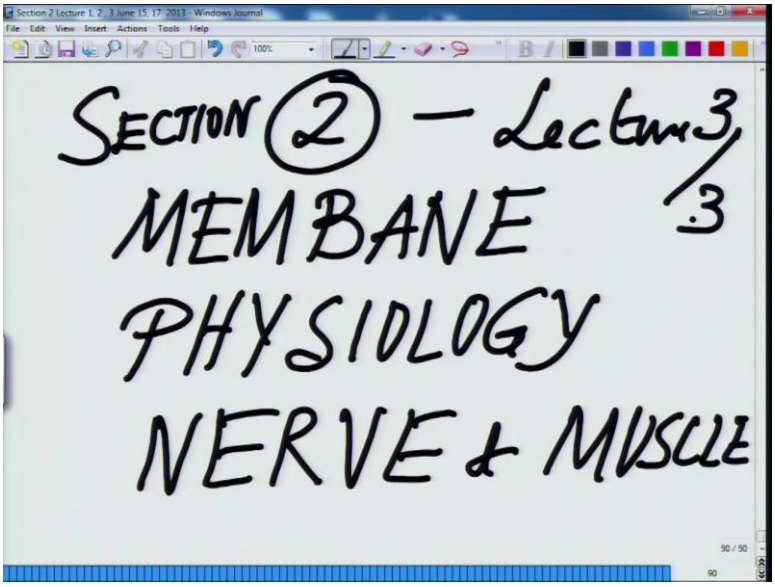
Animal Physiology
Prof. Mainak Das
Department of Biological Sciences and Bioengineering
Indian Institute of Technology, Kanpur

Module – 1
Lecture – 5

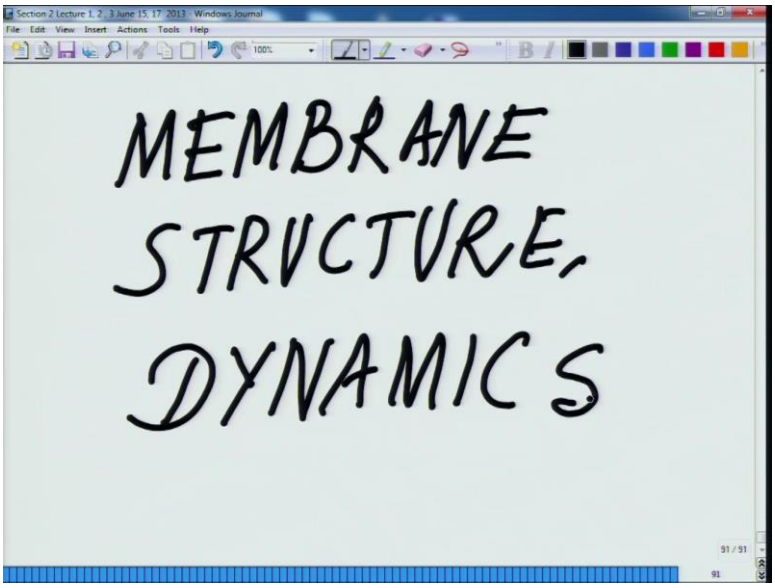
Welcome back to the course on Animal Physiology, we are getting into the section 2 and today we will be getting into the third and the final lecture of the section 2. Section 2 which consists of our membrane physiology of nerve and muscle.

(Refer Slide Time: 00:27)



So, we have already finished first 2 lectures and now we will be heading for the final lecture on this physiology of nerve and muscle, this is section 2. Section 2 and lecture 3 of 3, there are 3 lectures which we dedicated for this section, so we are done with first 2, today we are moving into the next lecture.

