Basics of Biology
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Module XI: Summary and Conclusions
Lecture 49
Summary (Part 1)

Hello everyone, this is Dr. Vishal Trivedi from Department of Biosciences and Bioengineering IIT, Guwahati and what we were discussing, we were discussing about the basics of the living organisms and in this course, which is almost about to end. So far what we have discussed, we have discussed about the different aspects of the living organisms.

So we started with a very basic understanding about the living organisms, where we discussed about the, what is the biology and how the biology is involved with to the different types of experimentations by the scientists and so on. So, in this particular module, what we are going to do is we are actually going to give you an overview of whatever we have discussed so far.

Since your exams are coming up very shortly, this kind of revision and this kind of recapitulation of whatever we have discussed so far, is actually going to help you to face the final exams or it will help you to prepare for the final exams. So, let us start our lecture today and what we are going to do today is, we are going to discuss about the very, superficially we are going to go through with the content what we have discussed so far in the last previous 11 modules.

And then we are going to deal some of the aspects which I feel that important for you to understand. And hopefully this is actually going to help you in terms of preparing for your exams. So, what we have started with, we started with the very basic understanding about the classifications, then we started about of the living different types of organisms and that could have helped you to understand how these organisms are complicated.

How they are actually been diversified from the other organisms and so on. And from where this diversity comes? This diversity comes because the every organism is trying to evolve over the course of time and that is how they are actually been evolved into the different types of species and different types of organisms.

With the basic understanding about the classification and the evolutions, we have then further moved on to tell you, give you the very detailed analysis or detailed description about the different types of cells, what are being found into the prokaryotic or the eukaryotic cell.

In the prokaryotic cell, we discuss about the cell wall we have discussed about the cell wall of the gram negative and gram positive we have also discussed very briefly about the gram staining and so on. And then we have also moved about the eukaryotic cell. So let us discuss some of these aspects in detail. And I hope it will help you to prepare for your exams.

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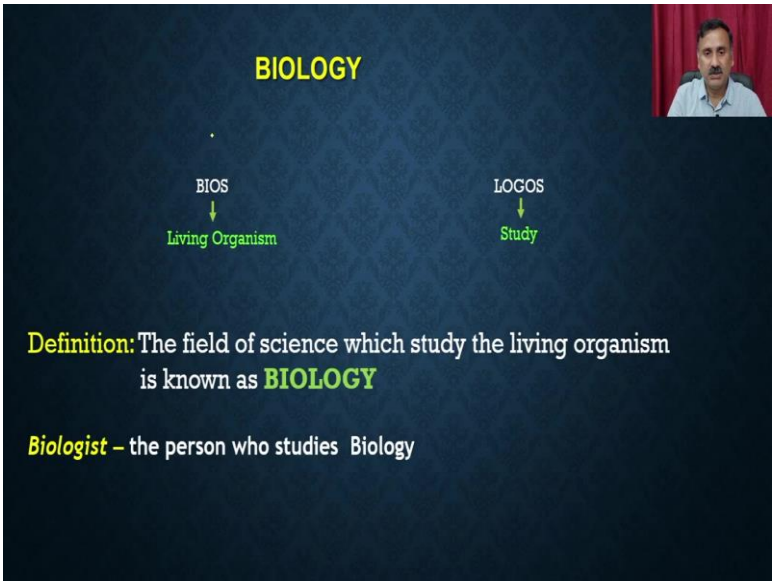

So we will start with a very basic same questions what is biology? Biology is a field of science, where you are actually going to deal with the different aspects of the living organisms. So, as the name suggests biology is a submission of the two words one is called as the BIOS the other one is called as the logos and the BIOS means the living organisms whereas the logos means the study.

So, this means the biology is, the definition of the biology is that it is the field of science, which actually study the living organism and that is known as the biology. So, and the person who actually studied the field of biology are called as the biologist. Now, since we are talking about the biology and the biology is a field of science, which is study the living organism, it is important for us to even discuss about the what is living organism and how the living organism is different from the non living organisms?

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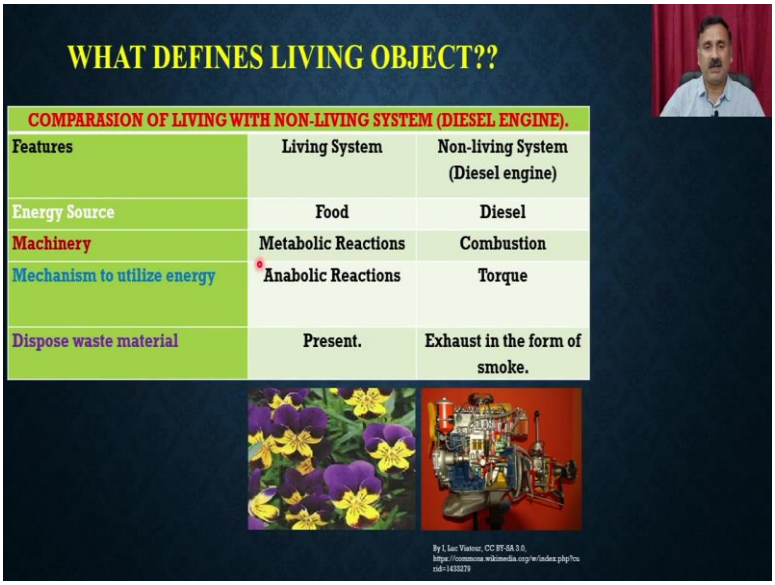

So, what is living organisms? Living organism, we have discussed in detail about the different types of the properties of the living organisms and here I have given you a comparative differences or comparison of the living organism versus the non living organisms. So, they are different in terms of the intake of the food their mode of how they are actually generating the energy and how they are actually disposing of the waste material.

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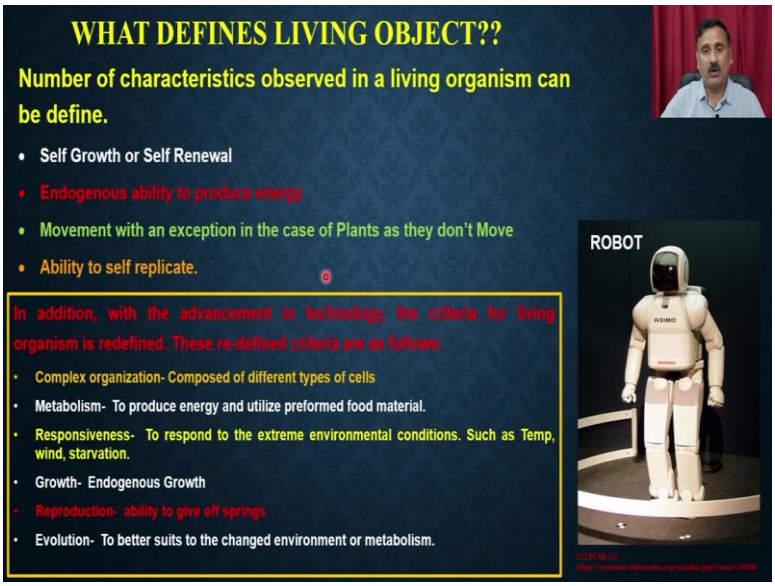

Now, we have also further moved on and discussed in detail or defined what are the conditions which is actually going to define as a living organisms. So, one of the important feature of the living organism is that it is should be having a self growth or self renewal, which means that growth should be in indigenous rather than exogenous.

And it should have the indigenous ability to produce the energy right, and then should have a movement with an exception that plants they do not move, but the plants are also the living organisms, and then they also should have the ability to self replicate.

And once we understood the living organism, once we understood the biology and how the different biologists have studied the field of biology and their contribution into the biology before they are moved on to the ask the first question is how we can actually be able to classify the different types of organisms.

