Host-Pathogen Interaction (Immunology)
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Lecture: 5
Branches of Immunology

Hi, in previous sessions I have discussed about history and the work the remarkable work which received the Nobel Prize. And now in this session I will discuss various branches of immunology and because now the Immunology is very established field a very established people are there it is a not a small thing it is a huge. So, I will just discuss about some of the branches of Immunology which is which is driven by those group of scientists or those group of immunologists who work particularly in that field.

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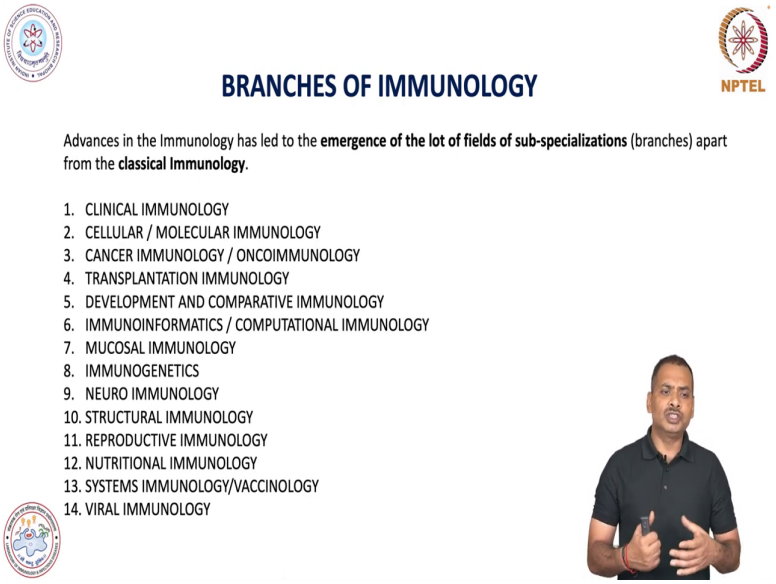

So, there are various branches of immunology and because of emergence of lot of field or sub specialization and the classical Immunology is it is not no more existing and now there is a specialized branches of Immunology. As you can see here there is a clinical Immunology, cellular or molecular Immunology, cancer Immunology which is also known as onco-immunology, transplantation Immunology, development and comparative Immunology, immunoinformatics because of now we have a lot of system engineer.

System biology engineer who turned to the biologist and their role is very crucial in development of Immunology. So, there is an immunoinformatics and computational

Immunology people do this kind of work also. There is a mucosal immunology and this is a very established field mucosal Immunology because there is a whole new set of mechanism new sets of cells which are present in the mucosal surfaces which giving defence against microbial pathogen without reacting with non-pathogenic entities like food.

So, when we eat food we do not have immune reaction but if it has a pathogen then we our immune system do react. So, so this all these things comes in a mucosal or Immunology. There is an immunogenetics. So, genetics plays a very important role in you know in various aspect of cellular and molecular events taking place in the cells. So, there is a very established field of Immunology which it which deals about this immunogenetics.

I will I will explain you each field with the with one slide there is a neuroimmunology we will discuss with slide, neuroimmunology and there is a structural Immunology, reproductive Immunology, nutritional Immunology and system Immunology or vaccine immunology and viral Immunology. So, these are some key field there are some more Immunology field like there is a parasitology which talks about the parasite.

And defence against parasites and there are bacterial or there are some specific bacteria people are there and they basically study the interaction of this bacteria with immunity. And how bacteria basically hijack the host immunity and evade the immune system and establish the infection on another hand we also investigate that how our immune system overcome these bacterial infection. What are the all molecular and cellular mechanisms are there.

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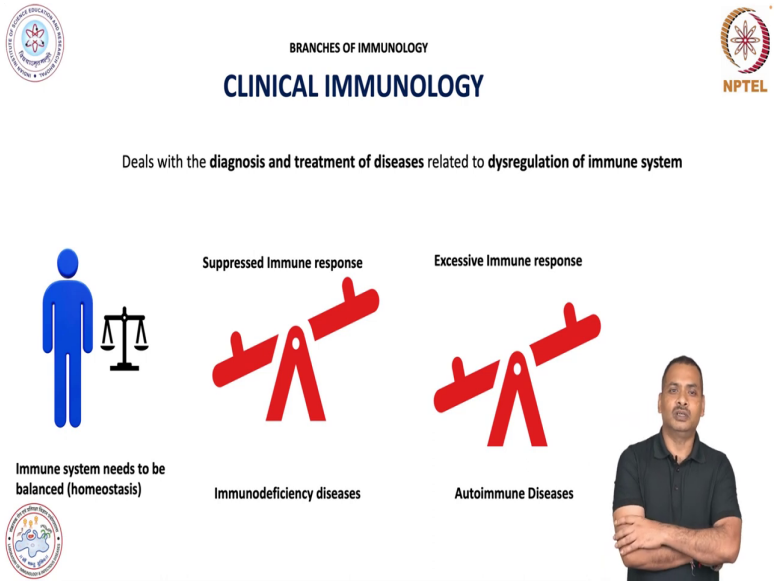

Now let us take each field first we will talk about the clinical Immunology. Basically this clinical Immunology deals with diagnosis and treatment of disease related to the dysregulation of immune system. Now there are here there is a word dysregulation of immune system. So, this regulation of immune system could be intrinsic or extrinsic. Intrinsic means if there is a some mutation in some very key molecules.

