Aspects of Biochemical Engineering
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Lecture – 02
Microbiology – I

Welcome back to my course aspects of biochemical engineering. In the last lecture I tried to summarize that what are the things I am going to cover in this course, and again let me tell you that you know initially we will be we will be discussing about the microbiology and biochemistry of the biological processes, then it will be followed by what are the different byproducts that is available in the market and then we will discuss about the stoichiometry of the bio process which will be by reaction kinetics and thermodynamics and reaction kinetics of the chemical process, then we will discuss about the reactor analysis.

And for designing the different reactors and then we will discuss the enigmatic reaction kinetics both using free enzyme as well as immobilized enzyme. Then we will discuss the cell growth kinetics substrate utilization and product formations. And this will be followed by transport phenomena of the different biological processes and ultimately that we are going to discuss that what are the different downstream processing we have in this particular biochemical process, and also, I discussed about the what is the details of the course content. Now today I am going to start my lecture I start with micro biology, because microbiology is the very important topic because I told you that biochemical system.

Such a unique system that is from one substrate we can get n number of products and here we want to change the microorganism. So, details little bit little information of microorganism may be useful to all to all of you. So, if you look at this first let us discuss about the characteristics of the living system, because how it differs from that of non-living system the first thing that we have with this system they are very sensitive to the environment, because I can give the example that if we are also living beings and if we increase the temperature

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Of the room had 45 degree centigrade or 50 degree centigrade we cannot we cannot stay here. So, immediately we will we will try to go out of the room.

So, similarly that same thing happened with the microorganism they are very sensitive to the temperatures indeed the pH sensitive indeed to the environmental conditions. So, this is one very important properties of the living system. The next is the acclimatization what do you mean by acclimatization because, but I can work at 45 degree centigrade the if slowly, slowly my room temperature increases after several days and now my body will be will be will withstand that particular temperature. So, a time will come, but even we can walk in this I can give a example, the astronaut those who are going to the exploration work in the that in the moon and other planets that you know that they had they are supposed to withstand the high temperature. And so, they passed through all this acclimatization processes I can give you another example.

Suppose we have an infection and we contain the regular in the in the day to day life and we take some antibiotics and same infection if we hawker saw afterwards the same dose antibiotics will may not be withstand, because your organism are quite withstand to with that particular dose. So, you know acclimatization is the very common property of the living system then metabolism, because I told you in the last class that you know in the living system we have metabolic pathways and through this metabolic pathways we get the different type of metabolites as for example, we all know that glucose is also is a kind of energy source

and glucose when is passed through this endosomal pathway it produces the pyruvic acid and then it passed through the tca cycle it produce it is.

That carbon dioxide and water. So, in process we develop some kind of that energy molecules like atp nadh and that we use as per our body requirement. The another important property of the living system is the reproduction, because they reproduce that this is the major difference between their living and non-living system. Living organism, they can re reproduce, but non-living system cannot reproduce, and another important property is of this is the waste generation in in all living system they generate some kind of waste that is the kind of property of the living system.

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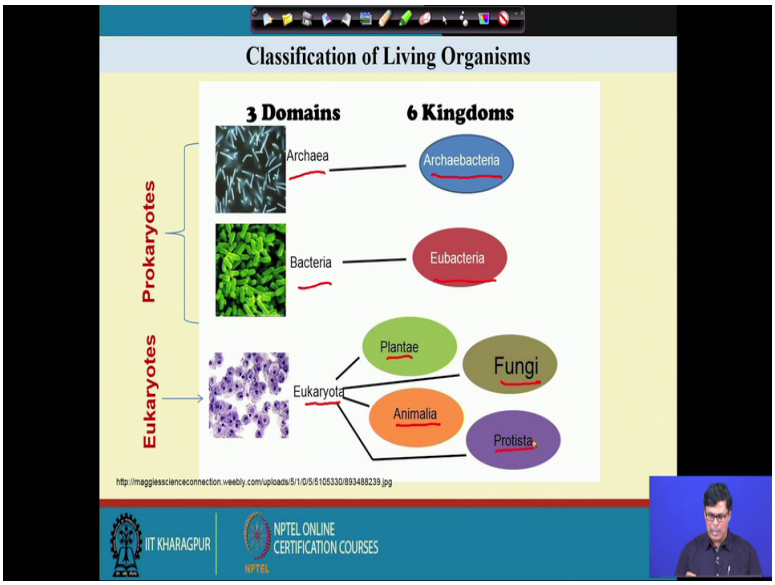

So now, question comes what is the classification of this living organisms. Whatever microorganisms we have first let me tell you what do you mean by microorganism. Micro organism; that means, those are microscopically visible because if you want to.

