

**Cell and Molecular Biology**  
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**Week 01**  
**Origin of Life and Evolution**  
**Lecture - 01**  
**Origin of Life (Part 1)**

Hello everyone this is Dr. Vishal Trivedi from Department of Biosciences and Bioengineering IIT Guwahati. 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 onto 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 ,you know acquired the characters acquired the features so that they will be able to adapt 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.

So what is life? So life is defined as the ability of an organism to reproduce, grow, produce 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 could be able to reproduce, which means it can be able to give you the offsprings, right? it could be able to utilize the raw material whether the raw material would be in the case of plant for example it could be a sunlight right or if it could be the other organisms like the plant itself could be a raw material for the other organisms some organisms are the herbivores and some organisms are the carnivora. But irrespective of that the life is going to be defined as the ability to 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 actually be able to grow in size. Like, for example, when we born, we are born as a child.

Right. Then slowly, slowly, slowly we grow in terms of height, in terms of our hands are big. Then we are. So that's how we become adult. Right.

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 be utilized 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's how the plants 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 the life is originated onto the earth the scientist as well as the philosophers have tried to understand the two important questions related to life. First is how the life originated onto the earth because this which looks very simple with the you know easy way that okay you have an organism it is utilizing and all that. but the first question is that how the organism have evolved an ability to do that and that we should be able to understand so the first question is that how life originated onto the earth and the second question is once the life originated onto the earth how it has actually acquired the different types of features like so how the different kinds of organisms are being formed you know that we have many types of invertebrate organisms we have different types of multivariate organisms we have plants we have the fungi we have different types of bacteria we have viruses we have viroids we have mycoplasma so how these different types of organisms which we have discussed in the previous module are being developed onto the earth right how these are the 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's start how the life originated onto earth and if you want to understand the life we have to first understand how the earth is formed and how why the life is also only present onto the earth. If you recall and if you go through with the different types of you know newspapers and all those kind 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 the earth but they don't have the life, so we first have to understand what will be unique about the earth so that the life is only originated onto the earth and you know what are the different conditions which are actually allowing the life to be originated onto earth. So, to understand these questions we are going to ask how the earth is formed and why there is a life onto 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 the other planet in the solar system came to existence about 4.5 to 5 billion years ago, right. And earth originally had two components. One is the solid mass like the earth, right, which is also called as the lithosphere and the surrounding gaseous envelope which is called as the atmosphere. You know all these, that you have the two major components.

One is the solid mass which is called as the lithosphere, which probably you commonly say as the surface. and the atmosphere right the air around that. So once the temperature of the primitive earth cooled down below 2000 degrees Celsius then the liquid component also came which is also 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. Now if you see the structure of an earth what you will see is that the earth has the different layers and these layers are as follows.

You have the baryospheres, you have the pyrospheres and you have the lithosphere. So this is I am talking about the solid mass which you are talking about right. So, you have the baryospheres. So, it is the central core of the earth. So, this is the baryosphere which is the central core of the earth and it is filled with a molten magma with a large quantity of iron and nickel.

So, this is the central part which is called as the barospheres and it is actually been filled with the minerals like the iron as well as the nickel. And this is the only portion which actually comes out from the earth in the form of when there will be you know volcano eruption. So then this portion comes out from the earth in the form of the lava right and that is how the it actually you know it is very hot and because this is the portion which is very very you know having a molten these metals right. So these metals once they comes out in the form of you know the or in the form of the lava, they become, you know, they destroy the regions. The baryospheres have two zone, 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 the liquid iron which is because why it is so because the inner core is a high temperature at 3400 degree Celsius whereas the inner core has a temperature at 4300 degree Celsius. and it also increase the pressure changes into the solid phase. So, inner core has a radius of the 800 miles whereas the outer core has a radius of the 1400 miles radius right and apart from that then you have the middle layer which is middle layer is 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 degree 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 you know the place which is filled with the different types of metals and mostly these metals are you know the silica, manganese and magnesium. So, you know that the silica is actually a main component which is forming the soil right and then you have the lithosphere. So, 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 aluminium. So if you recall these are the three layers you have the baryospheres 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 a volcano eruptions and then you have the middle layer which is also called as the pyrospheres and this middle layer is also consists 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 right.