And if this mutation will be there in the kid or in individual then there is a possibility that the immune system will be compromised there is a possibility. So, all those individuals they develop;e some kind of dys-reguvolaution of immune system and that result to the immunopathology or development of disease. So, here you can you can see there is a balance immunity and this balance immunity is basically maintaining the homeostasis and it is also defending against the pathogen.

Here there could be two major possibility one is that suppression of immune system. So, suppression of immune system could be taking place if some effective molecule which is playing a very important role against difference are somehow not producing in sufficient amount or it is not at all presenting. So, then there will be a suppression of immunity. One very good example which you will learn when I will discuss about the neutrophil there is a enzyme known as NADPH~~nadph~~ oxidase.

So, there are some individual who lack this enzymatic activity of NADPH~~nadph~~ oxidase then they develop those individuals basically those are the ~~Pediatric~~Paediatric individual they develop a disease known as CGD. So, this is a suppression of immunity and there could be excessive immunity. So, you know that there is a signalling pathway and in signalling pathway there is some negative regulators which basically stop the activation of pathway.

So, if some mutation or something happens in those molecules by intrinsic mean or by some extrinsic~~eme~~ means ~~signalling~~ or by some infection then that will result to the development of excessive immune response and that may cause to the may be responsible for the development of autoimmune disease. So, we all these things we study in the clinical Immunology. It is not only limited to the clinical Immunology.

But basically clinical Immunology they play important role in diagnosis and whatever possible way to treat that thing that complication. So, over there clinical immunologists are

there but it is not limited to the clinical immunologist, fundamental immunologists can also do research and perform various experiment in order to resolve this problem.

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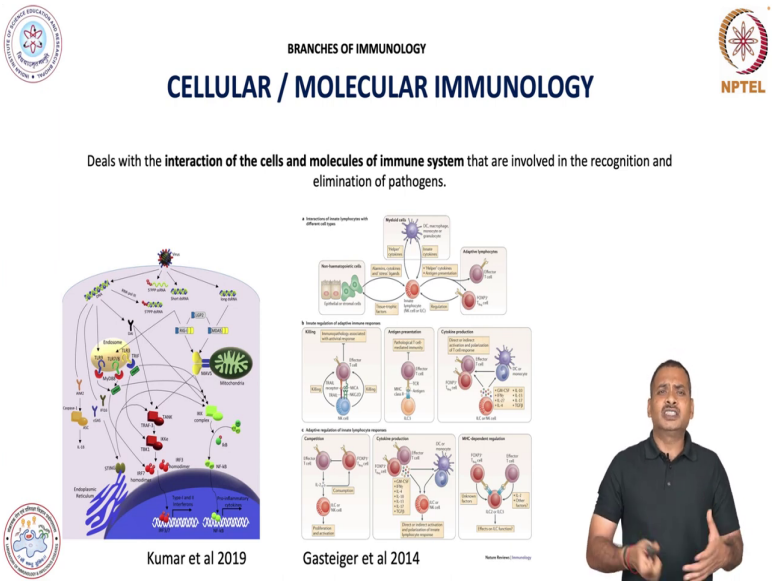

Another is cellular and molecular Immunology basically over there we look at the interaction of cell and molecules of immune system in general under normal scenario and of course we compare with disease scenario. So, basically here we look at all those molecules involved in for example defence~~ifference~~ against bacteria defence~~ifference~~ against viruses and so on and so forth. There are various cells they differentiate in particular scenario.

So, we also look at all those cells how they are differentiating and what are the micro environments which skews~~excuse~~ these cells for the differentiation of that particular cell type which is needed for the defence or needed for some immunopathology. So, all these things we study in the cellular and molecular Immunology.