If you see under there one naked eyes you will find just like a powder, but if you see under the microscope then we will see that what is the size and shape of that particular organism is that is why we call it microorganism, and microorganism broadly it can be divided into 2 different class one is called prokaryotes another is eukaryotes, now prokaryotes you can see that in the prokaryotes we have archaea we have bacteria and this is archaea this is called archaea bacteria and bacteria we have eubacteria, because most of the bacteria fall under this

category and this archaea is usually available in in some ways throughout the treatment process or some lagoon and other things it is available.

Now, eukaryotes we have you carry out with the plantae, fungi, animalia and protista these are the different types of that kingdoms that we have in this particular eukaryotes. In eukaryotes appears to be the bigger little bit bigger the size as compared to prokaryotes that I shall discuss in the later on.

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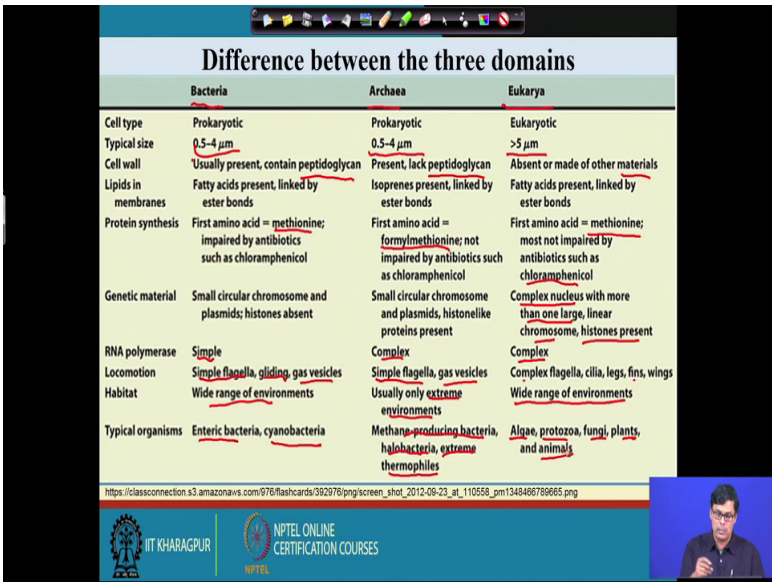

Now, question come over that you know the what is the difference between all these classes that you know I talk about the, bacteria then I talk about the archaea then then we talk about the eukarya now say if you look at the cell type this is called prokaryotes, this is also this I told you this was also prokaryote and this is eukaryote. Now if you look at the size of the organism this is in these 2 classe s that you know bacteria in archaea more less they are same this is 0.5 to 4 microns that is and in case of eukaryote this is more than 5 microns as I told you this is little bit of bigger cells.

Now if you look at the cell wall that the cell wall mostly content the peptidoglycan that in case of mostly in case of bacteria, when the archaea we have that present or lack both we have this both types is available. The in case of that eukarya that is you have absent or made of other materials this is the this is the difference that we have, the lipids in the membrane the fatty acid present linked with ester bond then isoprenes presence linked with ester bonds and

fatty acid present linked with ester bond this is more or less same. Now protein synthesis this is methionine and this is for formyl methionine and here we have methionine.

That; that means, in this is due to presence of the methionine this is impaired with the antibiotics such as grown pinnacle; that means, it cannot withstand that and that you know that and in case of this archaea this is impaired with the antibiotics such as chrome pinnacle, but it is most in case of eukaryoticyou courier this is most not impaired by the antibiotics such as grown pinnacle this is how their basic difference, now here I want to say as the genetic material is concerned it contains the small circular these chromosomes and here also small circular chromosomes and plasmids histone like protein presence.

And here complex nucleus this is very important with mode more than one large and linear chromosome and histone is presence. Now if I if you look at the RNA polymerase is very simple and both the archaea and eukarya this we have in complex in nature if you look at locomotion this is this has simple flagella gliding and gas vesicles then here hey archaea you have simple flagella gas vesicle and in case of eukarya this is you have complex flagella cilia lakes fins and wings and habitat the long range of this is in the environment was largely available and usually only the extreme environment the archaea is available and wide range environments also this eukarya also have been available a typical organisms are.

