Animal Physiology
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Module - 1
Lecture – 6

Welcome back to the NPTEL lecture series on animal physiology. So, we are in section six, where we are essentially dealing with the blood cells immunity and clotting. So, I give you a introduction, introducing the topic with red blood cells. Then we talked about the clotting factors involving platelets then we talked about how these different blood cells, the red blood cells, white blood cells, platelets are originated.

And what are the different components of blood in terms of plasma, plasma components, which is the fluidic component with suspended proteins electrolytes organic molecules organic waste, which the blood collects all the time and dump it out. And then we talked about the formed element in the form of the different cell types which are present there. And in the case of the genesis of the blood cells we talked about how from the stem cells.

There are two sets of cells which are formed which are the myeloid origin and the lymphoid origin, and from the lymphoid route it leads to the formation of the lymphocytes, which are one of the white blood cells and in the myeloid track it leads to the formation of r b c s, platelets from mega karyocyte breaking down of the mega karyocyte. So, the fragmentation of the mega karyocytes and then we talked about the formation of neutrophil, which is a white blood cell monocyte basophile eosinophil.

So, these different names of white blood cells what they got? I know eosinophil, basophile, neutrophile how they got all these names. So, today what we will do we will talk about the white blood cells and once we have done with white blood cells. Our next objective will be to understand about the blood grouping. How the blood grouping takes place and what are the influence of blood grouping and in between we will talk little bit after once we finish the white blood cells, we will talk about the different forms of immunity that is all we will be covering in that part. We would not go in depth to the immunity, because that is outside the privy of this course.

So, we will just touch upon the ways and rest you people can really, if any one of you is interested, I can suggest some of the books through which you can go through those books and that is all, we give much detailed study of immunity. So, coming back to the

white blood cells. So, we have already discussed the white blood cells have two sets of origin, a myeloid origin and a lymphoid origin.

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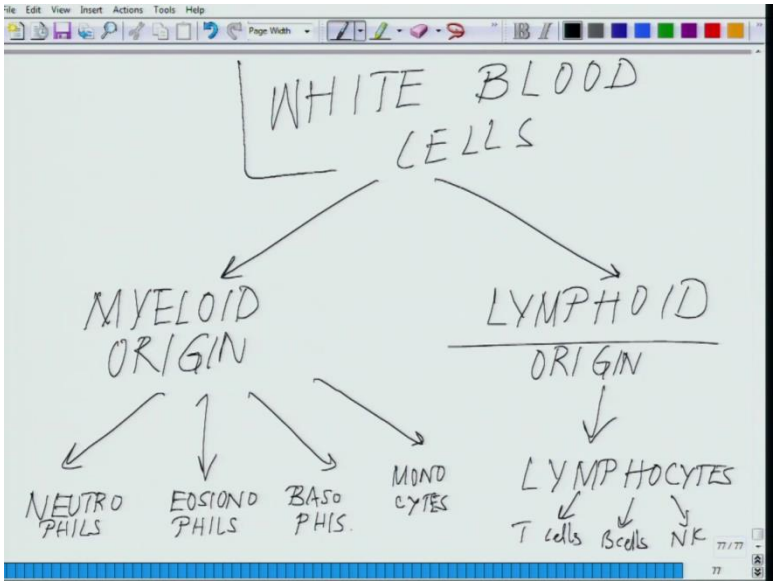

So, cross ok, let us talk about the white blood cells and the white blood cells as I told you, I have already shown this layout lymphoid origin and myeloid origin. And within myeloid origin you have four different types and here you have lymphocytes and I told you that, lymphocytes form T cells, form B cells and it form N K cells, which is also called natural killer cells ok.

So, this is natural killer cells I did not show you in the last the whole flow chart of the genesis of the blood and specifically with respect to white blood cells and on the myeloid origin we will be talking about a neutrophils, eosionophils, basophils and you have monocytes. Typically, if you take one micro liter of blood samples, typically you get around 6000, seven thousand odd white blood cells, which is distributed among these five different cell types neutrophil, eosinophil, basophil, lymphocytes, likewise ok.

So, what are the functions? So, first of all we will know different functions of the and what are the different features of these white blood cells. One of the features of these white blood cells, I have already shown you that the kind of huge size and they are also called poly morpho nuclear. Poly means many, morpho morphological features, nuclear. So, morphologically they have multiple nucleus. So, whenever you see under the another microscope, if you do the smear and you see essentially they look like more like.