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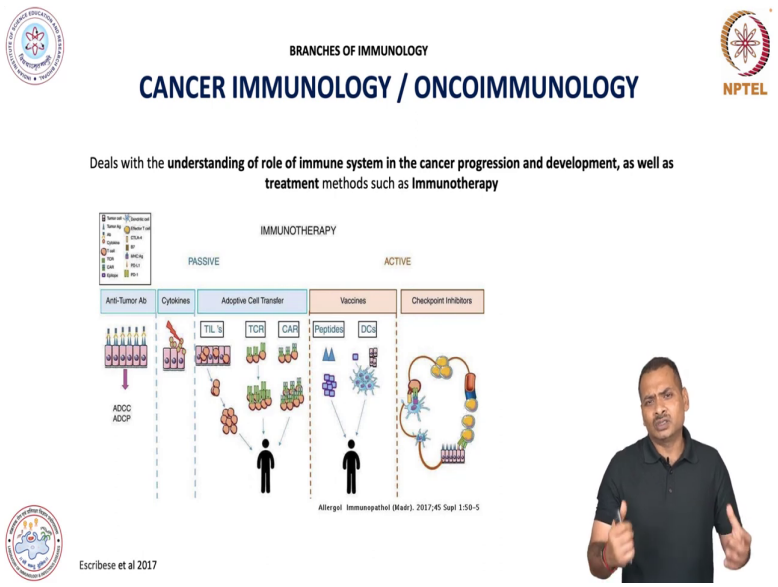

Cancer Immunology or onco-immunology this is the very big field and huge field here we basically understand the role of immune system basically interaction of role of immune system with the cancer. So, basically our immune system keeps on checking the transformed cell or cancerous cell if there is some cancerous cell this will this will our immune system will take care of that they basically go and eliminate there are specialized cells which basically eliminate these transformed cells and those cells later on you will study there are some cells known as NK cell or T cells.

So, all these things we study in the cancer Immunology besides this we also trigger the immune system in order to control the cancer in cancer patient and we call it as a cancer immunotherapy. There we use the tools of our understanding of immunology and we trigger the immune system in such a way in a controlled way. So, that the transformed or cancerous cell eliminated.

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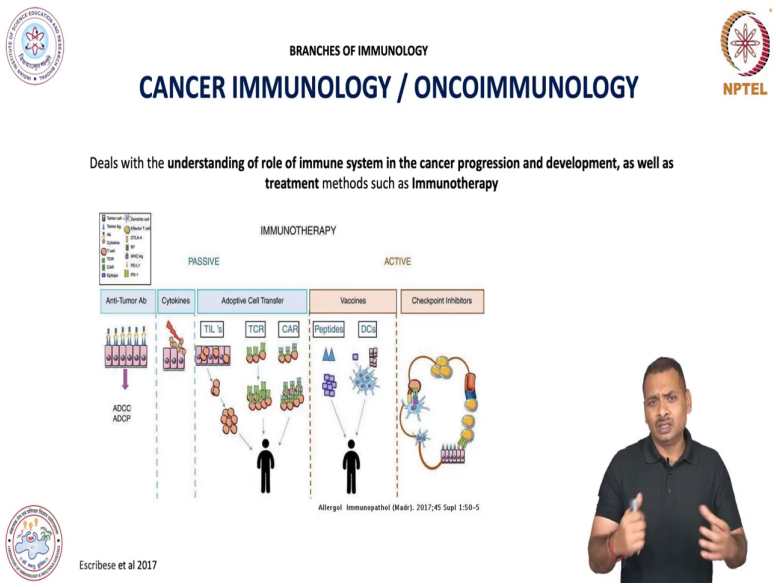

So, we discuss all this thing or learn all this thing or perform research in all these things in cancer Immunology or onco-immunology.

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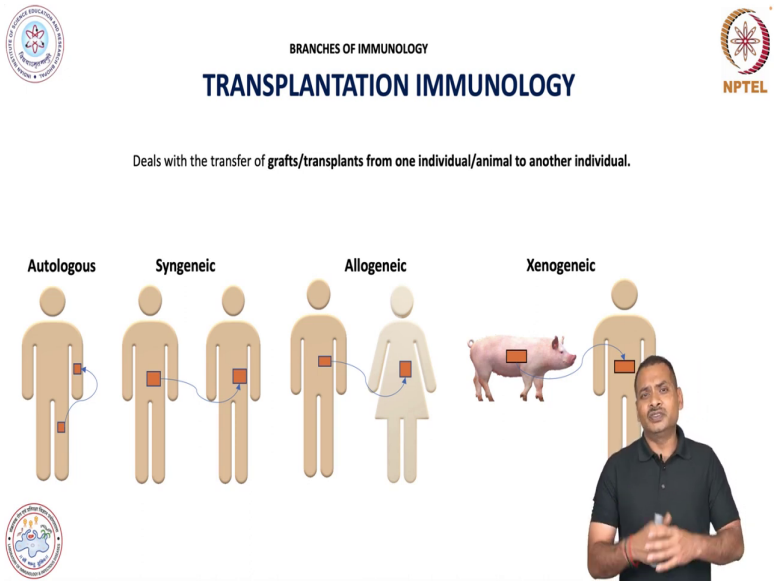

There is a transplantation immunology and that is very important graft or trans graftph. So, there is a you know that in some accident or in some scenario we need to replace the organ but this is not very simple you cannot just take the organ put organ from one individual and put it in that individual there is a lot of complication you need to match the tissue match various things and then this is possible.