Eubacteria and cyanobacteria in case of bacteria methane producing bacteria I told you and hello bacterium and also extreme thermophiles that presents that includes in the archaea and in case of eukarya we have algae proto giovanni plants and animals this is the broad class this is the difference of the different organisms that we have and now if we.

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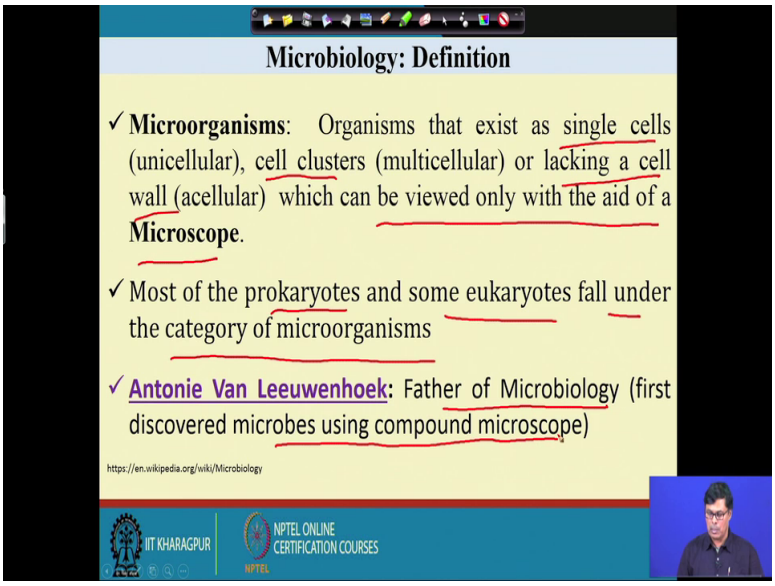

Look at the definition of microorganism, microorganism that exists has single cell what I call unicellular cell and also it can be available in the cluster form that this is clustered as well as the single cell also lacking of cell wall, because all this is called a cellular, because there are different types of cells are available organisms are available and what I mentioned they view only with the aid of microscope. This is the this is the definition of the microorganism that we have most of the prokaryotes have some of the eukaryote is fall under the category of microorganism. Now Antoni Van Leeuwenhoek this is the father he is the father of microbiology father discovered the micros form by using the compound microscope.

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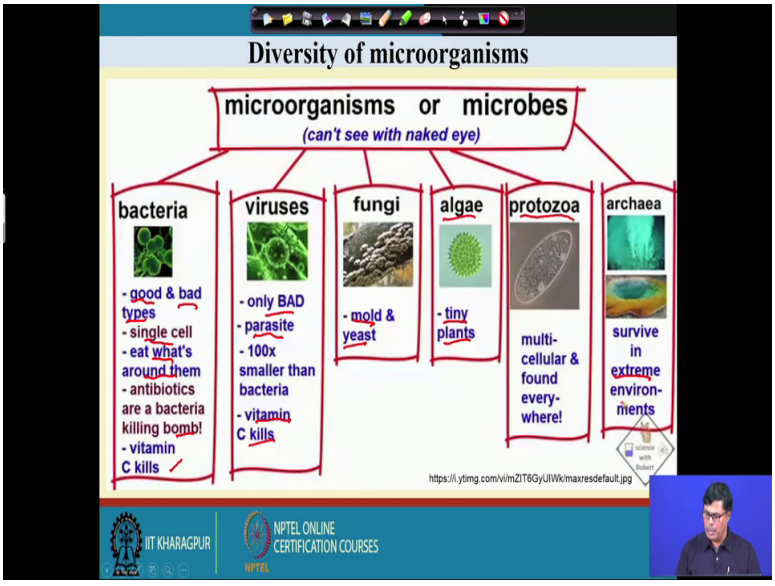

So, now what is the diversity of the microorganism if you look at the different microorganisms that is available in in the earth in the different forms. As for example, bacteria they have both the good and bad type, now what do you mean by good and bad type because this is good and bad type, what I want to mean that you know this bacteria or any living organism can be we can classified into 2 ways one is called pathogens another is non-pathogens. Pathogens means they are harmful to the human health and non-pathogens they are not harmful to the human they good we mean.