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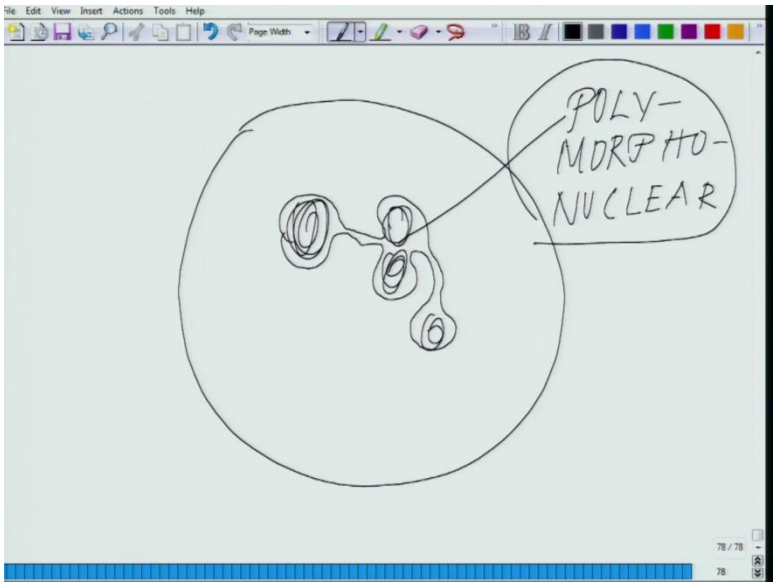

One second, save this, they will, mostly they will look like this. So, this is what is meant by poly morpho nuclear poly many morpho the look morpho nuclear. These cells have a very interesting features; you see this huge cell out there. These cells can change their shape, they can show a lot of amoeboid kind of have you heard of amoeba. So, one of the low organisms you know they change their shape they move through. So, in other word what happens it is like a given an example, how I mean something like, which is sponge kind of, if the vessel size say for example, it is flowing through at the vessel of this diameter the vessel size goes smaller. So, they change their shape, they become more like you know elongated.

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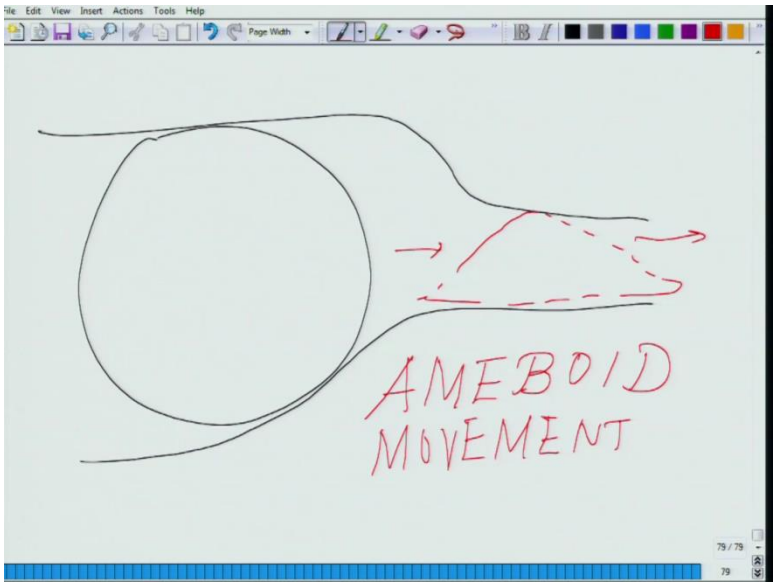

So, in other word, they have the feature like this of say for example, they travelling through the vessel like this and then the vessel becomes like this. Essentially they change their shape and they become the new shape becomes something like this and they will travel. So, they show something called amoeboid movement; this is one of their classic features. They have a amoeboidic movement, which could be observed.

The second thing, they have the ability to move out of the blood vessels, because if they cannot do. So, then they cannot reach the site of as, I have already told you they are involved in immunity. So, that is their major function. So, for the immunity for it is immune action suppose say for example, I draw that will make sense.

