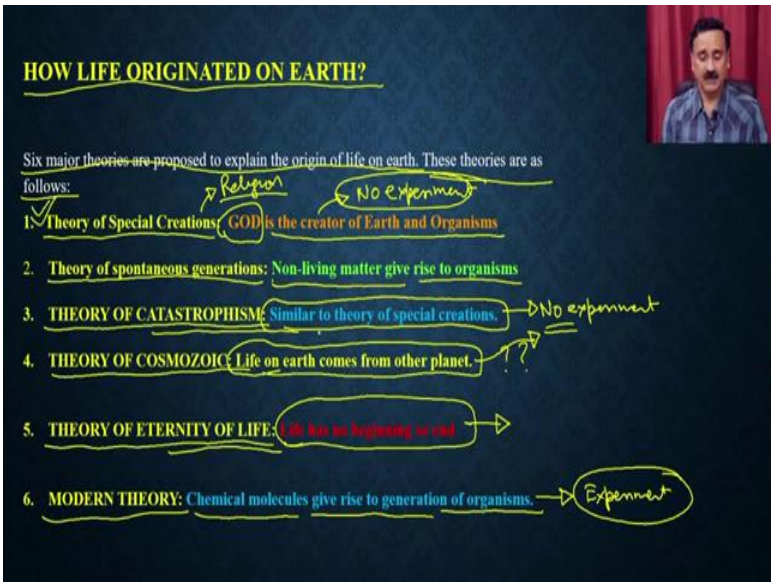

So what are the theories? These theories were mainly based onto the experimental basis or the assumption basis. So there are 6 major theories which are being proposed to explain the origin of life on the earth. These theories are as follows.

So you have the Theory of Special Creations so most of the religious bodies or most of the religion actually believes that the God or Bhagwan or whatever is actually the creator of the earth and the different organisms. This theory was completely being based on the trust as well as the belief and there was no experiment. So no experimental evidence that God has created the earth or God has created the organisms.

Then we have this Theory of spontaneous generation. So Theory of spontaneous generation believed or hypothesized, and there was couple of scientists who believed that the non-living matter give rise to the living organism.

Then we have the Theory of Catastrophism. So Theory of Catastrophism is also very similar to the Theory of Special Creations. It also believes that the life is originated by the God and then there were catastrophes and because of that some organisms are now vanished and so on. So that is how it actually are very much close to this and there was no experimental evidences. So there was no experimental evidences that it is actually been happening.

Then we have the Theory of Cosmozoics. So Theory of Cosmozoics the scientist who are supporting the Theory of Cosmozoics believe that the life on the earth comes from other planet. But the main question remained unanswered. Even if the life is comes on the earth from the other planet how the life originated on that planet? So that question is also not been answered and this theory is also is just been proposed without having any experimental.

Then we have Theory of Eternity. So Theory of Eternity is like a life has no beginning or the end, which means life is a continuous process. It cannot be destroyed. It cannot be originated. So why we are raising this question that how the life originated on the earth. So the Theory of Eternity of life is completely non-experimental and non scientific.

And then we have the Modern Theory of Origin of life which actually is also called as the chemical theory where people believe that the chemical molecule give rise to the generation of organism. And this theory is completely being dependent or completely been based on the experiments what has been done by the Miller and Urey.

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So let us start discussing each and every theory and how the why the people have not accepted these theories. So the first theory is Theory of Special Creations. The Theory of Special Creations is proposed that the life on earth is created by a superpower the God. So every religion has its own way of explaining this process. Some people said that the God took seven days actually to create different organisms and so on. And then so, and every religion has its own beliefs.

So according to the Christian belief the God has created the universe, planets, animals, plants and humans in the six natural days. Similar beliefs are also been proposed by other religion as well. So there are Hindu religion which also has proposed the similar kind of things. And all these are mostly been non-experimental. They were not been based on any kind of experiment. They were all based on the belief theories. So there are beliefs in the Theory of Special Creations.

But these are the points which are being proposed by this theory and then there are the contradictions. What is being said that all living organisms were created on the same day because if it is created by the God it can be actually been created by the same day? But if they are being created on the same day there should be no difference in their appearances.