This are non-pathogens they are not harmful to the human health about bad type means they are harmful to the human healths. Now they are single cell and it what is the what atoms them and anti-antibiotics are a bacterial killing boom, because different type of antibiotics can kill the bacteria and also it is vitamin c it kills the bacteria these are the different characteristics of the bacteria that we have. Then if you come to the virus silly that has little role to play in the byproduct formation process, but this is comes from the classification of microorganism, but it is the only bad because we do not find anything good in it; that means, they are mostly the pathogenic they are parasite, parasite mean they grow on the host organism and then they are vitamin c kills. Then fungi this is largely used by the

Industry mold and yeast this mold and yeast is largely used by the industry I can give the example that what citric acid producing industry we use the aspergillums niger for the production of citric acid, now in the penicillin production industry we use the penicillium cressona though these are the this we considered as the mold, but if you consider yeast it has also several applications we have food yeast and we have fodder yeast, food is you has some nutritional value particularly if you look at these bakers is they are largely used for the bread making industry and fodder is mostly used as the animal feed algae, now it is the lot of application in the industry that this is this is used as a food has as a source of protein as a for the production of biodiesel and also for it has some kind of therapeutic values.

Now we have this protozoa also does not have much often application as well bio industries are concerned they are multicellular and found everywhere the archaea they survive in the extreme climate environmental condition.

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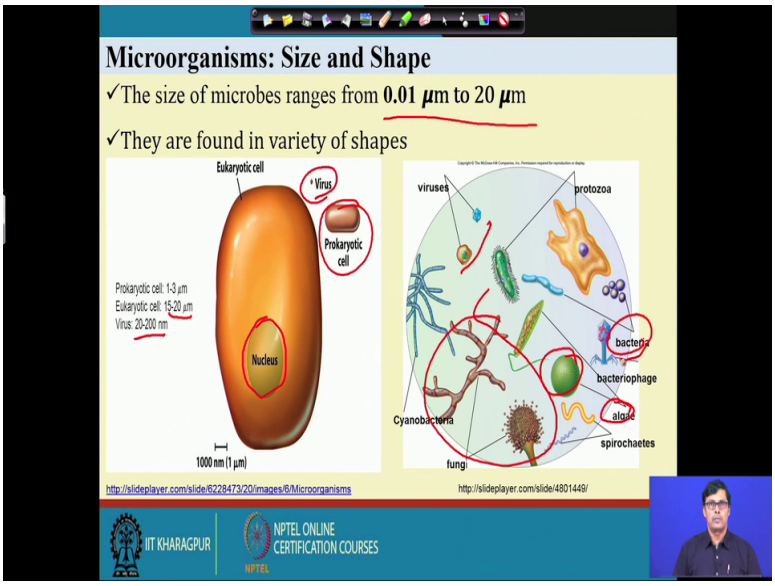

If you look at the size and shape of the microorganism as I and this size this is mostly varies; that is if you look at this is 0.01 microns to 20 microns. This is the average size that we have this is the microorganism that we present. Now let us give you some kind of pictorial view of this microorganism. Now this is called a eukaryotic cells I told you the size of the eukaryotic cell is much higher this is 15 to 20 microns virus is a smaller very tiny particle they 20 to 200 nanometer and here prokaryotic cells that the bacteria usually varies from 1 to 3 microns.

So, this is the eukaryotic cell only the facility is that they have defined nucleus what the prokaryotic cells they do not have any nucleus, and this is the virus how it looks and this is the prokaryotic cells how it looks, now here we have given some elaborate picture this is virus and these are the cyanobacteria this cyanobacteria has lot of industrial application particularly for increase the fertility of the soil, because they have nitrogen fixation property and this also some cyanobacteria also as we use as a source of proteins. Now you have fungi I told you that fungi has also a lot of application in the industry that that I have given the example of citric acid and penicillin producing industry then we have algae also we have is used in different places for the.

Nowadays that biodiesel is considered as a very good source as a substitute of the fossil fuel. So, then and algae plays very micro algae plays vital role there, and then bacteria also we have several applications particularly streptomycin production we use the bacterial

streptomycin for the production of streptomycin. So, we have bacteria files this kind of virus that we have.