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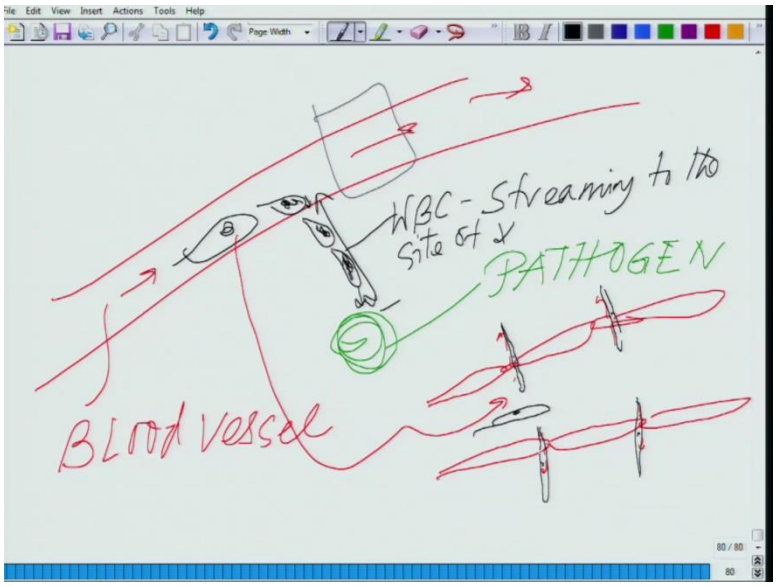

So, for example, you have a blood vessels out here and you have pathogen setting out here somewhere, which is significantly distanced from it the blood vessel. So, what they these cells will essentially do is they will start moving towards it, they will come out of the blood vessel they will start moving towards it. And this movement of course, they are moving. So, this is your, this is where the pathogen or the infection is setting and these are your WBC streaming to the site of pathogen and here you have the blood vessel, where the blood is flowing. So, they have that tendency to, they have the ability, tendency is a wrong words. They have the ability to come out of the blood vessel and move to the site of infection or out of injury, where they are being needed.

So, having said this here to realize, if they have to come out of the blood vessel, if you remember, where I was showing you the structure of the blood vessel their form of the endo theliar lining. So, if I had to blow up this image what I drew for you, if I blow up this image. So, the blood vessel structure will be more like this. You remember I talked about fenestrated capillaries and also those things. So, there is a very very little gap out here, very teeny tiny gap from which something can come out.

So, for a cell like this, which has to come out through this then it has to change it shape significantly it may have to take a shape like this before it can come out. So, that is the reason why I highlighted this point that they have a tendency they have the ability. So, in other word, if you have to change the shape that much it means the cyto skeletal protein,

which is making the framework of that cell is different from others, because you are squeezing your shape they are very, very smart cells. They are changing their shape like this to like this, like this elongated they can pierce through they can move through.

So, these are very, very smart structures, which can modulate their shape based on the situation and this is one of the hallmark of these cells second thing. So, see for example, they have to reach to the site. So, here is the white blood cell and it has to reach somewhere out here, here is the pathogenic onwards. So, these cells have the tendency just like the transmitters you know, you receive signal some signals coming they could receive the chemical signal then there were tendency to positive or negative chemotaxis. Chemotaxis means you are moving towards something in response to a chemical. There is a chemical sitting and it is sending out some kind of stimulus, which should be sensed by these cells and they start streaming like this.

As if army gets a signal and then from a g p s they get a signal they have to attack the army started crawling through there through that site. So, this is how they move and this is very, very tightly regulated and this is something amazing. The way they move to the site and when they could you now kind of you know, if imagine I mean, think of a very old city, where there are lot of valleys, lot of roads and through the army is moving through something like that. Just the way they you know, crawl through those of you have seen like you can some movies like the, I can give you a day to day example like a those who have seen black hawk down.

If you see the city of Mogadishu, how the, they are moving through all those you know curves and crevices of a city it is exactly the same way, the white blood cells have the ability to move through to and go to the site and capture on to the pathogen. And they fail to do so, you would not be alive. So, this is one of their. So, they have this chemo taxis kind of process they could really crawl through they could move to the site and they can sit on or they can you know surround the location of infection or pathogen or whatsoever ok.

So, from here what we will do after explaining this we will talk about the role of this individual WBCs and why they got this different name? Why we call it eosinophil, why we call it basophil, why we call it neutrophil? So, then genesis and their then from informative stuff that what is the general number you see. So, whenever you see a blood

report you should be able to you know figure out whether eosinophil has gone up or basophil has gone down and whatsoever so on and so forth. So, now, let us get back to the details of some of these different cells ok.