And we all know that there is a gradual decrease or gradual appearances of these animals, because when we do the fossil data, if you go by the fossil data what you will see is that the fossil is actually going to tell you the age of that particular animal or by that particular organisms,

and the ages of the different organisms, how they appeared on the earth is also very, very different. So this actually is not going to be applicable. Whereas the theory says that all living organisms were created same day by the God.

Then the second is there created in the present form, which means they are being created in the fully developed form as what you see today. If that is the case there should be no evolution. But we know that there are evolutionary markers what are present on to the organism. You have the vestigial organs. You have the other form of evidences that there is a evolution; there is a evolution through which the organisms are being evolved from the one form to another form. So this is also not being acceptable are not being proved conclusively.

And then they say that their bodies and organs are fully developed to meet the requirement to run the life cycle. That means there should be no adaptation. But that is also not true. There is an adaptation. There is a adaptation in the every organisms and that is how it actually gives rise to the different organisms. So all these three points which were been part of this particular theory are not been found to be true.

Apart from that there were series of objections to this particular Theory of Special Creations. What is the number one? So number one was the major objection. It was purely believed on the religious belief. It was purely based on the religious belief.

Then the second point was there was no experimental evidences to support the assumptions. So there was, see when you do, you try to sort out a problem you are first going to do a hypothesis. So you are going to first generate a hypothesis. Then this hypothesis has to be tested by doing a set of experiments and this then this experimenters have to analyze. So this was the scientific way of sorting out a problem and once you analyze you are actually going to refine your hypothesis.

But in this case there was hypothesis. There was hypothesis that God has created the earth and other planets as well as the animals plants and all that. But there was no experiments there was no analysis of those experiments and there was no further thing. So since this theory was based on a non-experimental basis most of the scientists have discarded this theory.

And the third objection was that the age of the different fossils proved that the living organism appear all in different time frame, which means there was not being created in six days because if they are being created in six days you are not going to see the change or difference between the different organisms. So because of this the Theory of Special Creations is not been acceptable or it was not been able to explain how the life originated on the earth.

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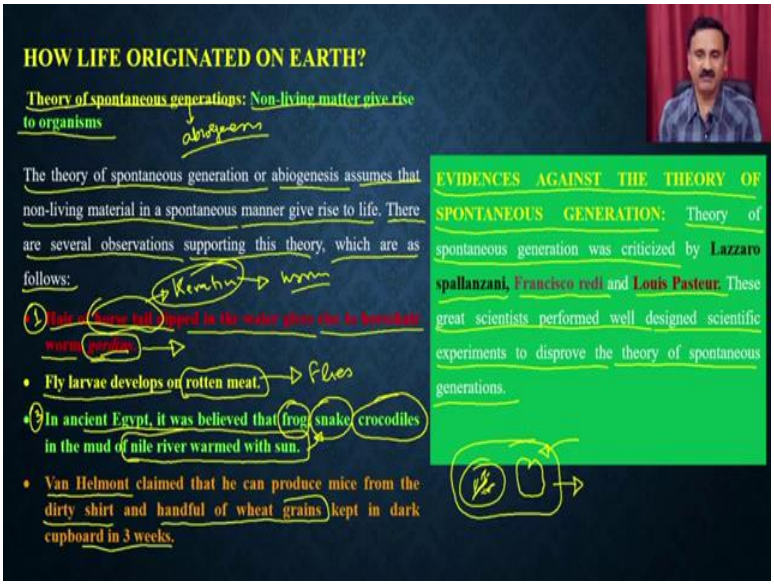

Then we have the second theory. The second theory was the Theory of spontaneous generations. So this theory is also called as Theory of abiogenesis. so according to this theory the non-living matter gave rise to the different organisms the Theory of spontaneous generation or the abiogenesis assumes that the non-living material in a spontaneous manner give rise to life. These are several observations supporting this theory which are as follows.

So there are observations. There were observations by the scientists or the common people that people have put together and then proposed this particular theory which says that the living organisms are being evolved from the nonliving organic or chemical molecules by a spontaneous manner which means there was no God involved in this, or there was no other factors involved.

So the first stage was that people have dipped the hair of horse tail in the water. So if you take the horse and if you dip the horse tail into the water what they have found is that it has given rise to the horse hair worm which is also called as the gordius. So that was the first evidence.