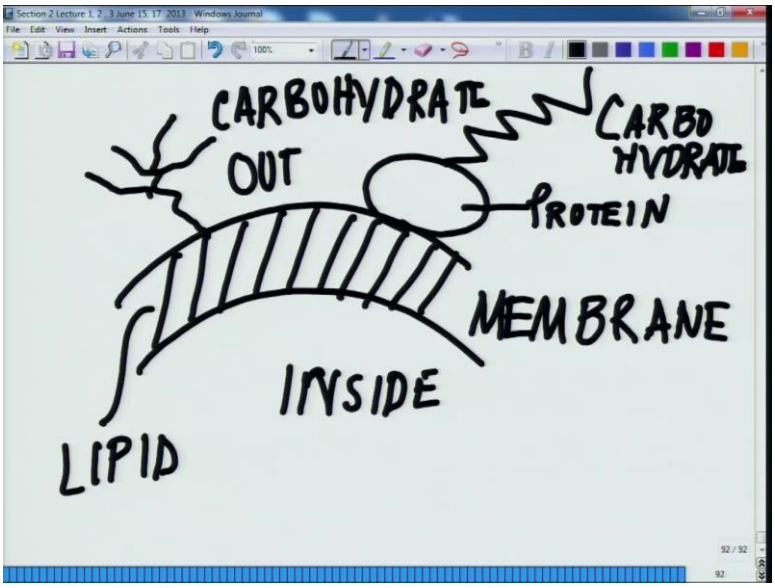
(Refer Slide Time: 01:10)



So, we started with this broad heading of membrane structure and dynamics, so we have talked widely about the structural part of the membrane, but we have not talked about the dynamics of it. Dynamics means the membrane is a very dynamic structure, there is continuous exchange of information from inside to outside the cell and this information transfer is rapidly carried out by the membrane. So, this whole dynamicity is governed by a wide range of transport phenomenon that is what will be discussing.

Before I move on to the dynamics of it, there are couple of stuff which I hurriedly crossed in the last lecture, almost in the fag end or the tail end of the last lecture, which I just want to reiterate it is a kind of carryover from the previous lecture and then I will move on to the dynamics part of it.

(Refer Slide Time: 02:14)

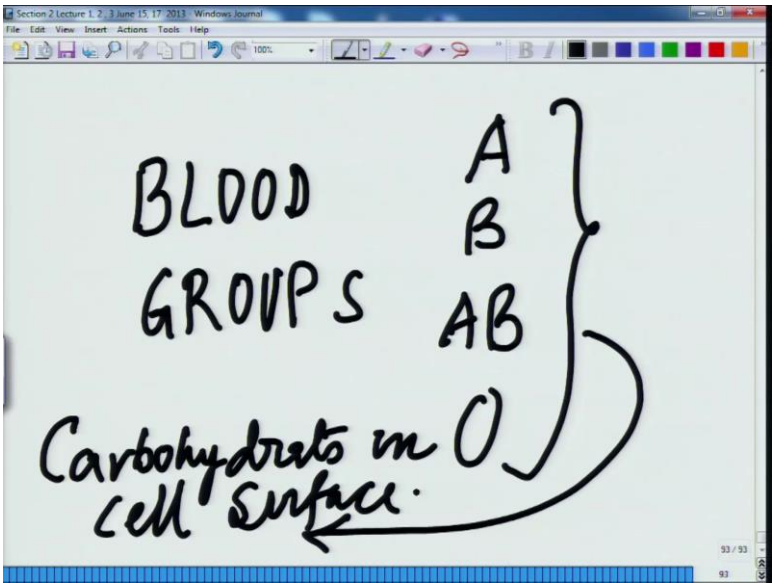


So, in the last lecture I was talking about the presence of the carbohydrates on top of the membrane. So, I told you there are two ways by which carbohydrates can bind, the carbohydrate by this, if this is the membrane, if this is the membrane which has been shown by two lines and I am just putting the hatch hatched this thing. So, one option is that the carbohydrate is directly attached the way it has been shown here on the lipid or there may be a protein like this.

So, which is represented by like this proteins and on top of the protein there is a carbohydrate, which is attached. So, there are two motives by which carbohydrate can attach on top of a membrane, here is the carbohydrate and here is the lipid and this is inside the cell and this one is outside the cell. So, I highlighted one point, but as in a rush we finished it the carbohydrates are present always on the outer surface.