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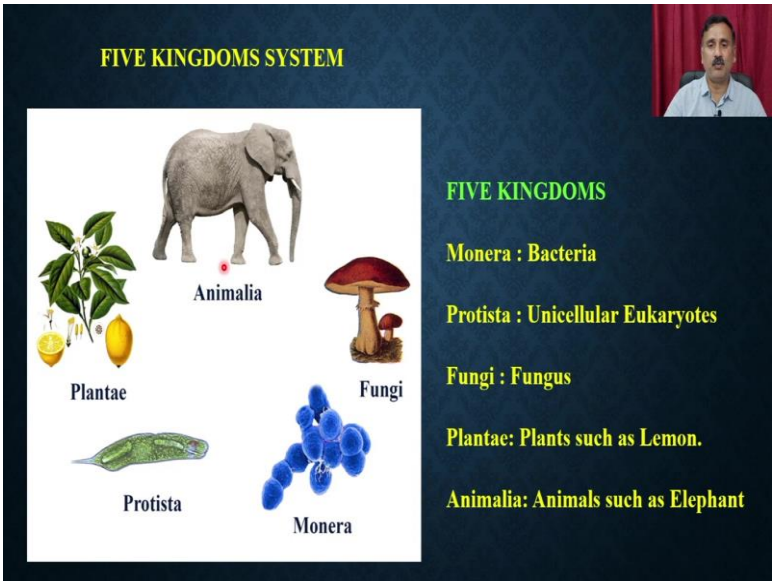

So, there was a proposal about the five kingdoms system, in a five kingdoms system, we have the five different kingdoms like Monera, Protista, Fungi, Plantae and Animalia and how these five kingdoms are being you know, how the animals are being classified into how the organisms are been classified into the five Kingdom is based on the differences or the similarity among the different types of organisms.

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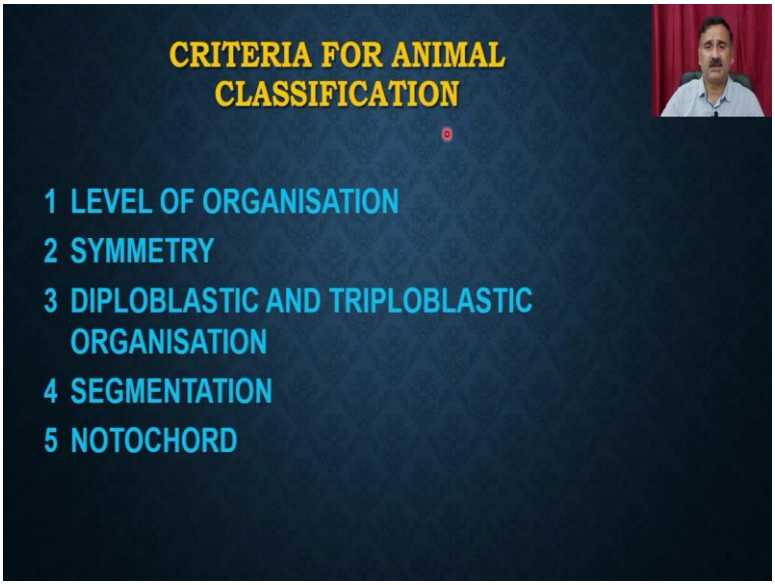

So, then further, we move further moved on to discuss about the different types of criteria what people have used to classify the living organisms. So, we discuss about the five different criteria like the level of organizations, symmetry, different types of the membranes or present or diploblastic or diploblastic organizations, segmentations and notochord. And based on these kinds of criteria of the classifications, the whole animal kingdom is been classified into the multiple sub phylum and phylum.

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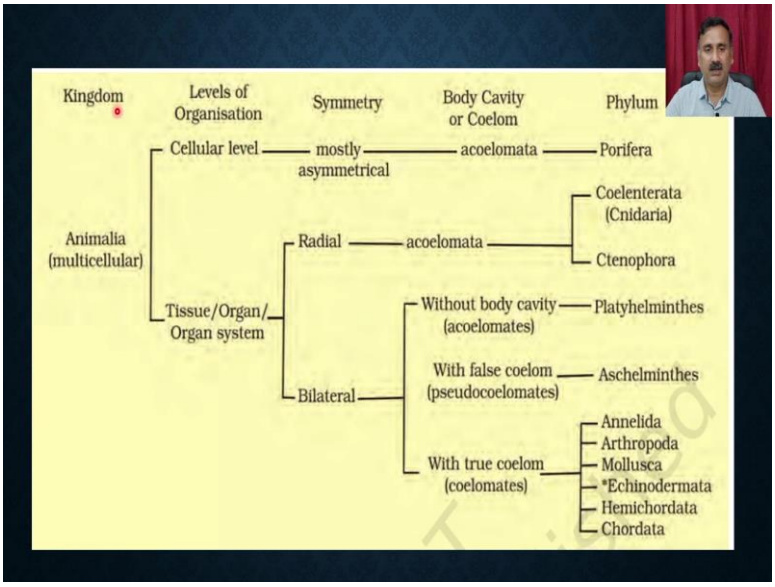

So, if you see it, how the Kingdom Animalia is been distributed. So, based on the level of organization, either you can have the cellular level organization or the tissue or the organ system of the organization, then within the symmetry you can have the asymmetrical, radial

symmetry or bilateral symmetry based on the body cavity, it could be acoelomate, coelomate or within the coelomate, you can have the pseudocoelomates or the coelomates.

And then within the and based on this it has been divided into the different phylum for example, within the Porifera, so Porifera is a cellular level of organizations mostly asymmetrical, acoelomate, so that is why these kinds of organisms which you are following these kinds of organizations, it is been classified into the Porifera.

Similarly, when the organization is the tissue level or organ system, then it could be radial or bilateral. So, if the symmetry is radial and organism is acoelomate, then it can either be coelenterate or the ctenophora and then if it is symmetry is bilateral, then it can be acoelomate, pseudocoelomates or the coelomate.

If it is acoelomate then it can be a platyhelminthes or the flatworm then if it is a false coelom that is a pseudocoelomates then it can be Aschelminthes and if the true coelomate then it could be the Annelida, arthropoda, Mollusca, Echinodermata, Hemichordata and Chordate. Remember that this is a summary of what we have discussed in the previous module.

So, we are not going to discuss in detail about all of the properties of these firearms and so on. And if you see here if the chordata is at the bottom and the chordata is a well defined and well developed organisms. So, after this we have also discussed about how the organisms are being evolved or how the organisms are being originated on to the earth.

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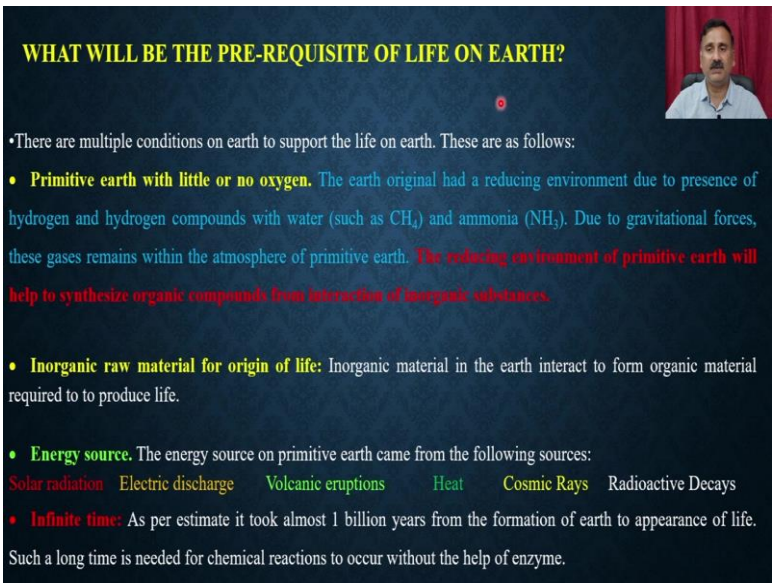

So, what is the pre-requisite of the life on the Earth? Because there is only one planet on which the life exist and that is the Earth right. So, there is a condition so primitive Earth with very little or no oxygen so that was the first criteria that why the Earth has been chosen as the planet for the origin of life right.