Then the second was that if you have a rotten meat and if you left the rotten meat, rotten meat as such then what you will see is that the fly larva is actually going to be developed on that. So this means the rotten meat given rise to flies.

Similarly this horse tail which is actually, horse tail made up of keratin. So horse tail is also keratin which is also the non-living material, because it is hair, and that also gives rise to this particular worm.

Then the third observation was that in the ancient Egypt the people believed that in the Nile river if it is, Nile river is warm with the sun then that give rise to spontaneously the development of frogs, snakes and as well as the crocodiles. So it was spontaneous. So people have observed that if there is a sun on to the Nile River it actually gave rise to the different types of animals like frogs, snakes and crocodiles.

And then ultimately one scientist which is called as Van Helmont that he has done experiment as well. So what he has done is he took a dirty shirt and it has taken a handful of wheat grains and then he has kept those things. So he took the wheat grains or the barley, and he took the shirt. So he took the shirt and he has put it into a cupboard. And that cupboard, he closed that cupboard for three weeks. What he could found is that this cupboard has actually developed the mices at the end.

But he could not able to explain how the mice have been developed. Or even majority of these things, they could not explain why only this particular worm is being developed, or why the flies were developed onto the rotten meat and so on. So then the peoples have started developing or acquiring the evidences which will actually going to disprove. So there were evidences which have been proved against the Theory of spontaneous generation.

So the Theory of spontaneous generation was criticized by the three scientists Spallanzani, Francisco redi and Louis Pasteur. And these great scientists performed the well-designed scientific experiments to disprove the Theory of spontaneous generations.

So they have, see these people have not done any experiment. They only proposed the hypothesis, and all these hypotheses were based on the observations. so there was no experiment except that

Van Helmont probably has done a very, very crude experiment where he has just kept the dirty shirt and handful of wheat grains and he found that after 21 days there is a development of mice.

But what he has not done is he has not done any kind of controlled experiments. He has not done any kind of other kind of things. So to disprove this theory or to test this theory actually these three scientists have done the very meticulously scientific experiments. So let us see that those experiments.

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So the first experiment is been done by Francisco redi. Francisco redi did a conclusive and well-defined experiment to disprove the Theory of spontaneous generation. What he has done, is he has took the three jar. What he has done is he has taken a rotten meat. He boiled that meat and, so that it becomes soft and then it gets rotten. So he took the three jars. One he took the meat into three jars and then he kept the one jar open. The second jar he has put gauze.

Gauze is a cloth actually which actually has the net on that. You might have seen the gauze which people used for causing the bandage to the wound or something. So this gauze is actually having a, will not allow the bigger animals or flies to get inside. But it can actually be able to allow the smell or other kind of things to come out.

So then the second jar he has closed with gauze. And the third jar he has closed with a parchment which means it has closed completely. So neither the smell can come out nor can the animals or the flies actually go inside.

So what he has done is he took the three jars. So the jar 1 was left open so that any animal or anything can be actually being able to go inside. Then jar 2 was covered with the gauze. As I said gauze is having a net. So it actually can, will not allow the flies to get inside but it can actually be able to allow the smell and other things to come out. Now the third jar it was covered with a parchment or the paper. The meat and the fishes decayed in all the three jars and it attracted the flies.

So what happened in the jar number 1? So first see that. So what happened is in the jar 1 where the smell as well as, the smell came out from this rotten meat as well as the fishes. So as a result the flies came. So flies came from outside and that is how the flies have actually given their babies or the maggots. And that is how it has proved. So the first experiment actually proved that the chemical molecules or the rotten meat or the non-living material has give rise to the life.

In the second object, second jar he has put it as a muslin cloth are the gauze. So gauze actually is doing something. So what he has done is it attracted the flies. But the flies cannot get inside. So even if you have the organic material inside it cannot give rise to maggots and all those kinds of things. But instead these files because they are attracted on to the top surface they have given the maggots on to the surface of this particular paper or paper cloth.

Then in the jar 3 which was conclusive that, which cannot actually give rise to the smell or it cannot attract the flies. So if there is no flies what he could found is that the there was no development of the maggots. So this actually proves that the Theory of abiogenesis is not true. It actually the pre-existing molecules or pre-existing organism which are giving life rise to the new organisms.