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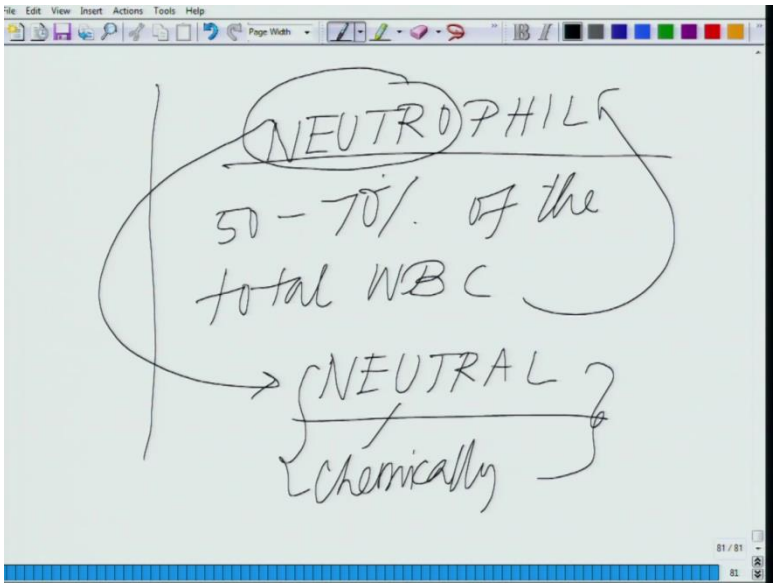

So, we will first start with neutrophil. Neutrophils are bigger than others and basically fifty to seventy percent of the total WBC is neutrophil. So, these are basically the, if you break this word, this neutro means they are neutral neither they are acidic neither they are basic they are chemically neutral.

So, basically you cannot stain them neither with an acidic dye or a basic dye why they are dye. So, this is something just slightly of the aim when digressing. So, whenever these dyes word, because most of the like almost pretty much the whole biology depends on dyes, imaging after image it, when you see something you believe it, if you do not see you would not believe it. So, the biology over the years have evolved have dependent enormously on imaging, it has depended enormously on different dyes, different florophores, different chromophores and everything. So, this chromophores, florophores dyes they work with very simple basic principle, if there is a basic component the acidic dye will go and bind, if there is acidic component a basic dye will go and bind or if there is a neutral thing then you need a neutral dye. So, since these cells are neutral in nature they do not they I mean chemically they are kind of neutral all they are. So, it is really

tough to stain them with ant basic or acidic dye and but mind it these are probably the biggest one among all of them and they are in highest number.

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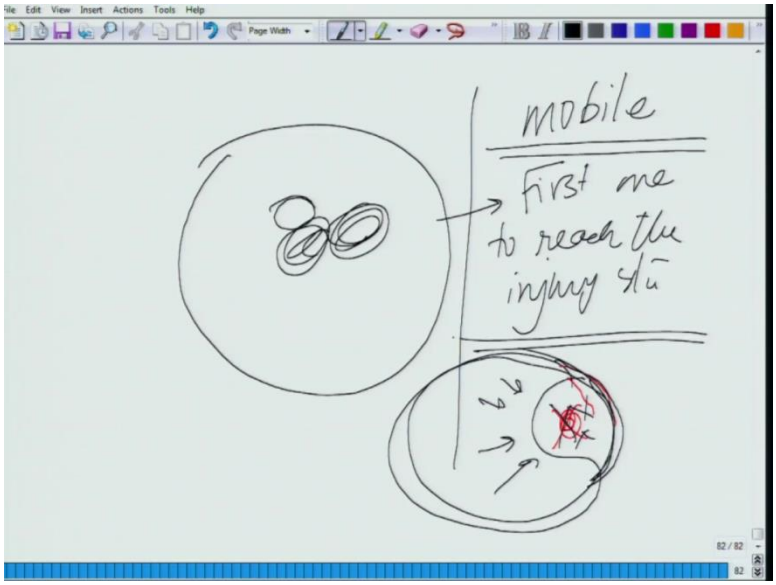

Once again, let me get back to the. So, this is basically they look more like thus, if you see them they will be like you know. So, this is pretty much how they look like. And they support in different kind of they have several functions they are highly mobile is one of their feature. They are highly mobile in nature and they are the first one they are generally the first one to reach the injury site.