And then we have the lot of inorganic raw material for the origin of life for example, all these inorganic material is required to produce the organic material and then it also require an energy source. So, energy source could be the solar radiation, electric discharge, volcanic eruptions, heat, cosmic rays are the radioactive decays, and then there is a in finite time.

So, as per the estimate it took almost 1 billion year from the formation of Earth to the appear of the life and that is why such a long time is required for the origin of life and origin of life is a very, very complicated process and there are many hypotheses, what has been proposed for explaining the origin of life on the Earth.

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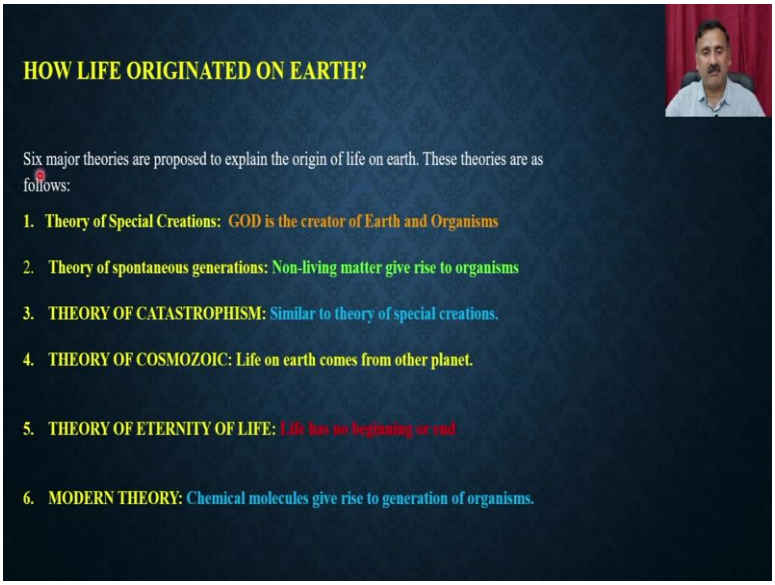

So, we have discussed about the six different types of theories, we have discussed about the theory of special creations, we have discussed about the theory of spontaneous generation theory of catastrophism, theory of cosmozoic, theory of eternity of life and then we have also discussed about modern chemical theory.

So, in the theory of special creation, God is the creator of Earth and the organisms and there are different steps in which the people have explained how the God has created the earth and as well as the different types of organisms, and there are all a lot of contradiction for most of these theories, including the modern theories.

So, as far as the experimental evidences is concerned, the theory of spontaneous generation and the theory of modern theory of chemical theory is actually been explained by the different types of experiments. Apart from that, there are so many experiments are being done to overrule the some of these, you know the proposals.

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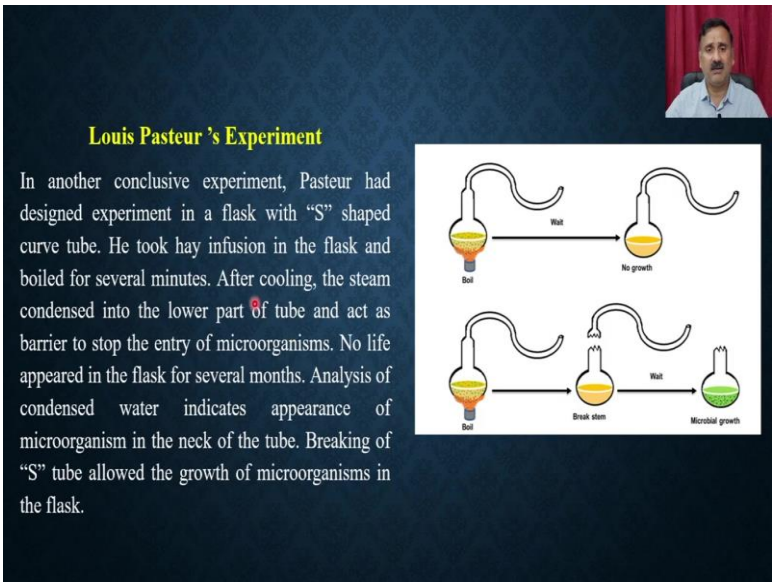

So, one of the classical example, which is always been done by the Louis Pasteur is that, where the Pasteur has actually grown the broth into an S shaped curve. So, in a Pasteur whatever he has done is he has taken the S shaped curve Q, and he took the hay infusion in the flask and boiled it for the several minutes.

He boiled it so that the broth is going to be sterile. And after cooling down, the steam which comes out from the broth is actually been condensed into the this S color tube okay. And it actually act as a barrier to stop the entry of microorganisms. So, no life appeared in the flask was several month analysis of the condensed water indicates the appearance of the micro organism of the neck and the breaking of the S tube.

So, when if he wants to confirm that it is basically because of this kind of barrier, he broken the S tube and that is how he got the microbial growth. And that is actually been an experiment to disprove the some of the early early access or earlier proposed theories.

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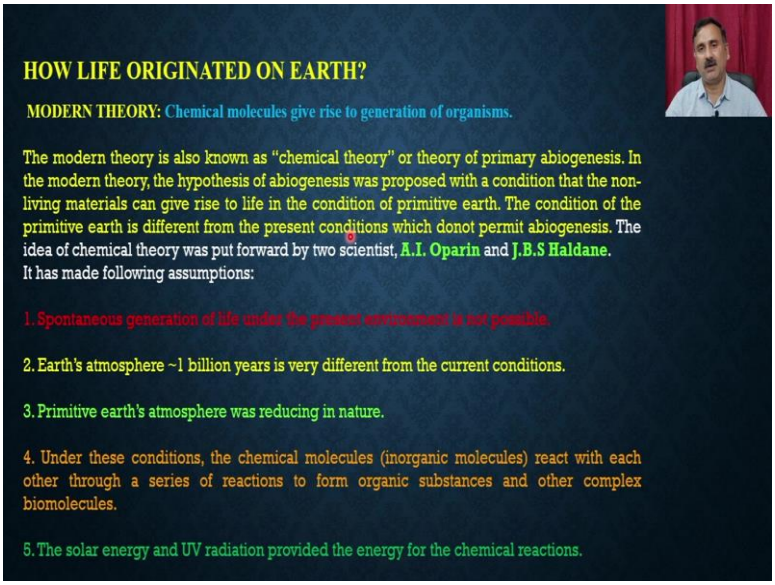

Subsequent to that, the people have this also proposed the modern theories and the modern theory is completely been a theory which is been dependent on the experiments. So, the modern theory or the chemical theory of the origin of life is been proposed by the AI Oparin and Haldane and it has the following assumptions.

The spontaneous generation of life under the present environment is not possible because the present environment is full of oxygen whereas in the primitive Earth it was the absence of oxygen, then the Earth's atmosphere approximately 1 billion years is a very different from the current conditions, then the primitive Earth atmosphere was reducing in nature currently, the Earth's atmosphere is oxidizing in nature.

Under these conditions, the chemical molecules react with each other through a series of reaction to form the organic substances and other complex biomolecule. And from where they are getting the energy, they are getting the energy from the solar energy and as well as the UV radiation.