Whereas you see in the jar 3 when it is closed completely it is not giving rise to any fly. So in the jar 1 the flies enters and layered egg which eventually gave rise to the new larvae. So that is the Theory of abiogenesis. Whereas in the jar 2 the flies could no longer be able to enter and no larvae was found inside the jar. So that was a disproof or discontradiction to the Theory of abiogenesis.

But the flies layered egg on the gauze to produce the larvae. And that is actually the point which Redi was trying to prove, that it is the fly which actually give rise to the maggot. It is not the

meat which gives rise to the maggots actually. And this was conclusively proved that the organisms arise from the pre-existing organism rather than the non-living matter.

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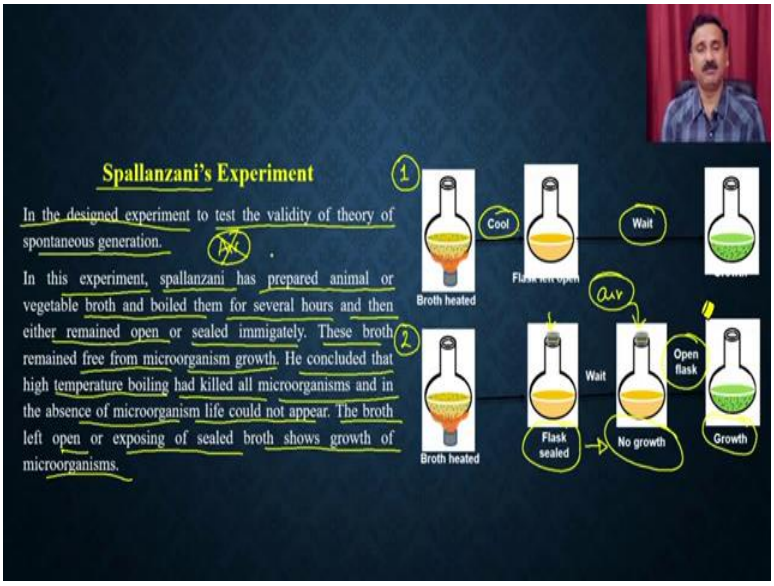

Now to make it more conclusive the other experiment is also been proved by Spallanzani and he also done the similar kind of experiments. So what he has done, he has actually took the two type of round bottom flask. So he took the two flasks. Then he took the meat broth and he boiled the meat broth. And then he allowed that broth to be cooled down. So once it cooled down and he left the flask open.

So he also took the two flasks, one is the flask which where he has let it be remain open, the other one he has closed. so in the designed experiment to test the validity of the Theory of spontaneous generation, in this experiment Spallanzani has prepared animal or the vegetable broth and boiled them for several hours and then either remained opened or sealed immediately. These broths remained free from the microorganism growth.

He concluded that high temperature boiling had killed all the microorganisms and in the absence of microorganisms life could not appear. The broth left open or exposing of the sealed broth shows the growth of the microorganisms.

So what he has done is he took the two flasks. He boiled the vegetable or the meat broth for several hours so that there will be if there is any microorganism which is present inside this broth should be get killed. So there should be no pre-existing broth. And then what has done is has

kept the broth open or the flask open. And then he allows the broth to be cooled down. So after sometime when he waited for the few days or few weeks what he could found is there would be a growth of microorganisms.

Similarly he has done the same way. But this time what he has done is he has sealed the flask while it was hot actually. So because of that there will be no entry of microorganisms from outside. And that is how this flask remains without growth. But what happened is as soon as, so that demonstrated that for the appearance of the microorganisms you require an external source. So to prove that what he has done is he opened the flask for some days and at what he could found is that there is a growth of microorganisms.

Now the major objection through the Redi's experiment or to the Spallanzani's experiment came because both of these experiments were not allowing one major component. One major component is air. So it was not allowing the entry of air. So the scientists who were the supporter of Theory of abiogenesis or the Theory of spontaneous generation say that you have actually, you have destroyed or you abolished the entry of air. And because of that the life is not been originated into this flask. Because air is a very, very important component for the living organisms and that is how you are actually, these experiments does not prove.