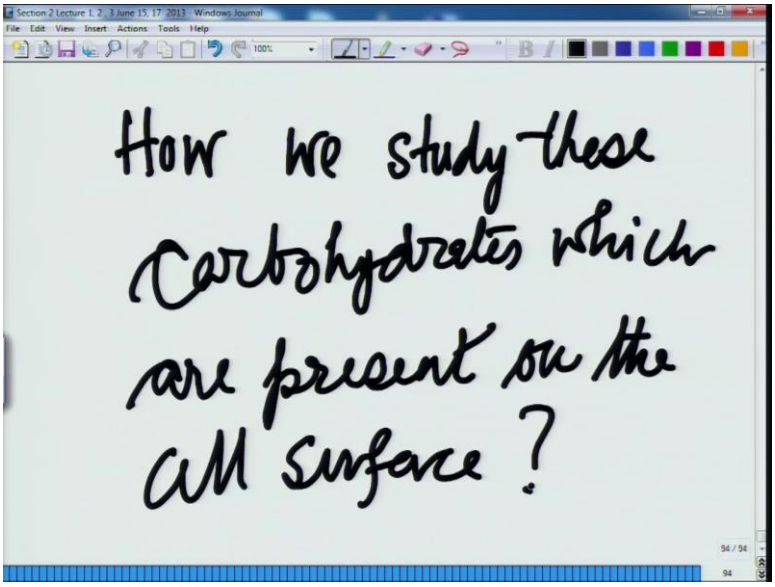
So, they face outside the cell, what really carbohydrates does actually, one of the thing which carbohydrate does is it helps in cell to cell signaling and it helps in the identification of the different cell types, they are kind of your house number. Then you have name of the colony, then you have the name of the city and on top of that there is a zip code or a pin code. So, that is how your letter reaches to a specific to your house, same way a cell has such identification mark. And those identification marks are in the form of carbohydrates, which are present on the cell surface, so these carbohydrate determines so all of you are aware of that we are having different kind of blood groups.

(Refer Slide Time: 04:21)



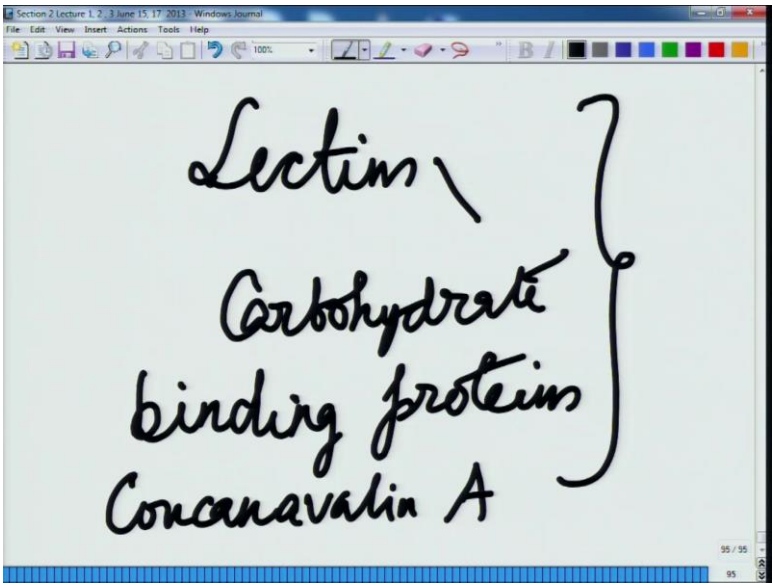
So, we have like you know as you are aware of you people have blood groups like A, B, AB and O, these blood group is determine by those carbohydrates, which are present on the surface. These are determined by the carbohydrates on cell surface, this is one of the major role and we will be discussing in depth what are the structure of these, apart from it there are certain, so how we study these carbohydrate.

(Refer Slide Time: 04:52)



So, under the broad heading how we study these carbohydrates, which are present on the cell surface.

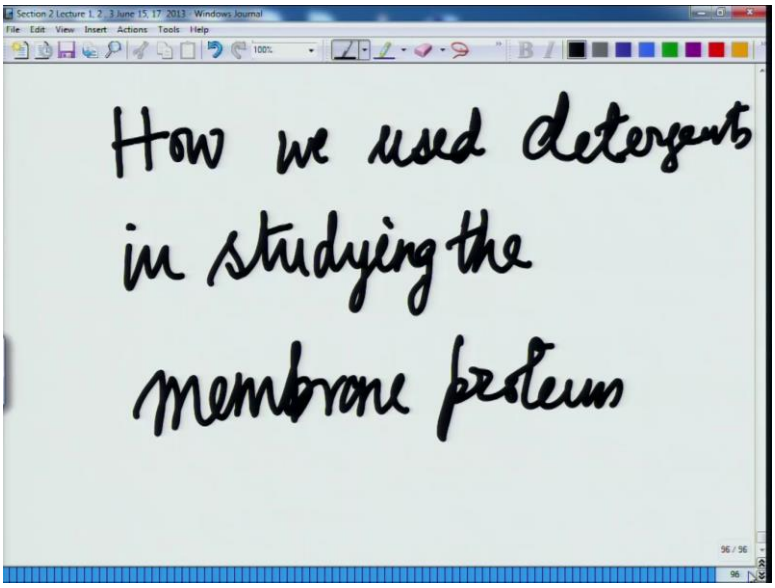
(Refer Slide Time: 05:19)