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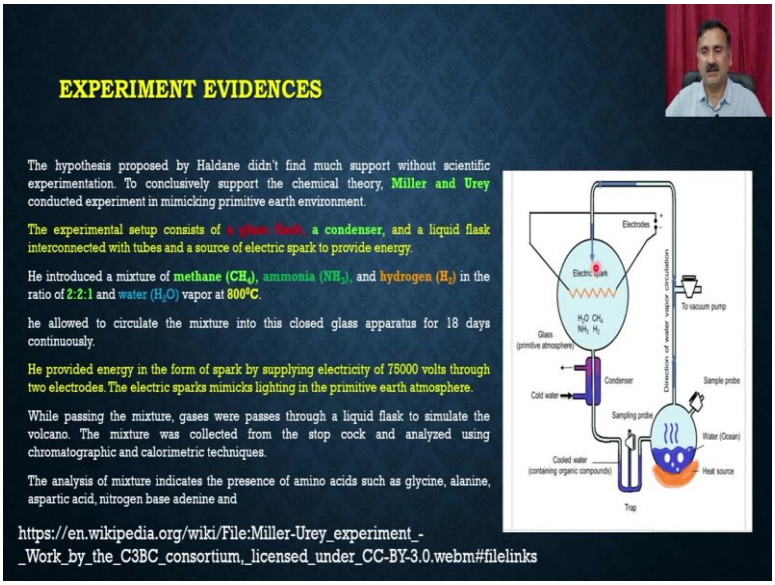

To prove these hypotheses, the Stanley Miller has done very classical experiments and where he has actually taken gaseous mixture, water, methane, ammonia and hydrogen and into a flask and that is how he circulated that flask into apparatus which has been designed by the Stanley Miller and based on this analysis, what he found is that the mixture of the amino acids is being formed like the glycine, alanine, aspartic acid and all that.

And I have given you a link here in case you want to see the demo of the how or actually animated movie, you can actually be able to click this and it will actually going to give you the animations how the this experiment is being performed.

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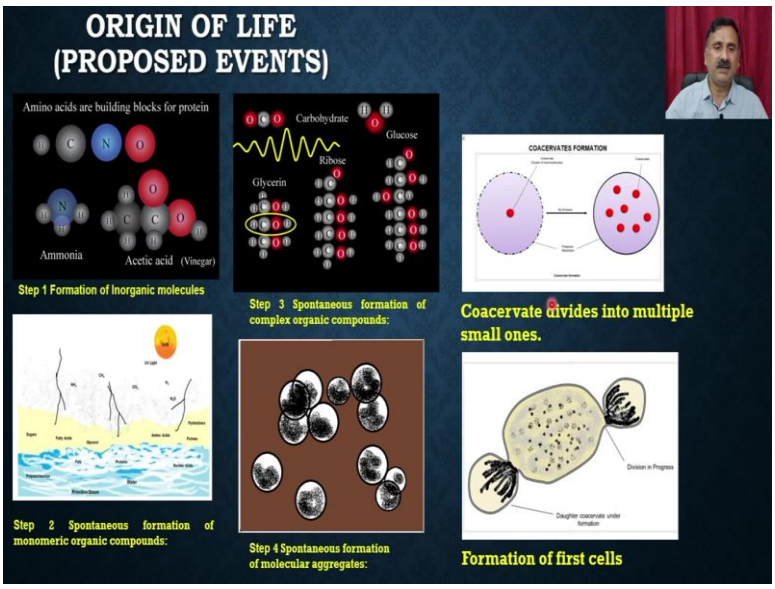

So, based on the modern theory, there are different steps in which the origin of life is actually being done right. For example, the in the step one there will be a formation of the inorganic molecules. So, inorganic molecules are being formed from the in from the condensation of the different types of so you have the inorganic molecules like the ammonia, acetic acid and so on and all these inorganic molecules are then subsequently being present into the primitive oceans and that will give rise to the formation of the monomeric organic compounds or the simple organic compounds.

Then in the step 3 these simple organic compounds were reacting with each other to give you the complex organic compounds such as the glycerine, ribose, glucose and so on. And once these complex organic compounds were formed, they were reacting with each other to form the coacervate and these are the proteinaceous aggregates where the protein is present inside and whereas the lipid is present outside and the coacervate were dividing into the, into the multiple small ones. A

nd that is how the coacervate were eventually being developed into the primitive cell or the first cell. And that is how the people has proposed the different types of the different types, different steps in which the origin of life could have been happened on to the Earth. These all these events are being proposed based on the data what people have, you know, developed by the Stanley Miller experiments or some of the presumptions.

And now, it is true that the primitive cell is been formed into the primordial action, but how primitive cell which evolved into the much complex multicellular system and as well as the very very complicated organisms like humans. So, for that, the people have discovered or people have proposed the different types of the theories to explain the evolutions.

So, there are chemical evolution. So, chemical evolution is being supported by the many types of evidences like the morphological instructional evidences and based on the this the people have proposed the mechanism of revolutions.

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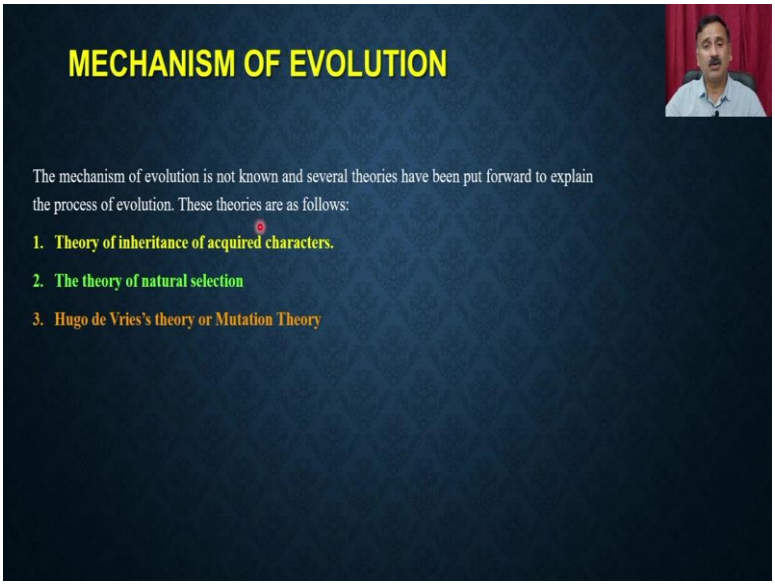

So, what we have discussed in this particular course, we have discussed about the 3 theories, we have discovered about the theory of inheritance of acquired character, and that is the theory which is given by the Lamarck. And then we also discuss about the theory of natural selection which has been done which has been proposed by the Charles Darwin.

And then we also discuss about the Hugo de Vries's theory or the mutations theory and all of these theories were having some of the positive aspects and some of the negative aspects and they were also heavily been criticized, because most of these theories were based on the non-scientific experiment, they were being done, they were be based on either the population studies or some of the mutational studies.

So, based on this discussion about these theories, it is been sure that the mechanism of evolution is still unclear, it could be a mixture of the Hugo de Vries's theory or mutations theory and as well as its theory of natural selections, but the Lamarck theory is also very much been used or very much relevant when the people have also taken up the modern molecular data or molecular components into that.

So, because when the Lamarck has proposed its theory of inheritance of acquired character there were so many information about the genetics, about the DNA and all those kinds of material is not or not known, right. So, that is why some of the all these theories were good to explain many things, but they were also lacking the full proof concept to explain the mechanism of evolutions. So, once we understood the mechanism of evolution, we have also discussed about the different types of cells.