So, there are various kind of or various kind of scenarios are there one is autologous transplantation this means that you take the tissue from the individual from one place and place it to the another place. So, this autologous is very common for skin. So, skin

transplantation. So, in general that what doctor is doing they take out the skin from one place and then they put it on another place in order to correct that particular problem.

Another is a syn~~er~~geneic which is a not so, common it is basically genetically same individual it is possible in case of mirror image twins. So, in since the mirror image twins have a same genetic background. So, in that scenario they can take any organ from one individual and place it to the another or another individual this is again a very simple scenario. However, this allogenic is a much more complex.

So, taking the organ or tissues from one individual and placing it to the another individual that we call it as allogenic. And this needs a lot of Investigation before performing ~~the~~ this kind of transplantation and all these things we study in the transplantation ~~ana~~immunology. Immunologists around the world they are making a lot of effort to take the organs from the animal and put it in the human.

And the most preferred model is a pigs. So, that we call it as a xeno~~Zeno~~geneic or xenograft and this needs a lot of research and lot of Investigation. So, so all these things we study in the transplantation Immunology.

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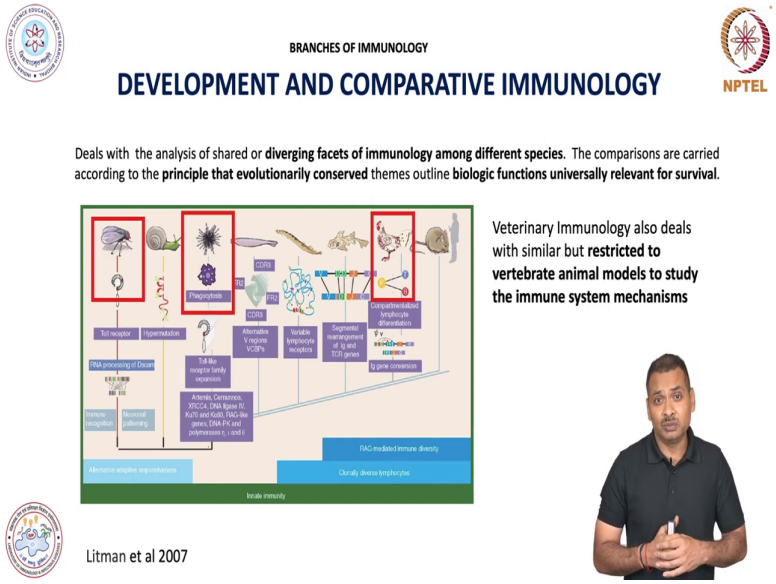

There is a development and comparative Immunology this is very interesting because there is a diverging facet of Immunology among different species. So, in some species some immune system is well developed in another species that may be not developed. So, when we do this comparative study then we basically try to figure out how this the system which is not

developed how it is taken care by or what are the factors cell or molecules are involved in giving that kind of protection.

So, this basically it is a comparison are carried according to the principle of evolutionary conserved themes outline the biological function universally relevant for the survival that what I have explained to you here. I would like to bring your attention that in history of Immunology you have studied that Emil Metchnikoff he discovered this phagocytosis in the in the in the starfish.

So, from there we our immunologist discovered or the scientists discovered that phagocytosis is also existing in human or other animals. The discovery of a pattern recognition receptor I have explained you in previous session the work of Julie Hoffman who received the Nobel Prize. He first discovered this pattern recognition receptor in flies and then this study was extended to the human by Bruce Beutler ~~barbus~~ particular and Ruslan Medzhitov~~Majitof~~ and Shizuo ~~a~~Akira and they basically opened a new field of Immunology which we call it as an innate immunobiology.

So, discovering in drosophila; result to the big discovery in human. So, discovery of to~~a~~ll receptors in flies here. One more organ in future you will you will study in great detail that there is an organ which is present in the in the bi~~r~~uds or ~~avians~~avian and that that organ is needed for the B cell development. So, that is also a discovery that there is a some B cells which is giving us some specific molecule known as antibody.

So, all those things disc all these discoveries result to the discovery in human. So, this is very important field. So, there is some similar field which we call it as a Veterinary Immunology also deals with a similar but restricted to the vertebrate animal models to study the immune system mechanism. So, veterinary Immunology is also one field.