So, outside you also has the atmosphere and you also has the hydrosphere right. So, this is what you have which actually we present around the earth. Now, how this actually can make the earth as a suitable planet for developing the life right. 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 a primitive environment was the reducing environment which means it was not containing the oxygen. So, there will 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 the oxygen is coupled 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 been remain 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 to 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 the 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 right spontaneously. Even if you keep a sugar molecule and you do not do anything it is actually going to get oxidized because there is a 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 deformed organic molecules. 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 onto the earth because it has a reducing environment and then it also has the gravitational forces to hold the gases within the atmosphere of the primitive gas. So what are the organic material what you have you have water you have methane you have ammonia and you all these are in the present of the gases because the temperature of the earth or the temperature of the primitive earth is approximately around 1000 degree Celsius.

So that it always keeps water not in the liquidified form that always keep 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 raw materials, essential inorganic materials, right. So inorganic material in the earth interact to form the organic material required to produce the life. For example, we have just discussed, right, in the previous slide that we have the, you know, we have the iron, we have the aluminium, we have the silica, we have the, you know, nickel and all these metals apart from these metals we also have the, you know, water. which is very very important for the life right you might have seen right if you keep water in a in a bucket or somewhere and if you leave it like that undisturbed you will see that the algae and all other kinds of live organisms originates right.

so that is actually the power of the water right because it allows the growth it allows the growth of the living organisms then you also have the methane you have the ammonia right and all these are very very essential for the you know 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 you know a very big source of energy in the form of sun right.

Then we have the electric discharge. So these are electric discharge will come when

there will be a lightening. Then we have the you know volcanic eruptions. So volcanic eruptions I think just we in the previous slide only we have discussed that if there will be a volcanic eruptions it gives rise to the you know it allows the coming out of the magma and it coming out of the lava right. So around 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 these reactions under the normal circumstances or at a very very low temperature right.

So you always require the energy if you want to form the complex molecules. And then there was no, the last point is the infinite time, right? As per the estimate, it took approximately 1 billion year 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 reactions, what you are going to do? Suppose I want to convert A into B, right? So, what I will do is I will just put an enzyme and I will put the cofactors, right. I will put some, once I put the enzyme, the A is going to be get converted in the range of milliseconds or seconds actually.

But since the enzyme were not present onto the primitive earth because enzymes are biological catalyst they can actually be able to enhance the rate of reactions right and that is how the A will get converted into a at a rapid rate but since the enzyme were not present onto 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 reactions of hydrogen and oxygen to give you the water and that is why it took so. 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 still we have the you know the original question left that how the life originated onto earth.

To understand that questions the people in the different eras actually you know proposed the different types of hypothesis or different types of theories to explain that. So what are these theories, these theories were mainly based on to the experimental basis or assumption based right So, there are six 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, the 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 been based on the trust as well as the belief and there was no

experiment so no experimental evidence that God has created the earth right or god has created the organisms . Then we have the theory of spontaneous generations. So theory of spontaneous generation believes or hypothesized and there were a couple of scientists who believe that the non-living matter give rise to the living organisms. 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's how it actually are very much close to the 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 cosmozoic the scientists who were supporting the theory of cosmozoic believe that the life on the earth comes from the other planet.

But the main questions remain the unanswered. Even if the life is comes from 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 a 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 you know 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 been dependent or completely been based on the experiments what has been done by the Miller and Urey. So let's start discussing each and every theory and why the people have not accepted these theories. So the first theory is the theory of special creations. The theory of special creation 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 God took seven days actually to create the different organisms and so on. So and every religion has its own beliefs. So according to the Christian belief the God has created the universe, planets, animals, plants and human in the six natural days. Similar beliefs are also being proposed by the 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 the any kind of experiments. They were all based on the 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 it's been says is that all living organisms were created on the same day because if it is created by the God, it can actually been created by the same day, right? 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, right? Because 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 that particular organisms and the ages of the different organism, 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, right? Then the second is they were 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 onto the different organisms right. 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 been acceptable or not been 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, right? There is a adaptation, there is a adaptation in the every organisms and that's how it actually give rise to the different organisms.

So all that these three points which were being 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. When you do try to you know sort out a problem you are first going to do a hypothesis right. you are going to first generate a hypothesis then this hypothesis has to be tested by doing the set of experiments and then these experimenters have to analyze right so this was the scientific way of sorting out a problem right and once you analyze then 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 the other planet 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 things. right Since this theory was based on a non-experimental basis, the most of the scientists have discarded this theory and the third objection was that the age of the different fossil proven that the living organism appear on earth in different time frame

which means there was not been created in 6 days because if there are been created in 6 days, you are not going to see the change or difference between the different organisms. So because of this the theory of special creation is not been acceptable or it was not been able to explain how the life originated on the earth.