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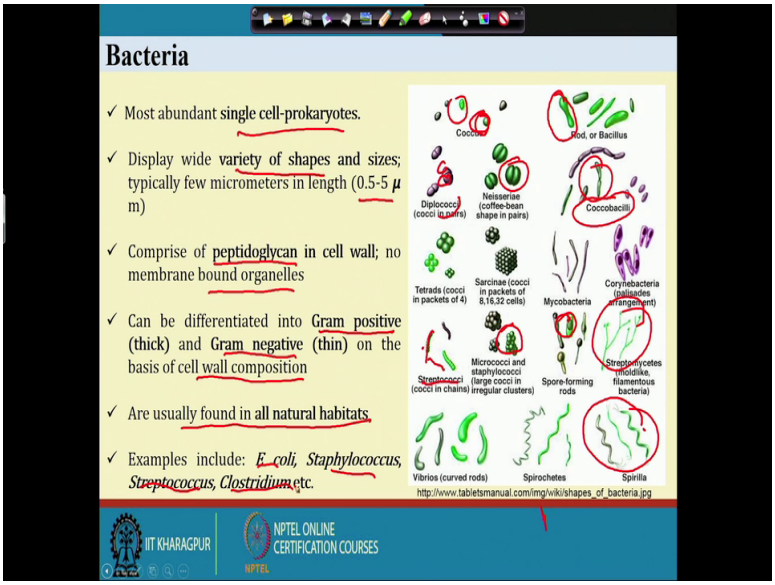

Now, let me give you the detailed information of this different organisms. So, if you look at the bacteria that mostly abandoned this is available in the nature and it is the single cell prokaryotes it is called single cell prokaryotes. And then it displays the variety of shape and size this 0.5 to 5 microns. Now if we can see it this is Cockeyed caucus it looks like you know as spear here you can see like this and Caucus small that you know sphere spherical shape we have Diplocockeyed means 2 spherical shape is there you can say then we have coffee bean shape in spears and this all also there is a rod shape it looks like this, and Coccobacilli it is it looks like this.

Now we have I want to tell you strep to cockeyed this is largely available this is their they are in a chain for missions you can see it here this is chain formation and this is the micro cockeyed or the Streptococci this is a cluster of cells that that you know spears that we have, this spore forming you can say their inside this there is a spores the spore there they can we stand the adverse conditions and this is the Streptomycin mood like structure it is a it looks like that and this is the burials, it is like this and this spiral this is looks like under the microscope and it looks this is the spiral gate.

These comprises of peptidoglycan this is the in the cell wall, no cell membrane found in the organize and can be differentiate from gram positive and gram-negative gram positive is the

thick and gram neg is the thin on the basis of the seal wall composition. And are used fine with the on natural habitat examples are equalized Streptococcus then we have Staphylococcus then Clostridium etcetera. The bacteria we have tremendous a lot of bacterias available in nature and they available in both the forms both pathogens and non-pathogens.

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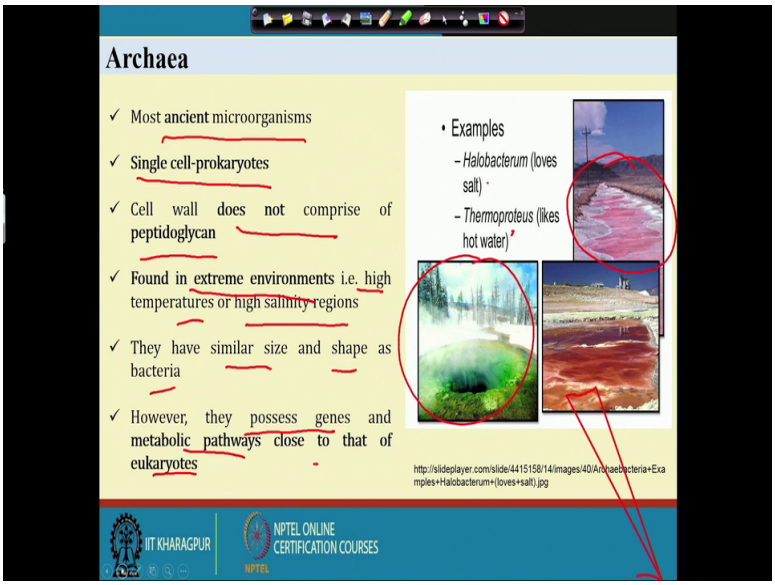

Now, archaea that you look at archaea is the more this is the ancient microorganism this is a very old microorganism, andI told you that this is available under adverse circumstances it is the is the single cell prokaryotes; cell wall does not comprises of peptidoglycans and found in extreme environments that is the high temperature and high silent region, that is the high temperature we have because there we havedifferent hot spring is, there this kind of organisms are available, and there they have similar size and shape as bacteria; however, they possess genes and metabolic pathway close to that eukaryotes and there this is this is how it availables in the different places this is hot spring, this is the thermo protease that is that hella bacteria available they are available in the high salt containing water the this is the archaea.