So, one of the potent tool is a range of molecules called lectins, these are carbohydrate binding proteins. And some of these major proteins are concanvalin A and there are something called glutamine and all these kind of molecules, which bind to these different carbohydrates are being used. So, these are the tools by which we study the carbohydrate molecules, which are present on the cell surface and they have a profound role to play in different kind of physiological processes, which are taking place.

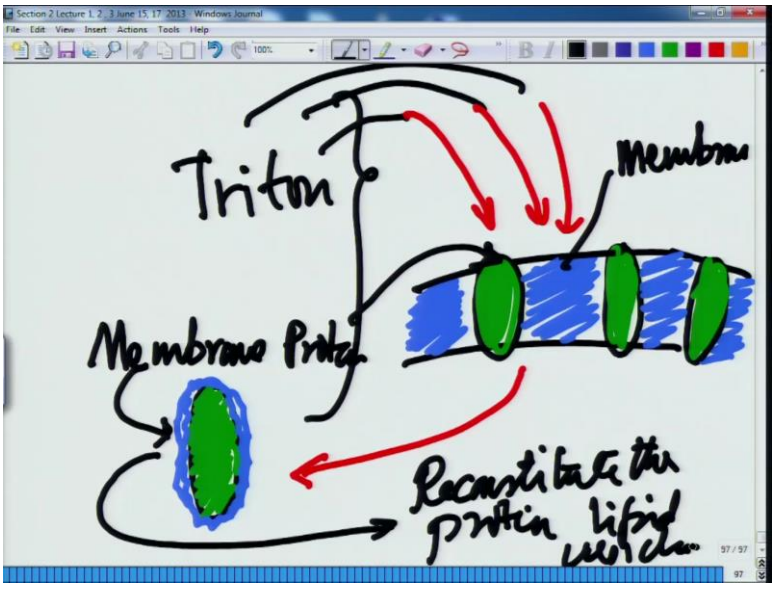
And not only cell identification they help in kimo taxis and the migration of the cell and several other phenomenon which are exceptionally important for proper physiological functioning of the body. Apart from it another topic where I kind of ended up, how we isolate the membrane proteins from the membrane using detergent.

(Refer Slide Time: 06:30)



We I talked about some of the detergents like you know how let me put the question, how we use detergents in studying the membrane proteins.

(Refer Slide Time: 06:58)



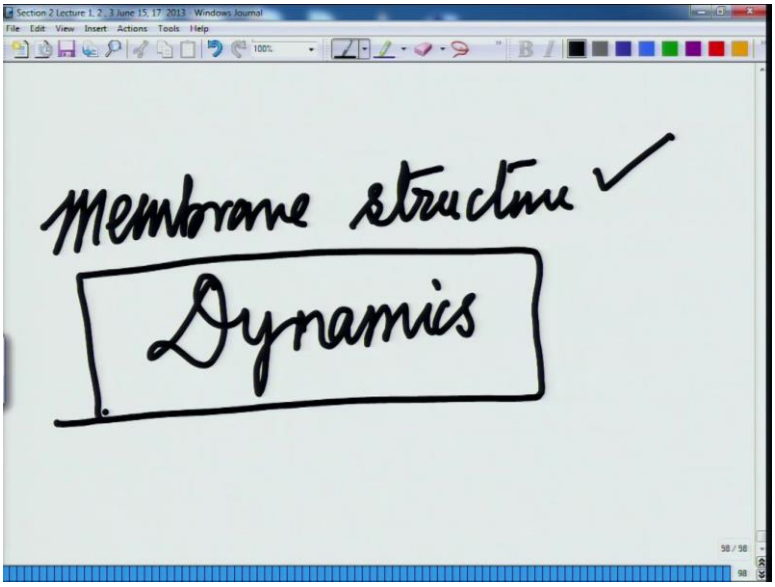
So, some of the detergent examples of the sum of the detergents, which I talked about in the class was triton and few others. So, what they exactly do is that say for example, if this is the membrane and you these membrane protein sitting here like this, so if this is the membrane, so let me give another shade. So, this is the green what you are seeing is