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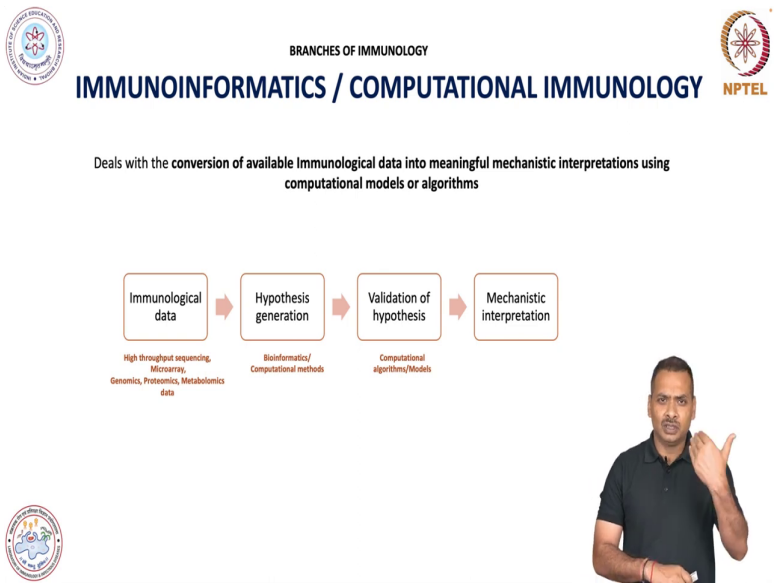

There is ~~immuno~~immune-~~-~~informatics or computational Immunology. So, now you know that there is a huge data about our defence system. For example, you perform the transcriptomic study. So, this transcriptomic study for example you are performing with some virus. So, one cell is infected with virus another is not. So, similar similarly that will generate lot of lot of ~~trust~~ transcriptome data. So, this is basically this transcriptome data you can obtain by microarray there is a genomic data there is a proteomic data there is a metabolomic data.

So, all these data this is a huge data. So, here the data scientist plays a very important role. So, they can they can investigate and they can basically come up with some novel finding this molecule may be playing a very important role in defence or in development of disease. So, they can give us some more predictions and those predictions can be extensively investigated and then we can conclude that this these molecule or these pathways are playing important role in particular defence.

So, over there this ~~immuno~~immune-informatics in ~~informatition~~informatician and computational immunologists play a very important role.

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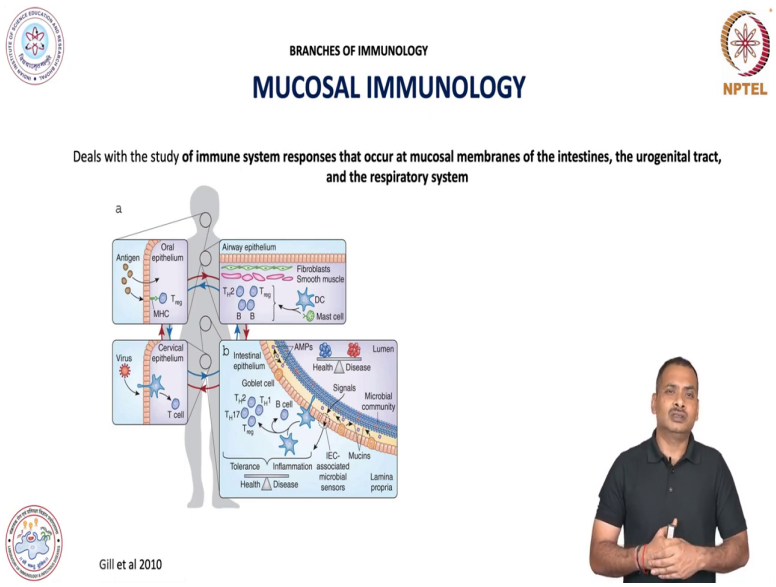

Mucosal Immunology as I told you in previous session. So, this is a very important field it is a very interesting to learn or to find out how this immune tolerance because when we eat the food then there is a no reaction but if it has a pathogen then that will react that our immune system will develop against those microbial Pathogen~~ways~~. So, this understanding this delicate balance of immune reaction and immune tolerance is a is a very interesting and in mucosal immunology~~aminology~~ basically we study the immune system how this immune system this delicate balance is maintained in our gut in ~~e~~urogenital tract and respiratory system.

So, over there, there is a some suppressor cells some activator cell all those things are there and this field is a recently very hot field because we do not know too much about this mucosal immunity.