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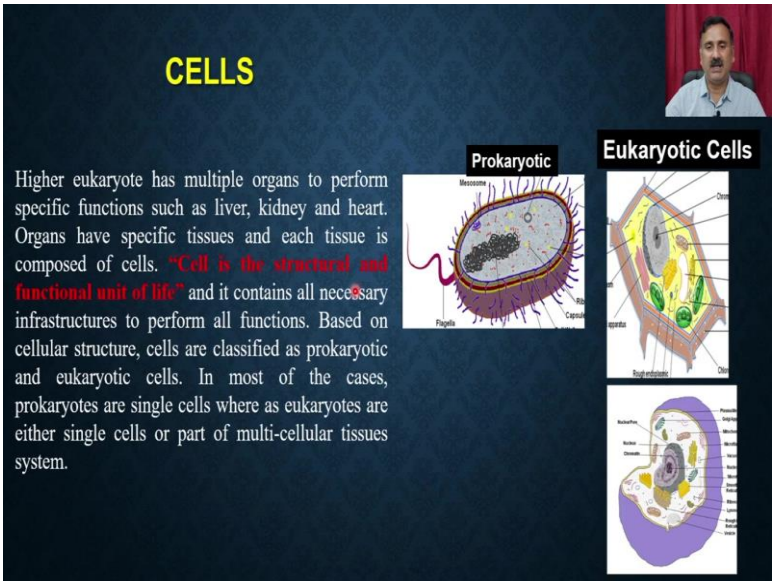

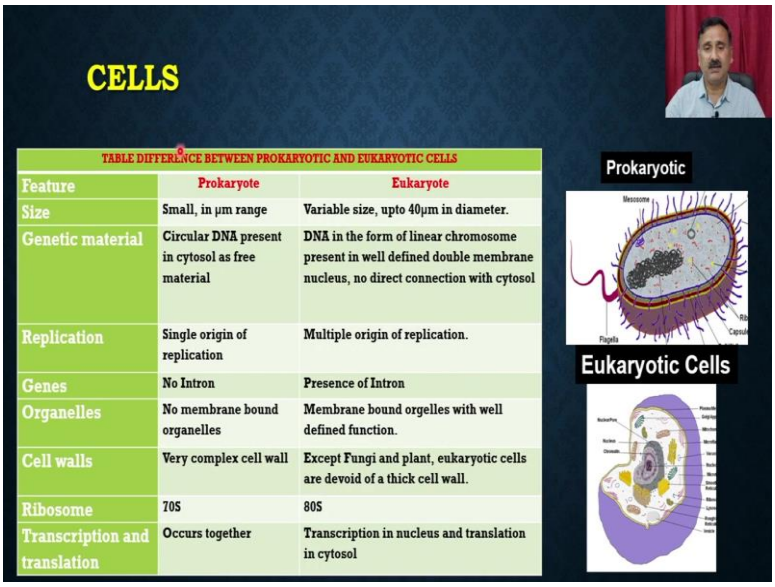

So, when we talk about the different types of cells, we have the cell is the structural and functional unit of life and the cell is it would be a prokaryotic cell or it could be a eukaryotic cell. In the eukaryotic cell, you can have the plant cell or the animal cell. And in this particular module, when we were discussing about the different types of cells, we discuss about the differences between the prokaryotic and eukaryotic cell.

So that as far as the differences is concerned, the prokaryotic cell the major differences that the prokaryotic cell does not contain the nucleus, it only contains a circular DNA which is present in the cytosol as a free material, whereas in the eukaryotes, the DNA is formed in the presence of linear chromosome and it has been encircled within a well defined double membrane nucleus whereas and which does not have a direct connection with the cytosol.

As far as the replication is concerned, the prokaryotes have the single origin of replication whereas, eukaryotes have the multiple origin replications. As far as the genes is concerned the prokaryotic gene does not contain the introns whereas, the eukaryotic gene contains the intron as far as the ribosome, ribosome is 70S in the case of prokaryotes.

And it is 80S in the case of eukaryotes and transcription and translations, translation and translation, our courts work occurs together in the case of prokaryotes, whereas, the transcription in nucleus and the translation in cytosol is different. So, transcription occurs inside the nucleus, then the RNA is formed and then it transported outside and it will be used for the translations.

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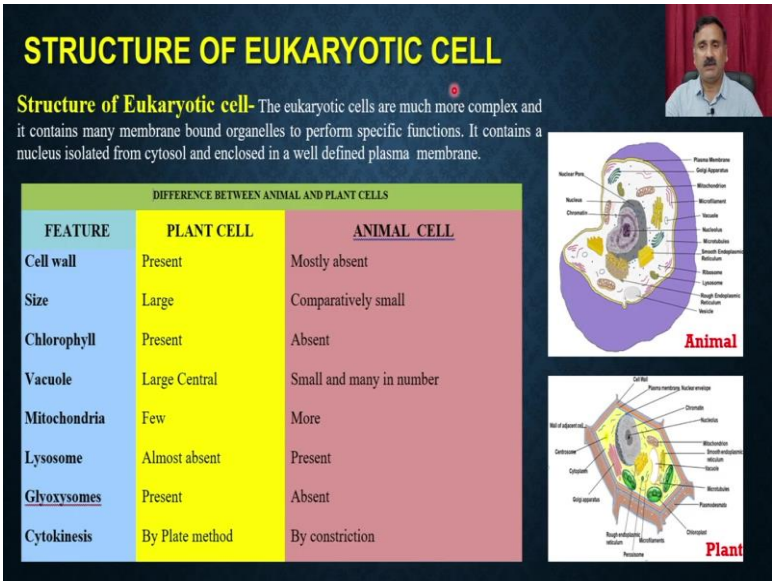

Then, we discuss about the structure of the eukaryotic cell and first thing that we have discussed we have discussed about the differences between the plant cell and the animal cell. So, this is the animal cell and this is a plant cell and there are so many differences, what we have discussed between the animal cell and the plant cell.

And then subsequent to that, we have also taken up the different types of organelles what are present in the either the plant cell or the animal cell. So, we have discussed about the mitochondria, plasma membrane, chloroplast, nucleus, we have discussed about the role of these organelles into the overall functioning of the cell and we also discuss about the organelles of the vesicular trafficking like endoplasmic reticulum, Golgi bodies and lysosomes. And, apart from that, we have also discussed about the differences between the plant cell and the animal cell.

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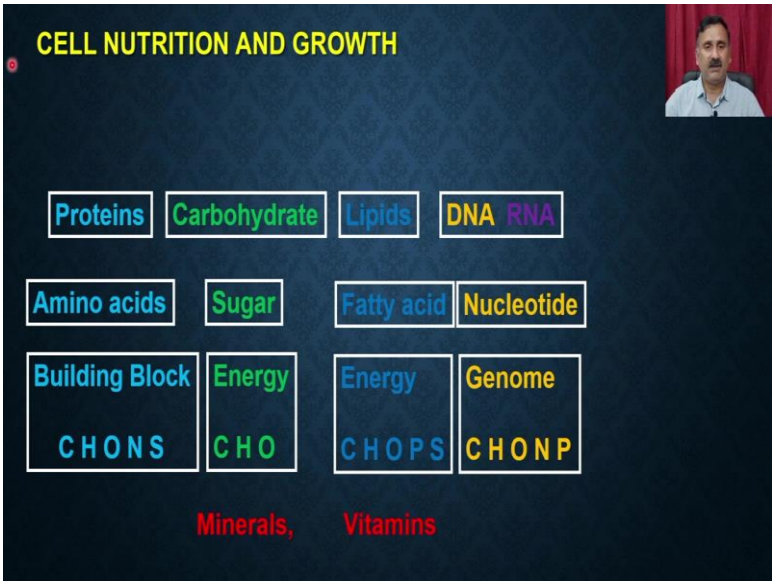