So, in other word they are the first one which basically reach to the site and the first thing they do they engulf all the bacteria they have a tendency to engulf the bacteria inside them, which I was showing you one time, like you know they go to the site like this and if this is the bacteria, which is sitting there which has to be engulfed. So, what they will essentially do they will just take it inside them like this and then they will destroy it and they destroy it using different chemical means I will come to that. So, they do it by sometime by hydrogen peroxide and all those things. So, they secrete they have granules which secrete hydrogen peroxide and kind of destroy this different bacteria ok. So, this is one their major function.

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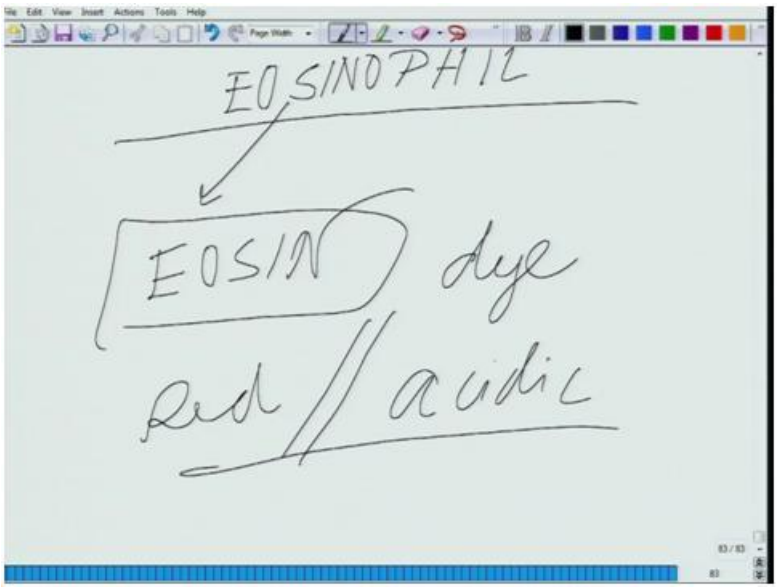

Then next come eosinophil. Eosinophil got it is name, because it binds to eosin dye and which is dark red in color and it is basically acidic in nature. And if you see it under the microscope then eosinophil will look red all over the red, red, red, red, red, because the eosin is red and it is acidic in nature that is why it is called eosinophil eosin dye. So, they just like the neutrophil they are also of the same kind they have the tendency to engulf go to the site of infection site of injury engulf the pathogen or surround the cell or damage cells or something and you know, destroy chop it down by engulfing it inside their body they huge, they smaller than neutrophil, but they are significantly big.

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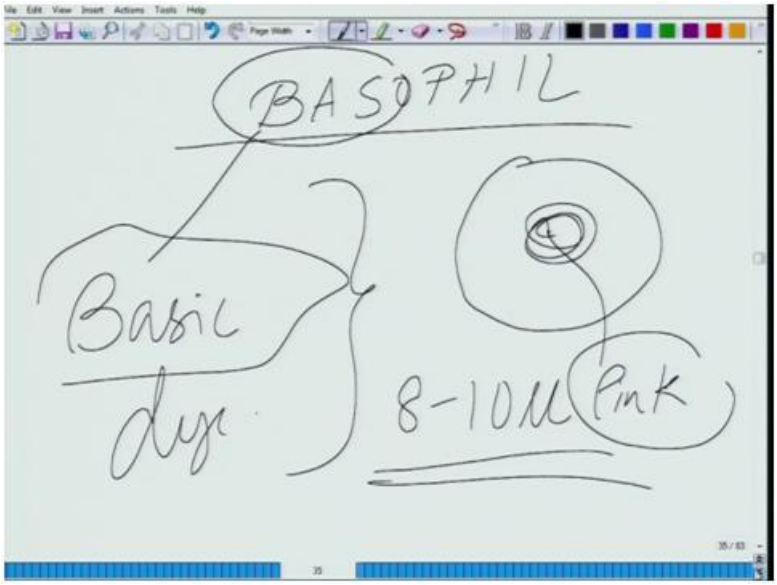

Then comes the next one, which is called the basophil, why it is called basophil? Of course, as the name indicates, as the name says these are called basophil, they bind to a basic dye; this is the tendency that is why they are called basophil. And these are approximately eight to ten micron big, where as eosinophil, I just they are of the same order, but slightly smaller than the basophil. These basophil are the basically the way they look like, they will look mostly in a blood smear, if you look at it, they will look more like pink color, this is how they look under the microscope, if you kind of see them ok. So, these have the tendency they contain histamine and heparin, which prevent blood clotting.