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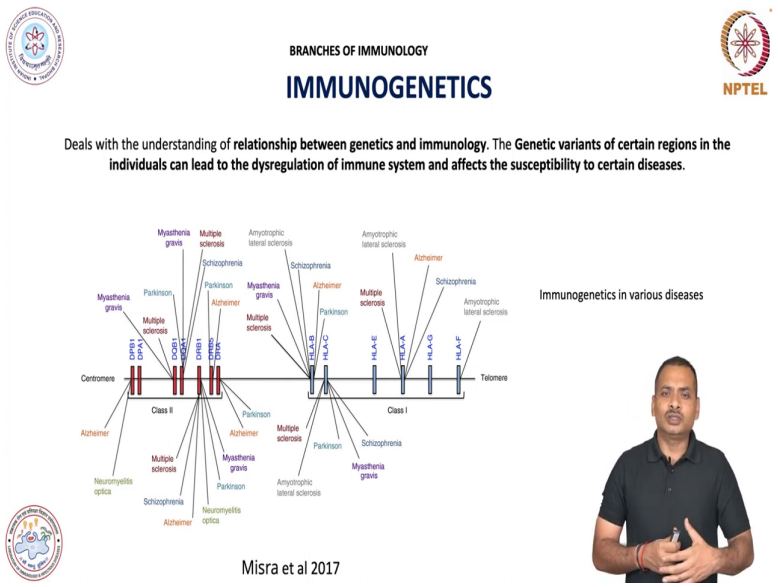

And now I will talk about the immunogenetics. So, immunogenetics is a another very important field there is a some set of gGene which is playing a very important role in pathogenesis of disease or development of some congenital diseases. Here you can see there are list of disease and it is associated with human major histocompatibility complex. So, all these thing we study in the immunogenetics.

And this immunogenetics is also helping in predicting this individual may be susceptible with this disease or all those things. So, this immunoinformatic can predict if you have a the genomic information or transcriptomic information. So, this is also very important field.

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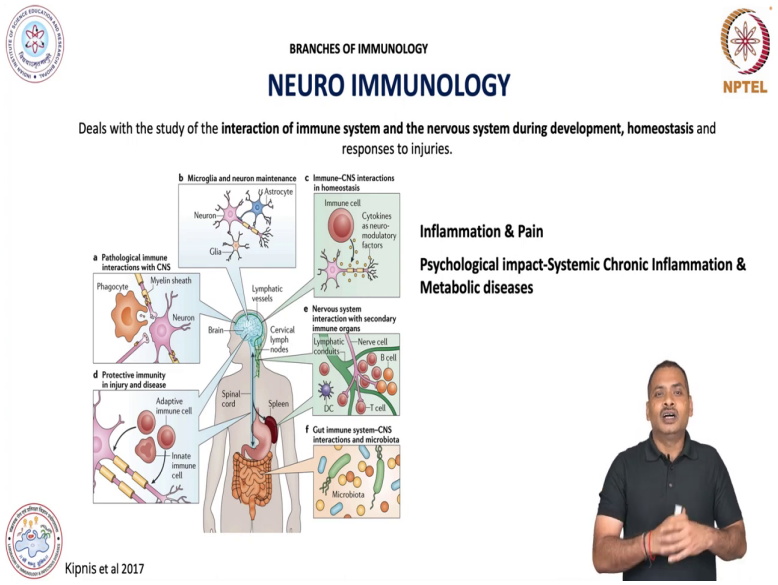

Neuro immunology basically and this deals with the study of the interaction of immune system and nervous system during development of immunity maintenance of homeostasis.

So, this is very complex field why I will tell you now there is a there is a concept that for most of disease there is a concept of having for ~~all for~~ these diseases the basis is inflammation.

So, there is a inflammation which can be mediated by some living and non-living and entity ~~tighty~~ like living entities bacteria viruses and so on. So, and non-living entity could be some dust pollutant or so and so, but there is another thing like a depression how depression result to the inflammation. How depression result to the inflammation and then development of various metabolic diseases like diabetes, hypertension, cardiovascular diseases and all those things.

How this immune reaction for example inflammation result to the pain. So, all those things basically we study in the neuro immunology and this is again very complex field and it is very difficult to conduct an experiment. So, this is about the neuro immunology here we generally ~~is~~ as I have told you that how this inflammation result to the pain. So, we at least it is not very clearly understood the molecular and cell cellular basis.

How this psychological impact result to the systemic chronic inflammation as I told you which result to the development of metabolic diseases. So, all these things we study in the neuro immunology.

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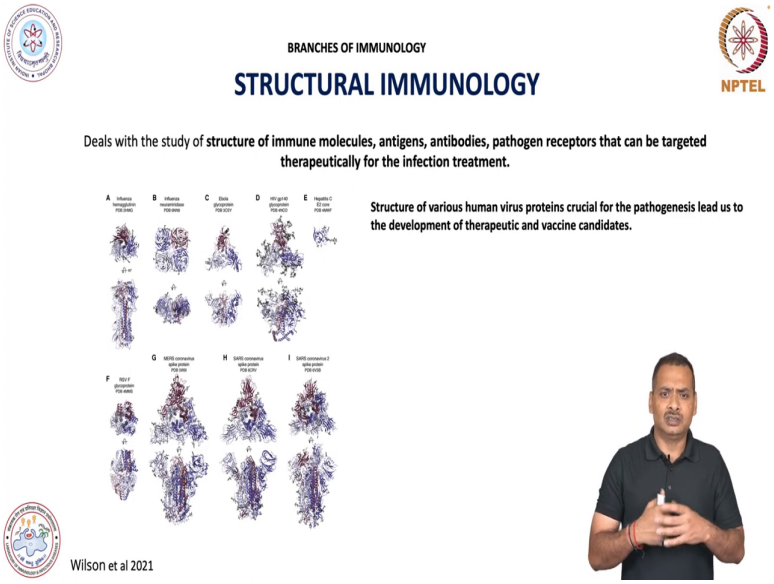