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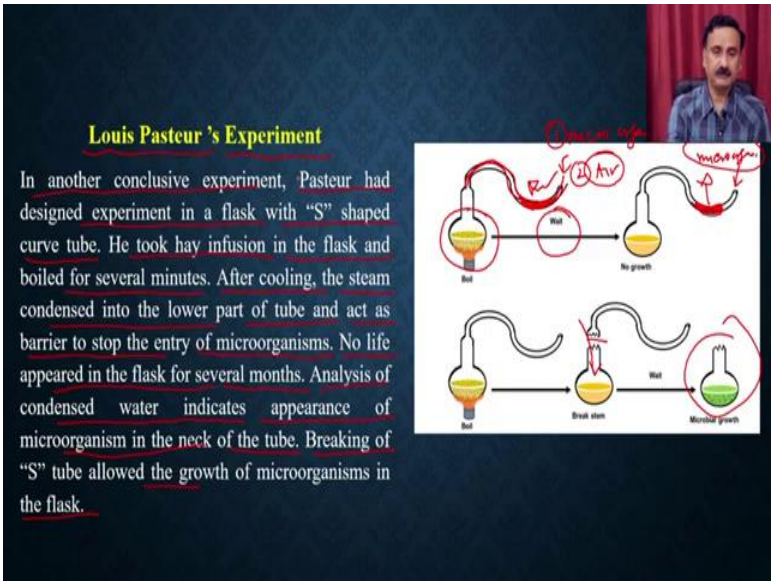

So to prove this particular point Louis Pasteur has also done a similar kind of experiment. So what he has done is Louis Pasteur has used S color flask. So what he has done is he has actually,

so in an another conclusive experiment Louis Pasteur had designed an experiment in a flask with a S-shaped curved tube. So what he has done is he took a S-shaped curved tube and he has done, what he has done, he has boiled the broth. So he took the hay infusion in the flask and boiled for several minutes or the hour. After cooling the steam condensed into the lower part of the tube and act as a barrier to stop the entry of microorganisms.

So what happened is he has boiled the broth and then the broth actually the vapors are coming and going but when he has stopped the heating the broth actually got condensed in this particular portion. So there was a layer of water which is being formed here so because of that it does not allow the entry of microorganisms.

So you are actually have the two components, one the entry of microorganisms and other is the entry of air. But it does not have any kind of interference in terms of entry of oxygen. So it allows the entry of oxygen. And then he allowed this flask to be remained open for several days and he could not found any growth. so because why it is so? Because this particular portion was causing a barrier to the entry of microorganisms.

But once he has broken this particular S-shaped knob and it allowed the entry of microorganisms what he could found is that there is a growth of the microorganisms. So no life appeared in the flask for several months. Analysis of the condensed water indicate the appearance of the microorganisms in the neck of the tube.

So what he has done is he took out this water and then he done the analysis what he could found is there are various type of micro organisms. But they could not to go and because of that there is no growth for even for several months. But when he has broken the neck and remove this S-tube from the flask the microorganism got the chance to enter into the flask and they have shown the growth.

Because of this particular type of phenomena Louis Pasteur has conclusively disproved the Theory of abiogenesis or Theory of spontaneous generation. And all these three experiments has proved that the life is not been generated from the non-living forms.

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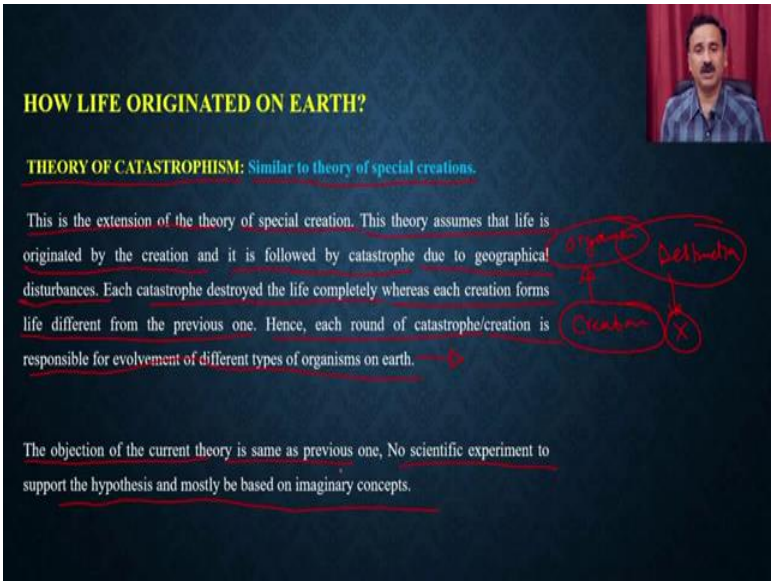

Now the third is, the second theory is, the next theory is Theory of Catastrophism. So it is similar to the Theory of Special Creations. This is the extension of the Theory of Special Creations. This theory assumed that the life is originated by the creation and it is followed by the catastrophes due to the geographical disturbance.