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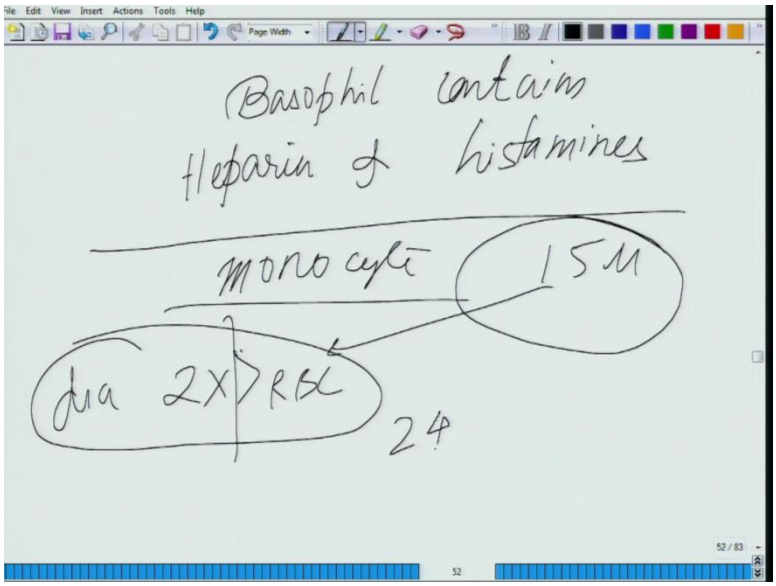

We have talked about this. So, this basophil contains heparin and histamines. So, the heparin as I have we have already talked in the clotting, they are anti clotting agents they prevent they help preventing clotting. So, in other word, they can show us the viscosity of the blood remains constant and talking about histamine. Histamines are the molecules, which are secreted whenever there is the inflammation in the body.

So, if you see some people take drugs like anti histamines. Anti histamines are given to ensure that those inflammatory these are mostly cyto kinds histamines. So, these histamines so, whenever there is an inflammation there is some, say for example, somebody have a asthma, their histamine level goes up or some kind of attack of pathogen histamine level goes up. So, sometimes anti histamines are giving and these histamines are secreted by this basophil cells ok. From here we move on to the next one which is called the monocytes. Monocytes are approximately fifteen micron in diameter, which is essentially two times the diameter of RBC, two times greater than the diameter of the RBC ok.

And these remains approximately for twenty four hours in the blood vessel and that is pretty much and they also follow the same function as followed by the neutrophil they reach to the site they engulf this cells and they destroy it. So, these different cells contain different kind of granular structures, some contains peroxide granules, which in the neutrophil, some contain histamine granules then heparin granules and they have

different roles in clotting in defense some of them contain peptides like defense sense neutrophil actually contains defense sense.

These are small peptides help in the defense mechanism. So, all of them are equipped the arsenal of our immunity is equipped with wide range of small molecules and they have complimentary role to play, whenever our system is under threat from any kind of pathogen, which is continuously we are continuously under threat from the surrounding pathogen. And these different molecules these small molecules, which are contain and which are being synthesized by these by these soldiers blood soldiers of our body they are continuously started responding to the these different changing environmental surrounding and based on that they act they secrete this different compound to help us to survive. From here so, we talked about the four different WBCs of the myeloid origin. Now, we will move on to the lymphocytes, which are from the other route from the lymphoid origin. So, when the lymphocytes they form the lymphoid origin, they form the lymphocytes. The lymphocytes could be classified into three groups.