There is a field which we call it as a structural Immunology. Basically, this field discuss about the structure of some receptor molecule and how this ligand will bind to this receptor. It

is not limited to this another level is how this pathogen for example recently you have seen the SARS CoV~~vid~~2 virus and this binds to the ~~S~~ACE2 receptor. So, this structural information is very much needed in order to develop appropriate vaccine or some molecule in order to control this disease.

So, if you discover some small molecule then that can be used for the treatment of SARS CoV~~vid~~2 infection. So, this is also very important field where you basically study the structure of immune molecules antigen antibody pathogen receptor that can target it therapeutically for infection for infectious disease treatment.

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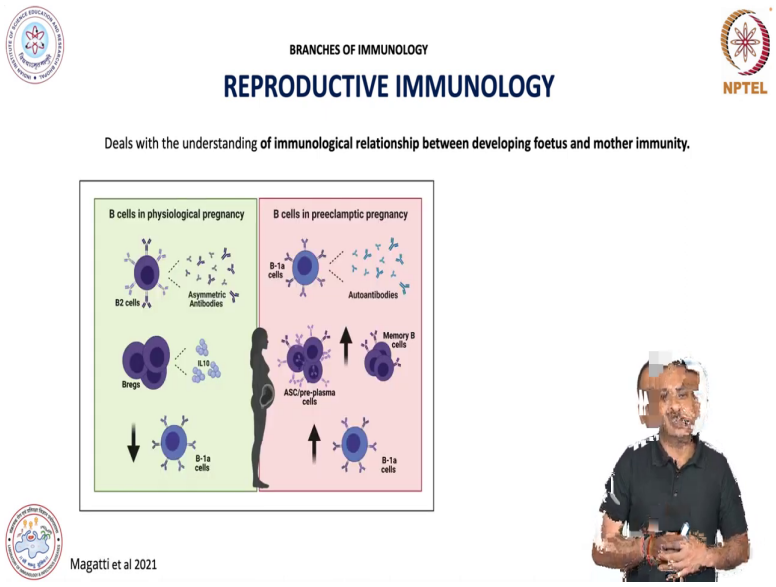

Another is reproductive Immunology this is very important in ~~our~~ and basically it deals with the understanding of immunological relationship between developing ~~fetus~~foetus, mother immunity. This is one component another is that as you know that when the host receive any foreign molecule that reacts but reproductive system is the system which is immune privilege because when sperm passes through this reproductive female reproductive tract then there is a no immune reaction.

So, how it is taking place? So, what is the molecular mechanism cellular mechanism and besides this when ~~fetus~~foetus is developing in mother then there is a there is a interaction between the ~~fetus~~foetus immunity with the with the mother immunity. So, how these things are balanced why not this mother is rejecting that ~~fetus~~foetus. So, all those things we study in this reproductive Immunology nutritional Immunology.

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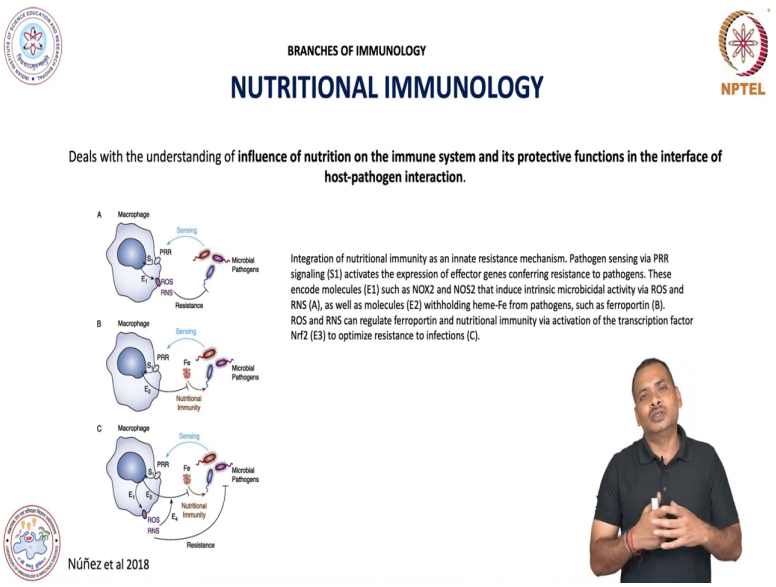

So, nutritional immunology this is also playing a very important role for example if during infection if you take or there is a hyperglycemia then that that will cause difficulty in healing of wound. Similarly, some infection if you there is a there is some nutritional thing which is playing a very important role in defending that microbial infection. So, here you can see that there is a there is a some signal and there is a some pathogen and this basically for pathogen growth there is a need of iron. So, if we restrict this kind of thing then we can protect the host from the severity of infection.