Each catastrophe destroyed the life completely where as each creation forms life remained different from the previous one. Hence each round of catastrophe or creation is responsible for the involvement of the different types of organisms on the earth. So what this theory says there is a creation portion. So there is a creation and there is destruction, destruction because of the different types of natural calamities like volcanic eruption, the lightning, the earthquake and all those kind of things. So that actually is going to destroy the organism. And there is a creation.

So that creation is going to be done by the God. And that is actually going to put the organism. And because of it the different organisms are being appeared on to the earth. And that is why we have the different types of organisms.

The objection of this particular current theory is same as the previous one. No scientific experiment is there to support the hypothesis and mostly it is the imaginary concept. So that is why the people do not believe that there is a Theory of Catastrophism.

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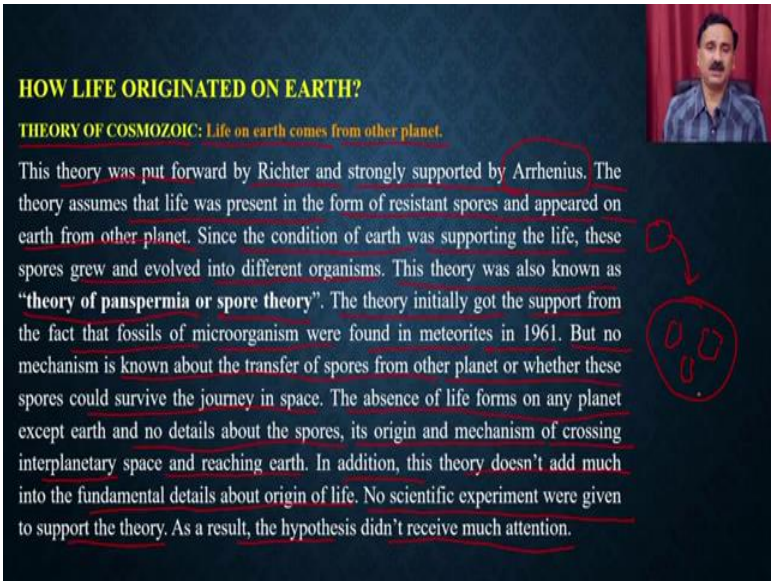

Then the second theory is Theory of Cosmozoics. The Theory of Cosmozoics believes that the life on the earth comes from the other planet. This theory was put forward by the scientist called Richter and it was strongly being supported by another scientist which is called as Arrhenius. The theory assumes that the life was present in the form of resistant spores and appeared on to the earth from the other planet.

Since the conditions on earth was supporting the life these spores grew and evolved into the different organisms, which means this theory says there are spores which fall on to the earth and they were coming from the other planet and that is how they have given the appearance of the different types of organisms. And that could happen at the different era. So that so we have different types of organisms.

This theory was also known as the Theory of the panspermia or spores theory. The theory initially got the support from the fact that the fossil of microorganisms were found in meteorites in the 1961. So this theory initially got the support because there were fossils which were found in the meteorites. But no mechanism is known about the transfer of spores from the other planet or whether these spores could survive the journey in the space.

You know that the space is actually having a very, very non living non-life supporting conditions. So if that is the case how these spores were viable while they were travelling from another planet to the earth? And the absence of life forms on any other planet except earth is actually is not

giving any detail about the spores, its origin and the mechanism of crossing the interplanetary space and the reaching of the earth.

In addition this theory does not add much into the fundamental details about the origin of life because what it says is the life forms come from the other planet and that is how it is been at it is been actually been developed on to the earth. But what it does not give the fundamental question if how the life originated on that particular planet.