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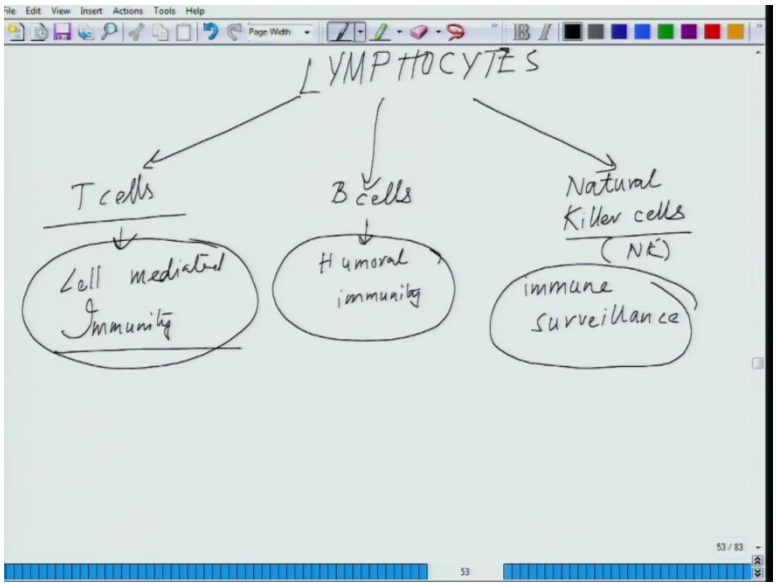

Coming to the lymphocytes, save it ok. So, lymphocytes are classified to T cells, B cells and natural killer cells or NK cells sometime in short they are called NK cells. So, the T cells are also called cell mediated immunity, I will come to that very soon. Cell mediated immunity and B cells are called are responsible for humoral immunity and natural killer cells are responsible for immune surveillance, immune surveillance ok.

So, in other word what is happening is these T cells which are involved in cell mediated immunity. These cells just like the neutrophil, basophil, eosinophil, monocytes move to the site of infection and at that site they multiply could you know surround the cells or they secrete certain compounds, which will ensure that the pathogen gets destroyed or they activate the other WBCs of the myeloid origin, which are reaching. So, it is mostly a direct cellular action at the site or on the pathogen that is why it is called cell mediated immunity.

Yet there is another one which is called humoral immunity. Humoral immunity is there are a section of cells all lymphocytes, which secrete something called antibodies that is where it starts the whole origin of antibodies. These antibodies go and of course, they do the same thing just like other chemicals does, but this antibody lead to the whole concept of vaccine development what does that mean.

So, that essentially means that say for example, you are attacked by a pathogen for the first time. So, your body will of course, fight it out and during that process those B cells will generate some antibodies in your body, which will fight against that specific pathogen fine. First time the pathogen attacked you are ill for some days and then you know the B cells handed along with B cells along with T cells, NK cells and the whole myeloid WBCs handle the situation, but the body remembers it. How it remembers, because in your blood titer there are very small number of those B cell antibodies, which are present against that x y z pathogen. So, next time when it attacks they are much more well equipped it is just like you know attack first time somebody beat you first time. So, you know the next time you know how to handle this individual.

So, now the body is in strategically much more sound position to handle it. So, that is why they say that you know, you should felt a lot times specially in your childhood little bit here and there sneezing coughing and we should not give antibiotics or anything, because you develop your immunity let your b cells continuously you know charge up the system. So, you are always charge up. So, you know you have that memory. So, you know next time when it happens you can fight it out. That form of immunity falls under this whole B cell or humoral immunity, where different antibodies are being formed and that is whole subject in it is own. The whole feel of immunity and within immunity also humoral immunity is a, I mean like one of the very well explored and very intense research is going on all these areas those are like kind of almost all life line you can call

them you know, because we are always at war. So, if you understand that how these antibodies are functioning it could help us a lot.

So, talking about this I told you that this is the genesis of the whole vaccine is this. So, basically the whole idea is that. So, say for example, I wanted to create a vaccine. So, what I do I take that pathogen x y z pathogen and I inject it into a system at a very very low titer at a very low concentration titing itself is a very very low concentration. So, automatically it will spark up the production of the B cell antibodies. So, now your system is pre incubated to face that disease and that is where. So, for example, you just draw it that will make sense.

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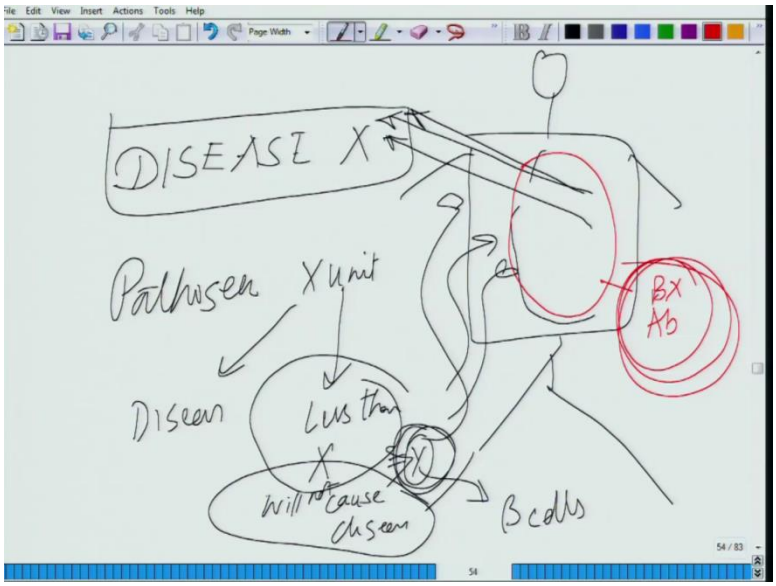