the lipid bilayer, the blue what you are seeing is the lipid bilayer and this green are the membrane protein, which are spanning across the membrane.

So, what we do is say for example this red, we add a detergent say for example, try it what a detergent does is something very interesting, next come out depending on the concentration of the detergent to get out of is that, they get this membrane protein, let me shade it in green, the way it is. And on top of that you have a small layering of the lipids around it likewise, and once you have this particular membrane protein out of the surface though it is exceptionally challenging process by the way.

Here is the membrane protein for your further experiment, we reconstitute membrane protein, so this is a membrane protein and this is the membrane and this is where you are adding triton into it. And then we reconstitute the protein in lipid vesicles, this is the part which I wish to highlight in this, this is a carryover from the previous lecture. We are just horridly close on because of the time constraint in the last lecture, so this is what was missing, so this is the tail piece which I needed to add, before I start with the membrane structure and dynamics.

(Refer Slide Time: 09:06)



So, coming back to it, so where we are supposed to use start this lecture membrane structure, so we are done with the structural part, so this part is done. Now, we are starting the dynamics part and I told you broadly dynamics is the all kind of movements

which are taking place across the membrane, so there are different transport phenomenon which dictates the dynamics part of it or the dynamicity of the membrane.

Because, you have to realize that there are several molecules, which has to be exchanged across the membrane, the water has to be exchanged, the salt has to be exchanged at times there are nutrients like glucose, which is the major energy currency has to be exchanged. Because, we have to have to glucose intake, then there is movement of several small molecules across the membrane and this process has to be regulated with exceptional precision and clarity.

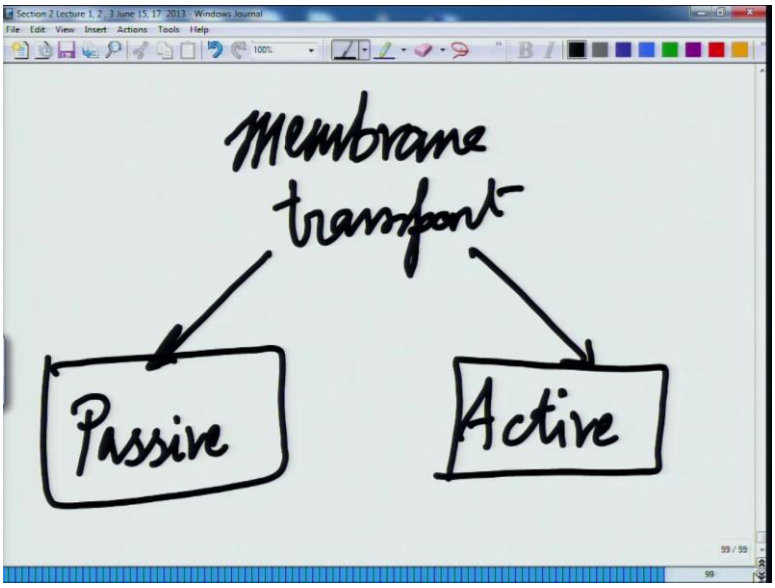
Otherwise, we would not survive, not only that cell need to secrete out the wide range of molecules outside it, if some of these includes neurotransmitters, which have to secreted by the nerve cells to communicate with other nerve cells. There are endocrine cells which secrete, hormones which takes care of a wide range of physiological functions which we deal with, apart from it the cell has to regulate it is water.

Some time it has to take in water, some time it has to get rid of water, some time it has to through away the toxic material from inside the cell, so that it can survive. Apart from it there are several other energy transaction processes, which requests a lot of membrane dynamic processes, which includes conduction, which includes energy synthesis especially in the case of mitochondrial membrane, in the case of photosynthetic membrane.