So and apart from that there were no experiments which was supporting this particular theory. So as a result the hypothesis did not receive the much attention. Although this theory was very, very attractive. It was going to solve the problem that it okay spores came from the other planet and and that is how we have the earth, we have the life on the earth. But it does not give any insight into the major question that how the life is originated on to the, on to that particular planet as well. So how the life forms formed on to the any planet is not been addressed by this particular theory.

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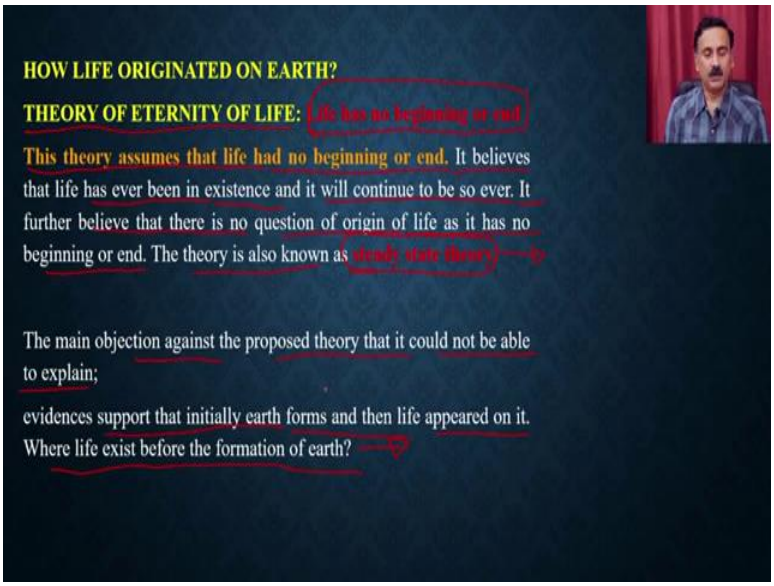

Then we have another theory which is called as the Theory of Eternity of life. So this theory believes that the life has no beginning or to the end, which is very, very funny and interesting assumption. So this theory assumes that life had no beginning and the end. It believes that life has ever been existence and it will continue to be so far.

So life is, you cannot destroy the life and it cannot be originated. So there is no question of raising this question that how the life originated on the earth. So it further believes that there is no question of origin of life. It has no beginning or the end. So that theory is also known as steady state theory, which means it says that life is a, cannot be created, cannot be destroyed. And that is how this theory is also called as Theory of Eternity of life or the steady state theory.

The main objection against the proposed theory is that it could not be able to explain evidences supporting that the initial earth forms and then the life appeared on the earth, whereas life existed before the formation of the earth. So this theory does not be able to explain many of the objections.

So we have discussed the five major theories. We have discussed about the Theory of Special Creations. We discussed about the spontaneous generations. We discussed about the Theory of Catastrophisms. We have discussed about the Theory of Cosmozoics and we have discussed about the Theory of Eternity of life. What we have discussed, what we have understood from this theories is we have discussed so far about the five theories, that the life is originated.

So for example Theory of Special Creations, the Theory of Special Creations says that the God is the creator of the earth and other organism and all these organisms appeared on the same day on earth. But we known that all these things are, assumptions are wrong. Most of these theories were based on the without conducting any experiments. So and that was the major issue that even if the experiments were done, like for example experiments were done by the Redi's or Spallanzani or Louis Pasteur these experiments were done only to disprove the Theory of abiogenesis rather than providing any kind of evidences to support.

The evidences even if the evidences were been given for the Theory of abiogenesis like the generation of the different types of animals in the Nile river or the development of the worms in the, when you dip the horse tail or when you keep the wheat with the dirty shirt it actually gives rise to different types of mices.

All these evidences are superficial. They were not very well-defined scientific evidences and they were not scientific experiments to disprove or prove these particular theories. Although the Redi's experiment, Spallanzani experiment or Louis Pasteur experiments clearly disprove that

there is a Theory of abiogenesis. It is not applicable or not been able to explain completely the origin of life on the earth.

So with this we are going to conclude for today's lecture. In the next lecture we are going to discuss about the modern theory, modern theory origin of life which is also called as the chemical theory. And in that lecture we are going to see the well-defined experiments and how the life would be developed on to the earth. So with this I would like to conclude my lecture here. Thank you.