This is how it differs from the that of bacteria.

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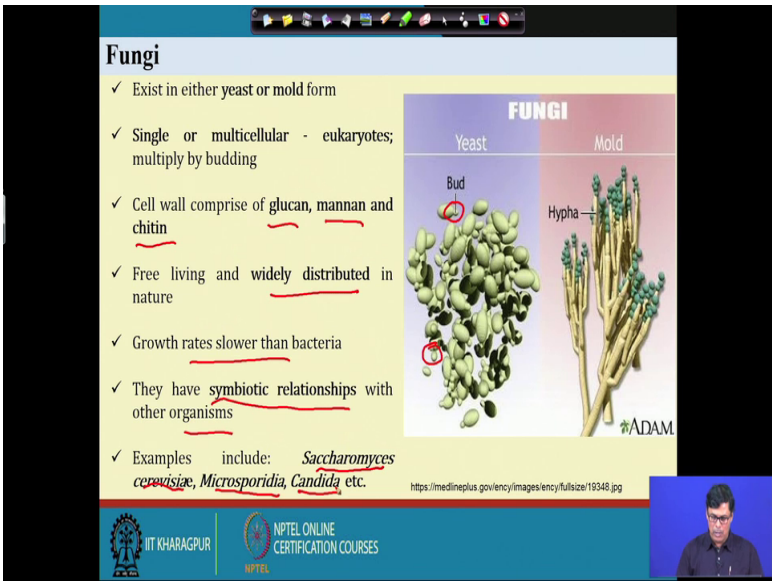

Now, if you look at the fungi and fungi has lot of application as for industries concerned and now these exist in 2 different forms, one is we called one is we call yeast another is mold this now they may be single there is a heavy multicellular eukaryotes and multiplied by budding I can show you this budding if you that you know that if you look.

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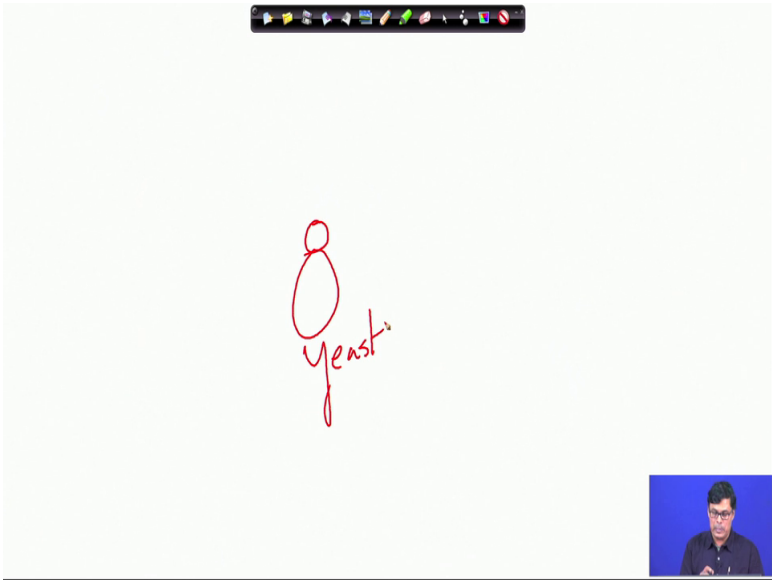

At like this the budding is like this this is it like this the yeast we have mostly we have this budding characteristics. So, this is the specialty of the yeast. So, we have yeah, I have I can

give the example of saccharomyces here this is this has the budding if you see under the microscope.

Then the cell wall comparisons of glucan mannan and chitin this is the cell wall composition that we have. Here also you can see the budding, here we have budding; and here we have budding you can see that and cell wall comprises of glucan manon and chitin and I here I want to point out one thing I walk with citric acid industry and we produce citric acid by using aspergillus niger, and aspergillus niger cell wall contains chitin and this we use what the production of block quality of paper.

Now this is free living and widely distributed in the nature and growth and I can tell you that aspergillus niger is mostly available in the rotten citrus food and also if you look at penicillium crisisunum it is available in the bread, because in the bread you will find green sports if you find out the old breads; sometimes we find some kind of fungal infection it looks like green color this is mostly the penicillium spaces that we have.