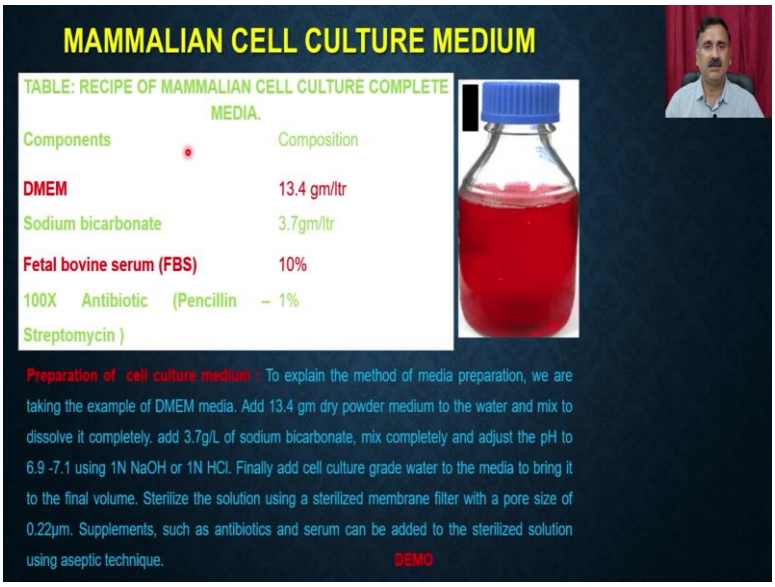

Subsequently, that we have very briefly discussed about what is the requirement of different types of cells for their replication or that for their growth. So, for every cell it requires a protein carbohydrate, lipids and DNA and RNA protein is being supplied in the form of amino acids, carbohydrate in the form of sugar, fatty acid and nucleotides and all these are required, because you want to synthesize the different types of biomolecules.

And we also discussed very briefly about how you can be able to grow the cells under the in vitro conditions by preparing the mammalian cell culture media and how at and we have also shown you a very small demo how you can be able to prepare the cell culture media.

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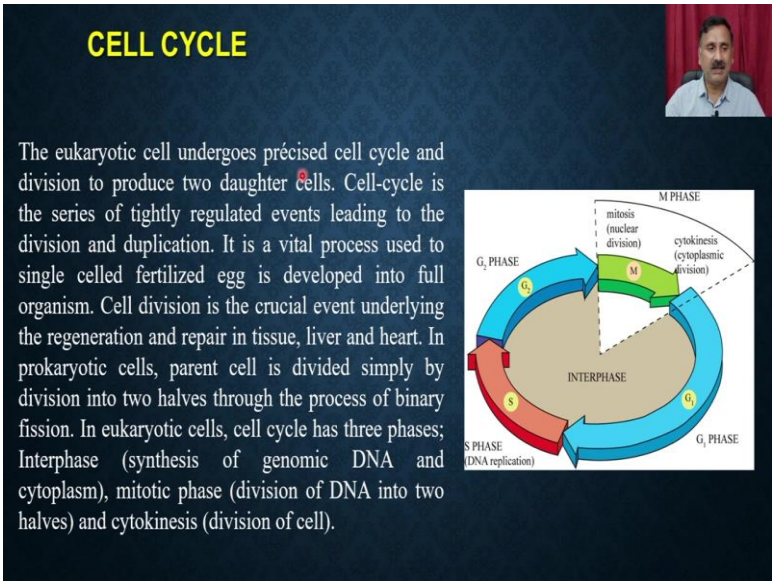

Apart from that, we also discuss about the cell cycle and cell cycles are actually been you know been discussed, so that you understand that when one single cell is dividing and giving rise to 2 cell it does not happen in the all of sudden, it actually cell undergoes the different phases where you have the G1 phase, S phase G2 phase and M phase.

So, within the G1 phase, it actually prepared the cells for the DNA replication. And in the S phase, there will be a DNA replication or the synthesis of DNA and then in the G2 phase it actually prepare the cell for the division and in within the M cell it is actually going to go for the division. So, after the M phase, it is actually going to divide and give you the 2 cells, one mother cell and the other one is a daughter cell.

Now, after discussing the cells, the cell cycles and so on and while we were discussing about the cell cycle, we have also shown you a couple of demos how you can be able to study these events under the invitro conditions utilizing the flow cytometer. We said that what are the molecules are responsible for you know, governing these processes and there are 4 molecules which are present in the cell.

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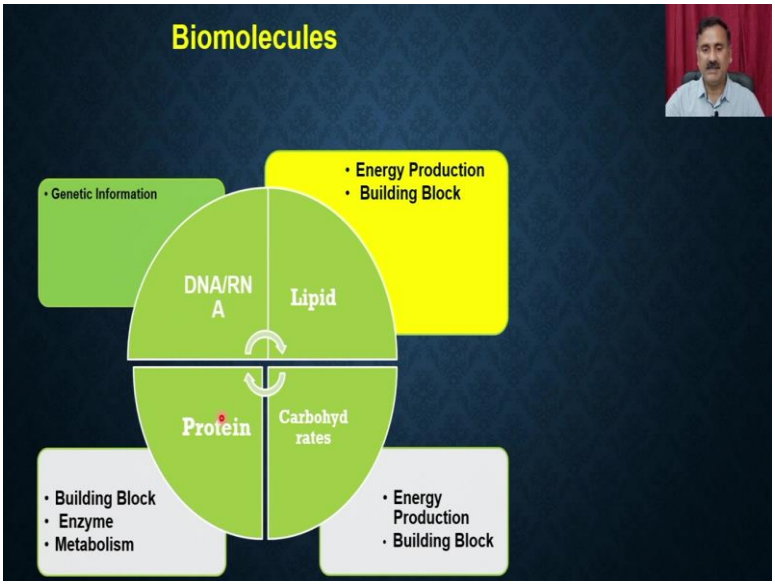

These are DNA or RNA, lipids, protein and carbohydrates. So, we also discuss about the different types of biomolecules. So, DNA and RNA is required for maintaining the genetic information, lipid is required for producing the energy and as well as it is a building block because the lipid is a part of plasma membrane.

And then we also discuss about the carbohydrate. So, carbohydrate is a energy production and as well as the building blocks, some of the carbohydrates are being used for modifying the protein as well as the lipids. And the protein is a building block, it is worked as an enzyme and it also works as a metabolism.

So, in this particular module, when we were talking about the biomolecules, we discussed, each of these biomolecules in detail, their structure, their functions and their role in the governance of the different types of cellular processes.

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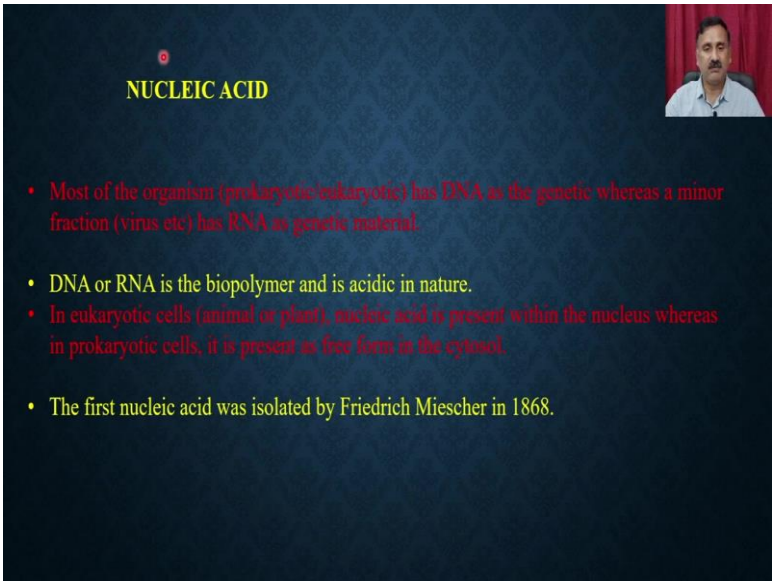

So we started with nucleic acids and most of the organisms actually has a DNA as a genetic material whereas, the minor fraction such as the viruses has RNA as a genetic material. So, DNA or RNA is the biopolymer and it is acidic in nature and that is why it is called as a nucleic acid. In eukaryotic cell, the nucleic acid is present within the nucleus, whereas in the prokaryotic cell, it is present as the free form into the cytosol. The first nucleic acid was isolated by the Friedrich Miescher in the year of 1868.