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 give 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 was observation 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 non-living 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 thing 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 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 right. Similarly, this horse tail which is actually you know horse tail is made up of right keratin right. So, a horse tail is also keratin. So, which is also you know the non-living material right because it is hair right and that also give rise to this particular worm right. Then the third observation was that in the ancient Egypt the people believed that in the Nile river if it is Nile river is you know warm with the sun. then that give rise to spontaneously the development of frogs, snakes and as well as the crocodiles.

So, it was a spontaneous right. So, people have observed that if there is a sun onto the Nile river, it actually give rise to the different types of animals like frogs, snakes and crocodiles. And then ultimately the one scientist which is called as the Van Helmont that he has done an experiment as well. So, what he has done is he took dirty shirts and it has taken a handful of wheat grain and then he has kept those things right, so it has took the wheat grains. or the barley you know and he took the shirt right so he took the shirt and he put it into a cupboard and that cupboard he closed that cupboard for three weeks okay. What he could found is that this cupboard has actually developed the mice at the end okay but he could not be able to explain how the mice are being developed or even a majority of these things they could not be able to explain why only the this particular

worm is been developed or why the flies were developed onto the rotten meat and so on.

So, then the people have started developing or accruing the evidences which will actually going to disprove. So, there were evidences which are been proved against the theory of spontaneous generation. So, the theory of spontaneous generation was criticized by the three scientists the Spallanzani, Francisco Redi and the Louis Pasteur and these great scientists perform the well-designed scientific experiments to disprove the theory of spontaneous generations. See, these people have not done any experiment they were only proposed the hypothesis and they and the all these hypothesis were based on the observation. So there was no experiment except that the Van Helmont probably has done a very very crude experiment.

where he has just kept the dirty shirt and a 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 control experiment, 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.

So the first experiment is being done by the 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 jars. What he has done is he has taken a rotten meat, okay he boiled that meat and so that it becomes soft and then it gets rotten right 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 a gauze Gauze is actually is a cloth actually which actually has the net on that right you might have seen the gauze which people use for causing the bandage okay 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 actually be able to allow the you know the smell or other kind of things to come out. So then the second jar he has closed with a gauze. In the third jar he has closed with a parchment which means it has actually closed completely.

So neither the smell can come out nor the animals or the flies can actually go inside. So what he has done is he took the three jars, the jar one was left open so that the any animal or anything can actually be able to go inside. Then jar two was covered with the gauze as I said you know 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. Then 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 one? So first see that. So what happened is in the jar one where the smell came out right from this rotten meat as well as the fishes. So as a

result the flies came right. So flies came from outside and that is how the flies are 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 non-living material has give rise to the life. Then the second object, second jar he has put it as a muslin cloth or the gauze right.

So gauze actually is doing something. So what he has done 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 kind of things, but instead these flies because they are attracted on to the top surface, they have given the maggots on to the surface of this particular paper cloth. Then in the jar 3 which was conclusive 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 there was no development of 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 rise to the new organisms whereas you see the 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 give rise to the new larvae. So that is the theory of abiogenesis right whereas in the jar 2 the flies could not be able to enter and no larva was found inside the jar. So that was a disproof or you know contradictions to the theory of abiogenesis but the flies laid egg on the gauze to produce the larva and that is actually the point which the Redi was trying to prove that it is the fly which actually give rise to the maggot. It is not the meat which give rise to the maggots actually. And, this was conclusively proved that the organisms arise from the pre-existing organism rather than the non-living matters.

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

So, in the designed experiment to test the validity of 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 open or sealed immediately. These broths remained free from the microorganism growth right. He concluded that high temperature boiling had killed all the microorganism 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

microorganism. 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 will be any microorganism which is present inside this broth should be get killed.

So there should be no pre-existing broth and then what he has done is he has kept the broth open or the flask open and then he allowed the broth to be cooled down. So after some time when he waited for the you know few days or few weeks what he could found is there will 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 when it was hot actually. So because of that there will be no entry of microorganisms from outside and that is how this flask remains you know without growth. But what happened is as soon as, so he that demonstrated that for the appearance of the microorganisms you require an external source.

You can, so to prove that what he has done is he opened the flask for some days and what he could found is that there is a growth of microorganisms. Now the major objection to the Redi's experiment or to the Spallanzani experiment came because both of these experiments were not allowing one major component. One major component is air right. So it was not allowing the entry of air. So the scientists who were the supporter of the theory of abiogenesis or the theory of spontaneous generation says that you know you have destroyed or you abolished the entry of air and because of that the life has not been originated into this flask because air is a very very important component for the living organisms and that's how you are actually this experiment does not prove.