So, say for example, here is an say, let us take the example of say one mint. So, let us take an example, this is an individual ok. Now, what I do that? I take say for example, for disease x, could be any disease, could be chicken pox, small pox or what is so ever disease x. So, I want this person to get an immunity against disease x. So, what I will do when this individual maybe very young or infant or older age what is so ever. I know the pathogen for disease x and I know the level say for example, x unit will cause disease so, anything less than x unit.

So, less than x fairly very very less than x will not cause any disease, will not cause disease, but this amount, which is say for example, equal to y, this amount is good enough to activate the B cells. So, what I do? I pickup this titer and inject it in this

person. So, as soon as I inject it into this person the B cells, which are needed the antibodies, which are needed to fight against this disease, fight against this disease gets flared up.

So, now, in the blood vessel in all his blood those specific Bx antibodies are present there. So, whenever this disease comes this person is much more well equipped to fight against that disease. So, this is the whole game of antibodies and this is the whole genesis of the vaccine development, where it all started. And then rest is all history and we all know that whenever a child is born, the child is given a lot of vaccines and specially in the tropical countries, which most susceptible to the wide range of tropical disease for which several vaccines are being developed over the years.

You starting from kalazar to influenza and everything there are whole series of vaccines which are there. So, in other word what you are doing, you are tweaking the system you are just charging up, this is kind of charging mechanism and it is a very clever mechanism though. So, people are trying to find out vaccine for aids, which is currently one of them in the market. People are trying to find out vaccine against malaria, which is a very terrible problem in the tropical countries and little bit of sub tropical, but mostly on the tropical countries ok.

So, up end little bit of up and down along the tropical rainforest, these are some serious serious problems could we find these. So, vaccine this is one of the hottest area where things are happening these are kind of happening zones ok. Then you have the natural killer cells. These cells are as I told you, these are surveillance they just roam, just like a g p s, they are moving around moving around ok, there is a problem. They keep on chemotactically sending signals immediately the whole army started moving into that site, ok fine we have to take care of it. So, after talking this about talking about all this different kind of WBCs and everything I wish to close in with two aspect, the immunity could be classified in two levels. One is the intrinsic what we have in a so, for example, some of the thing is that our skins they produce a lot of peptides those are form of immunity.

Different structures of our body they prevent the entry of the pathogen those are immunes our immune system. So, there are several molecules several different kinds. So, those are all falling under inept immunity those are all under the big classification of

inept immunity and yet there is another form of immunity, which is governed by these antibodies, which is the other class. So, proudly speaking immunity could be divided into inept immunity and other form of immunity, which is governed by antibodies and the phagocytosis and all those kind of things.

So, the major so, though this is not part of it the major receptors which are involved in a immunity are called toll like receptors t l r in short form this toll like receptor. It is just like we have seen on highways you have the toll routes, toll booths where you pay and you move it just like that they are all over our body even including into the nervous system this toll like receptors ensure something, which has not paid the money should not enter. So, if pathogen is not about to pay the money to entry your system they try to you know they try to fool this toll like receptors and move into the system. So, this toll like receptors and all this falls under inept immunity.

And then comes the rest of the immunity we discovered by all these different kind of cells. So, this is the overall. So, though this is not part of this curriculum, but just to give you an idea, how this immunity could be classified it. So, that is a inept immunity and the immunity what I told you all these different kind of cells, which are involved with humoral immunity cell mediated immunity then immunity offered by this cells from the myeloid origin and everything. And you cannot really very when there is a zone, where pretty much both the immune systems merge inept immunity I mean there is a over lapping zone ok. So, with this I will close in on this. And then next class what we will do? We will talk about how the blood groupings are being done and how that effects in the child birth ok.

Thanks a lot.