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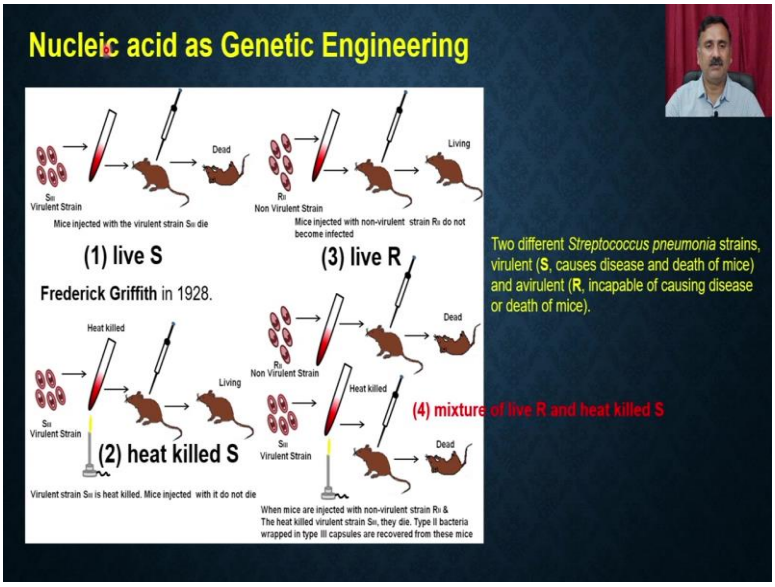

And then we discuss about how we people have identified as the nucleic acid is the genetic material. So, this is a classical experiment of the Frederick Griffith in the year of 1928, where he has taken the 2 different strains of the bacteria and one is virulent strain the other one is

nonvirulent stain and then he has injected the mice with these virulent strains in the 4 different conditions either taken the life strain live or you know, non virulent stains or heat killed virulent stains or the mixture of that.

And based on this, he has concluded that the DNA is been genetic material, because, the when he has used a mixture of the live attenuated strain versus plus heat killed virulent strain, the DNA from the virulent stain is being transferred into the R strain and that is how it is actually going to also be responsible for killing of the mice.

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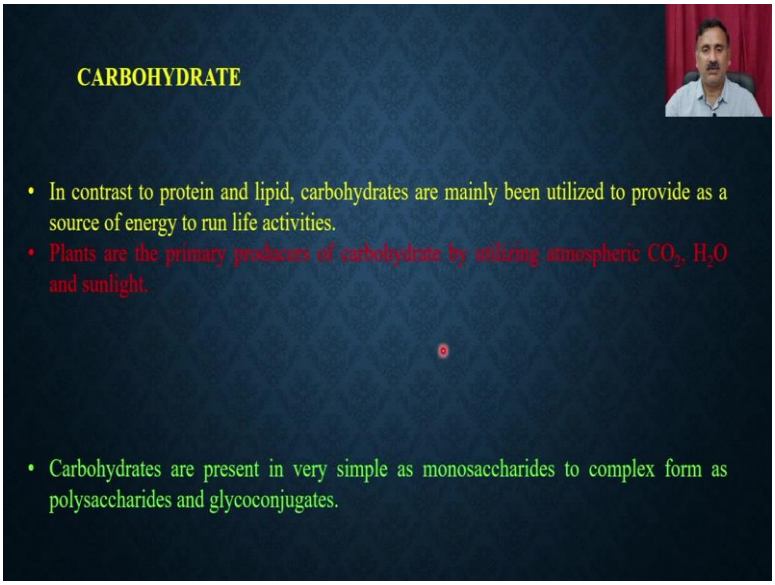

And then we will discuss about the carbohydrates. So, carbohydrates are the mixture of the, are the biomolecules which are formed by the carbon, hydrogen, oxygens, and they are the primary producer of carbohydrates. So, plants are the primary producer of carbohydrate by utilizing the carbon dioxide water and sunlight.

And we have also discussed about the different steps of the photosynthesis and carbohydrates are present in a very simple as like monosaccharides to complex forms such as polysaccharides and glycoconjugates. And what is the role of the carbohydrates? The carbohydrates are participating in the different types of metabolic reactions and that is how they are actually being used very extensively for generating the energy.

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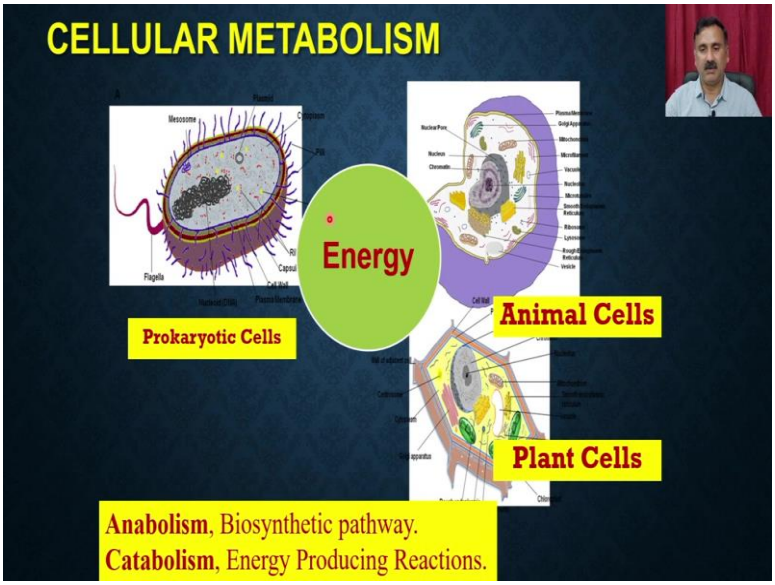

So, this is you know the role of the carbohydrates, it is actually been used for energy production. So, energy whether it is for the prokaryotic cell, animal cell or the plant cell. So, we have the 2 different types of cellular metabolisms, which could be anabolism or the catabolism. Anabolism is the biosynthetic pathway, where you are actually going to have the synthesis of the different types of biomolecules.

So, it is actually a pathway where the energy is going to be consumed whereas, the catabolism the catabolism is the energy producing reactions and where actually the carbohydrate is actually participating into the cellular metabolism. So, when we were talking about the cellular metabolism, we discuss about the glycolysis, we discuss about the Krebs cycle, and we also discuss about the ATP you know the ATP balance sheets for the glycolysis and as well as the Krebs cycle.