So to prove this particular point the Lewy Pasteur has also done a similar kind of experiment. So what he has done is the Louis Pasteur has used a S curved flask okay. So what he has done is so in an another conclusive experiments The 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 microorganism. So what happened is he has boiled the broth and then the broth actually the vapors are coming and going right but when he has stopped the heating the broth actually got condensed in this particular portion right. So there was a layer of water which is being formed here. So, because of that it does not allow the entry of microorganism. So, you are actually have the two component one the entry of microorganism the 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 remain open for several days and he could not found any growth. So because why it is so because this particular portion was you know 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 indicates the appearance of the microorganism 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 many type of microorganism but they could not go and because of that there is no growth for even for several months. But when he has broken the neck and did not 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 the 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 being generated from the non-living forms. Now the second theory is that the next theory is the theory of catastrophism.

So it is similar to the theory of special creations. This is the extension of the theory of special creation. This theory assumed that the life is originated by the creation. and it is followed by the Castrophes due to the geographical disturbance. Each Catastrophe destroyed the life completely whereas each creation forms life remain different from the previous one. Hence, each round of Catastrophe or creation is responsible for the involvement of the different types of organism on the earth.

So, what this theory says? There is a creation portion, so there is a creation and there is a destruction. Destruction because of the different types of natural calamities like volcanic eruptions, the lightening, 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 the different organisms are being appeared onto the earth and that's why we have the different types of organisms. The objection of this particular current theory is same as the previous one, right.

No scientific experiment is there to support the hypothesis and mostly it is a imaginary concept. So, that's why the people don't believe that there is a theory of catastrophism. Then the second theory is the theory of cosmozoic. The theory of cosmozoic 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 been supported by another scientist which is

called as the Arrhenius. The theory assumes that the life was present in the form of resistance force and appeared onto the earth from the other planet since the condition of earth was supporting the life these spores grew and evolved into the different organisms which means this theory says there are spores which was fall onto 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 a different era so that is how they there we have a different types of organisms.

This theory was also known as the theory of the panspermia or the sperm theory The theory initially got the support from the fact that the fossil of the microorganisms were found in the Meteorites in the 1961. This theory initially got the support because they were you know they were fossils which were found in the meteorites but no mechanism is known about the transfer of spore 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 traveling from the another planet to the earth. And the absence of life form on any other planet except earth is actually is not giving any detail about the force, 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 detail about the origin of life because what it says is the life forms come from the other planet and that's how it will actually been developed onto the earth but what it does not give the fundamental question is how the life originated on that particular planet right and all the apart from that they have there were no experiments which were supporting this particular theory. So as a result the hypothesis did not receive the much attention. Although this theory was very very you know attractive it will you know it was you know going to solve the problem that okay the force came from the other planet and that is how we have the life on the earth but it does not give any insight into the major question that how the life is originated onto the that particular planet as well. So how the life forms formed onto the any planet is been not been addressed by this particular theory.

Then we have the 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 assumptions. So this theory assumes that life had no beginning on the end right. It believes that life has ever been existence and it will continue to be so far. So life is like you cannot destroy the life and it cannot be originated so that there's no question of raising this you know question that how the life originated on the earth So, it further believed that there is no question of origin of life, right, it has no beginning or the end. So, that theory is also known as the steady state theory which means it says that life is a,

you know, cannot be created, cannot be destroyed, okay, and that's 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 exists before the formation of the earth, right. So this theory does not be able to explain many of these objections. So with this you know we have discussed the five major theories, we have discussed about the theory of special creations, we discussed about the theory of spontaneous generations, we discussed about the theory of catabolism, we have discussed about the theory of cosmozoic and we have discussed about the theory of eternity of life. What we have discussed, what we have understood from these theories is that we have discussed so far about the five theories. For example, the theory of special creation, that the theory of special creation says that the God is the creator of the earth.

and the other organism and all these organisms are appeared on the same day on the earth but we know that all these things are assumptions are wrong. Most of the these theories were based on the without conducting any experiments. So, and that was the major issues that even if the experiments were done like for example, the experiments were done by the Redi or Spallanzani or the Louis Pasteur. These experiments were done only to disprove the theory of abiogenesis rather than to 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 the horse tail or when you keep the you know the wheat with the dirty shirt it actually give rise to the different types of mice all these evidences are superficial they were not very well defined scientific evidences and they were not scientific experiments right.

to disprove or prove these particular theories. Although the Redi's experiment, Spallanzani's experiments or the Louis Pasteur experiment clearly disproved that there is a the theory of abiogenesis is not, you know 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 of the life, 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 could be developed onto the earth. So with this I would like to conclude my lecture here. Thank you.