Then they their growth rate is comparably lowered has compared to the bacteria I can this is the usually find out on the basis of a doubling time doubling time is the time required double the cell population I can give the example that in case of bacteria the doubling time is about 15 to 20 minutes, but in case of e cell it is about one to one and half hours and in case of fungi like aspergillus niger it may be couple of hours. So, there they have symbiotic relationship with other organisms symbiotic means they love each other and examples saccharomyces.

Cervisiae largely used for alcohol making industry also for bakers is fermentation process the micro sporydia and canidia; canidea that is largely user they for that east.

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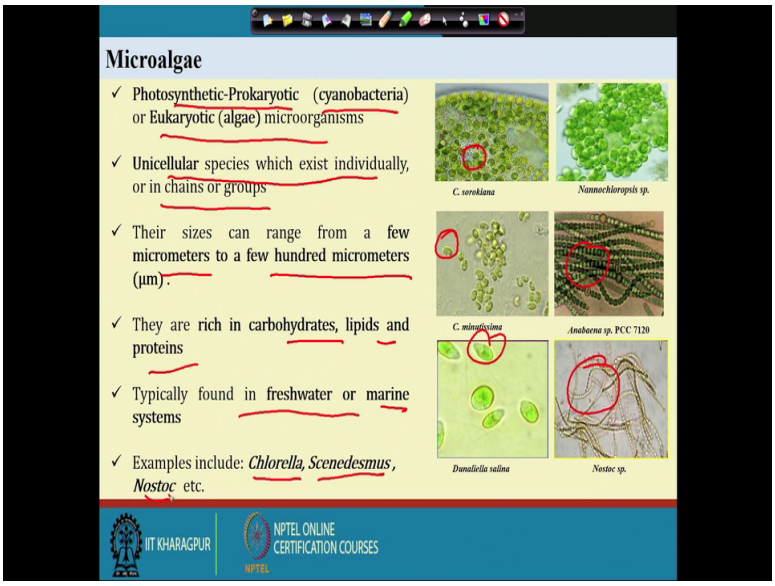

Now microalgae if you look at microalgae this is for photosynthetic that prokaryotics and this is called cyanobacteria, I told you this is largely used in the for the has a bio fertilizer that they have the nitrogen fixation property, because and this is largely used for the plant growth. And eukaryotes is this algae microorganism that is also available this is unicellular spaces the existing individually or in chain or groups, you can see here this organism they can have individually like this and they can have available in the chain also here you can find out that that this is how they available in the nature their sizes can be range a few micrometer to a few 100 micrometers they are reaching carbohydrate lipids and proteins.

I told you this is largely used for the production of biodiesel one advantage with the microalgae that their growth rate this is also a portable photo synthetic organism and their growth rate is much high as compared to the plant system. So, so it is lot of people lot of industry they wanted this microalgae they are exploring microalgae how it can be used for the betterment of our society as for example, I told you the replacement of that you know that fossil fuel by using biodiesel also it can be used as a source of protein, because I know in India and also in the several parts of the world they considered spirulina I can give the very difficult.

Very typical example that largely used for in the form of tablet, in the form of food, in the form of drinks that is use and this has not only the food value that has some kind of therapeutic value the typically it is found in the freshwater and marine system examples

include the Chlorella, Scenedesmus, Nostoc, these are the different organism that is the available with us , I So, I in conclusion I want to say that today you I want to discuss in this particular lecture, I want to give a broad classification of the microorganism. I told you that whatever the living cells we have broadly it can be classified into 2 types eukaryotes and prokaryotes, and what is the it includes all the all the microorganisms available in the nature and microorganism basically we mean the organisms whose morphology is that can be visible under the microscope.

We cannot see under the naked eyes if you see under naked eyes we will find there just like powder. And they have because this organism can be broadly classified into 2 types one is called pathogens another is non pathogens; we mostly in the biochemical product formation mostly we consider the nonpathogenic organism for the product formation as for example, baker yeast that is used for likening on bread largely used in the bread baking industry, we have I have given the example of a aspergillus niger that is used for the production of citric acid penicillin isogenum that is used for the production of penicillin. So, there they have lot of use and also this is used for the treatment of wastewater with different archaea spaces that can be used for the treatment of wastewater.

Thank you very much.