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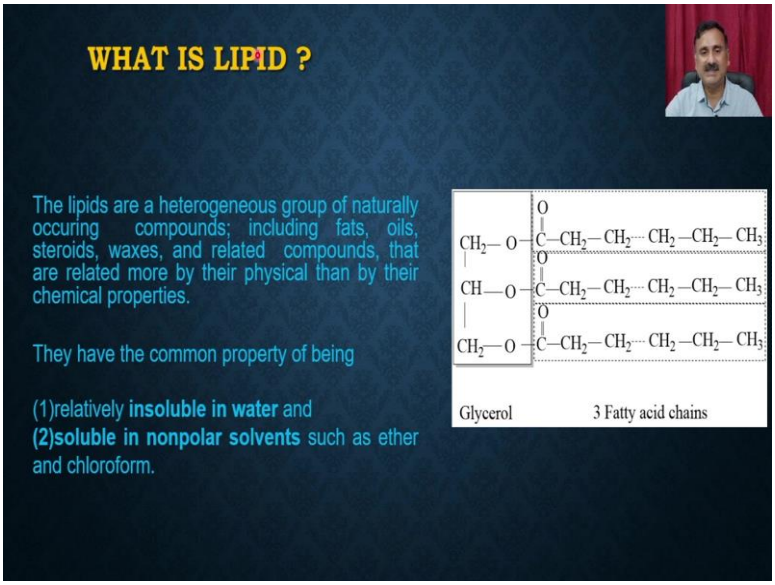

Subsequent to that we discuss about the lipids and lipids are the heterogeneous group of the naturally occurring compounds including the fat and all that. They have the common property of being a relatively insoluble in water and they are soluble in nonpolar solvents such as the ether and chloroform. And lipid is made up of the two different types of groups it has the backbone, which is made up of the glycerol and it also has the fatty acid so it can have the 3 fatty acid chains, and that is how this is called as the lipids.

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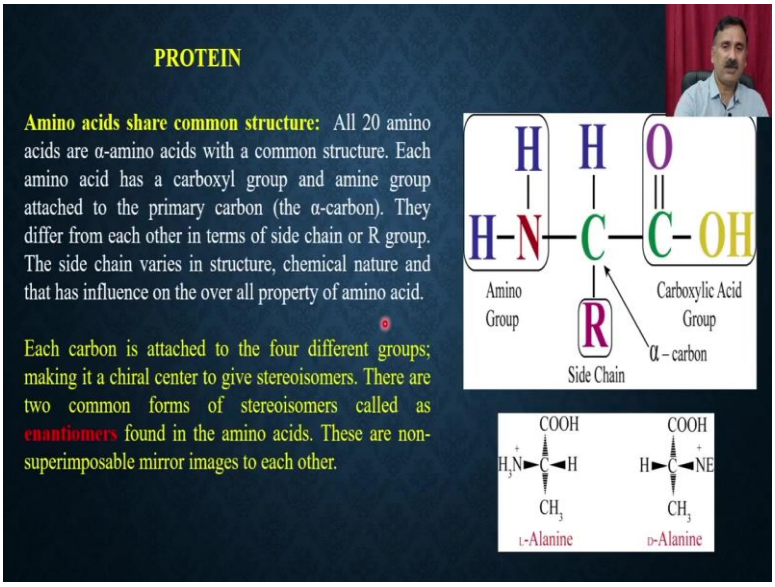

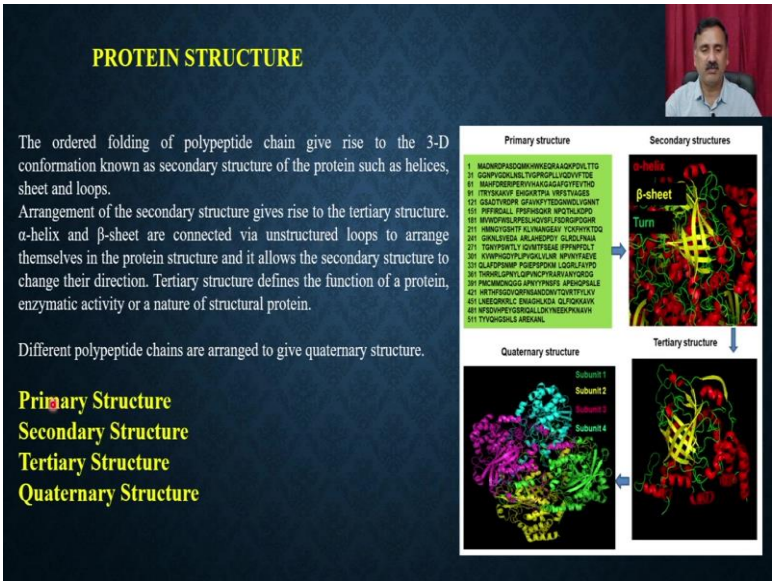

Then we discuss about very extensively about the proteins. So, proteins are made up of the amino acids, and where the amino acid is actually having the 4 groups attached to a single carbon. So, you in one side, you can have the amino groups other side is carboxyl group, the 3rd is the side chains and the hydrogen and based on the R chain, amino acid could be of different types.

So we have 20 different types of amino acids which are present in the proteins and the protein is actually adopting the four different types of structures, it could be a primary structure, secondary structures, tertiary structure and a quaternary structure. So what you see here is this is the primary structures where the amino acids are attached to each other by the peptide bonds.

And then that gives rise to because when you have the amino acids attached to each other, they forced to each other and that is how they are going to form the secondary structure. So secondary structure could be alpha helix, beta sheets and turns and once the cells, the secondary structure folds to each other, it actually gives the tertiary structures and the quaternary structures.

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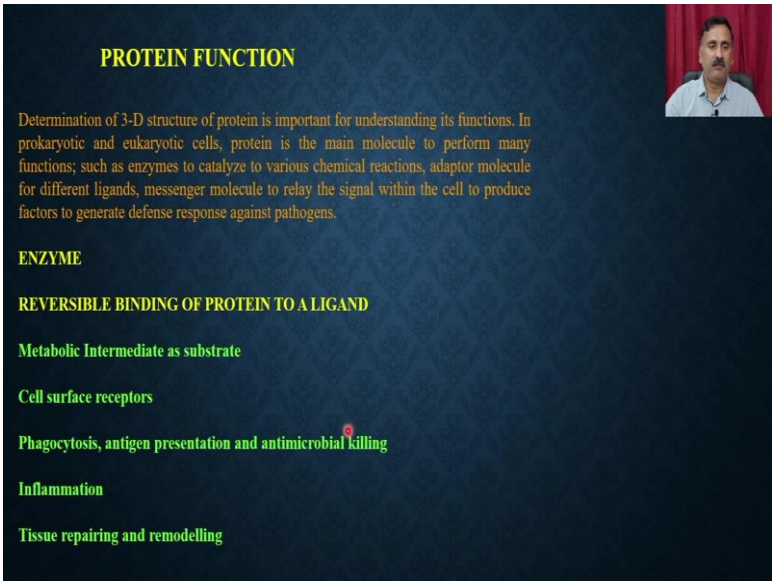

Proteins are also playing a very crucial role in terms of the different types of functions. So, proteins could be working as an enzyme they could be having a receptor for the ligands they could be metabolic intermediate as a substrate, they could be cell surface receptors, they could be having a role in the different types of cellular processes like phagocytosis, antigen presentations, anti microbial killing, and the proteins could have the role in the inflammation and tissue repair and remodeling and all these functions, we have discussed in details and how the proteins are participating into any of the some of these reactions.

So, with this, we have completed our summary of this course up to the biomolecules. So, what we have discussed? We had discussed about the classifications, evolutions, understanding the different types of cells, whether it is prokaryotic or eukaryotic cell and the organelles, their structure their role, and then we ultimately also discuss about the biomolecules.

And subsequent to that, we are also going to discuss or summarize what we have discussed into the cellular processes and as well as the physiological processes in our subsequent lectures. So, with this, I would like to conclude my lecture here in our subsequent lecture, we are also going to summarize what we have discussed into the cellular processes and human physiology. So, with this I would like to conclude my lecture here. Thank you.