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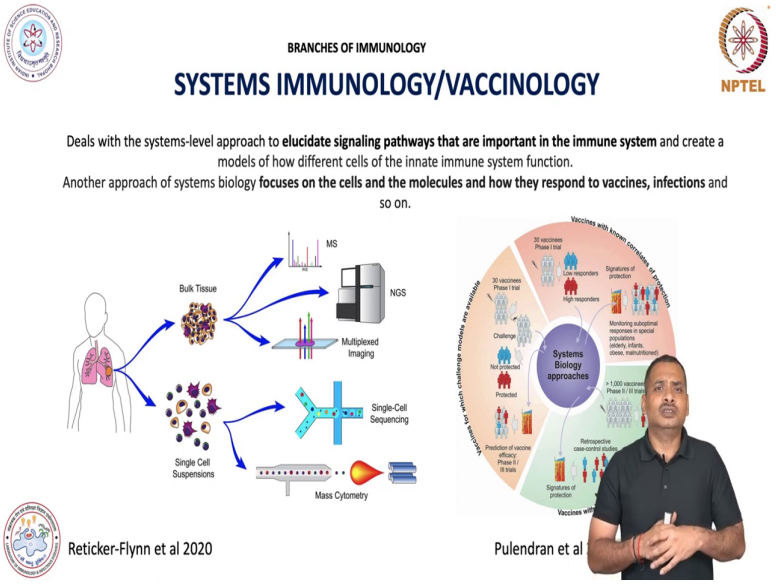

System biology and vaccine biology I have told you. So, now we have a lot of, our wealth of information. So, by using this information you can you can understand there is a bulk tissue information or there is a single cell RNA data also. So, by using by applying all those computational or data science engineering methods we can it is possible that we can find out

some novel pathway novel molecule during the infection. And this will also help in development of a vaccine our effect of vaccine.

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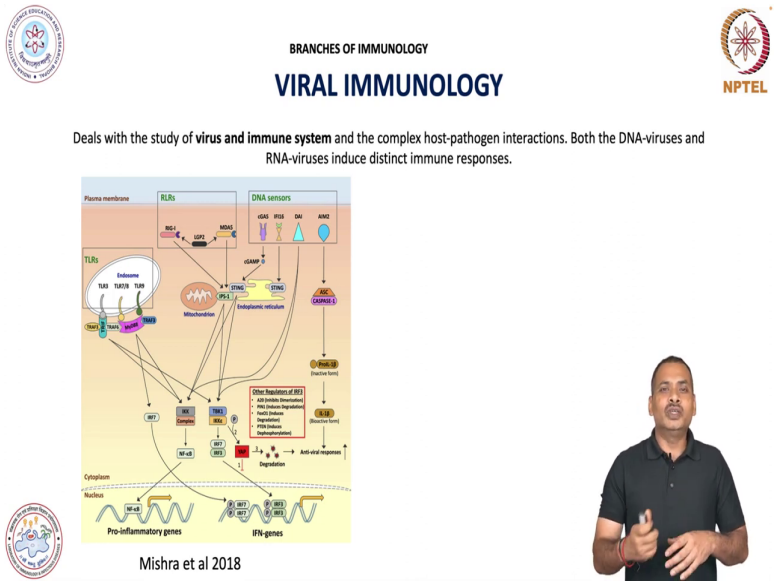

So, finally I will talk about the viral Immunology. It is like other infectious disease there are variety of viruses DNA viruses RNA viruses and RNA viruses are again so, many kinds. So, how our immune system respond to various kind of viruses and for different viruses what kind of immune response or protective responses are there how we can how we can exploit some signature.

For example there are some regulatory molecule known as micro RNA, these micro RNA basically produced in our body in order to control the transcript but these micro RNA can also interact with the viral genome. And once this will interact then this may I do not know this may suppress the viral replication or this may support the ~~w~~viral replication depends on type of this micro RNA.

So, we in basically investigate all those things in viral Immunology. And with this I will stop here and we will move to next session. In coming session we will I will introduce with immunity I will talk about some properties of immunity and how this innate and adaptive immunity communicates each other thank you.