So, what we will do in this section or in this lecture, first of all we will broadly classify the different transport phenomenon of molecules, which regulates a lot of physiological processes in the body. So, broadly speaking if I have to classify the different phenomenon or transport phenomenon, the transport phenomenon could be classified into two broad groups.

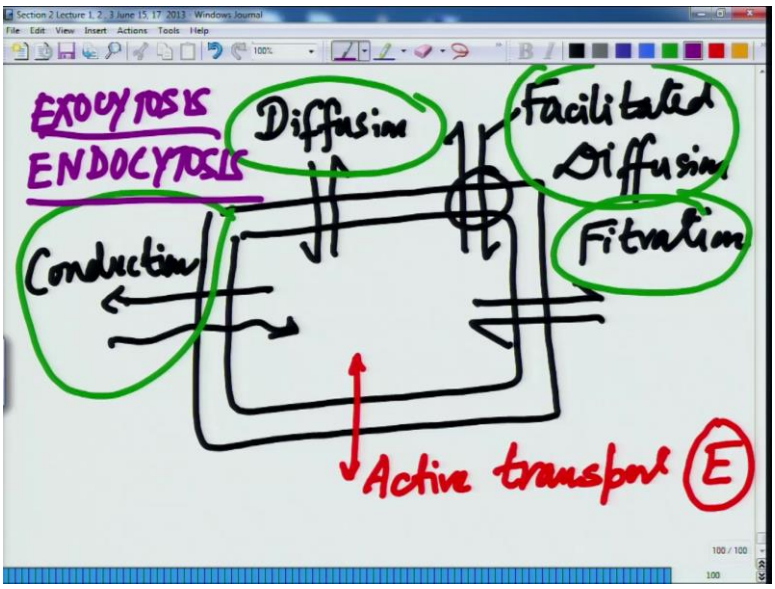
One is energy dependent process, the other one is the independent process or in other words, one is without need for any energy and the other one is you need energy for the transport to take place. So, based on that there are two terms, one is called the passive transport where you do not need any kind of energy, there are physical constraint which leads to the movement of x, y, z molecules and there is active transport.

(Refer Slide Time: 12:18)



So, broadly let me classify it in terms of the membrane transport, if I had to put it like this membrane transport, it could fall under passive transport and active transport, these are the two broad and an a very, very broad heading you can classify them.

(Refer Slide Time: 12:46)

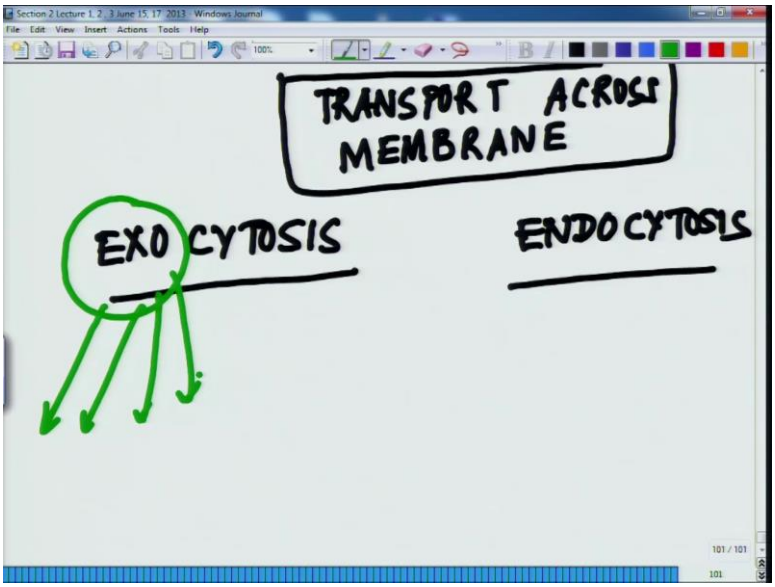


And based on that, if I have to diagrammatically show you and if I consider this as a cell say for example, this box structure is a cell with bi lipid layer. So, one of the passive transport is diffusion, then you have something called will come in depth with that facilitated diffusion. Then you have something called filtration, then you have

conduction, then I am now putting something on red, which is called active transport, this is I am putting it red purposefully.

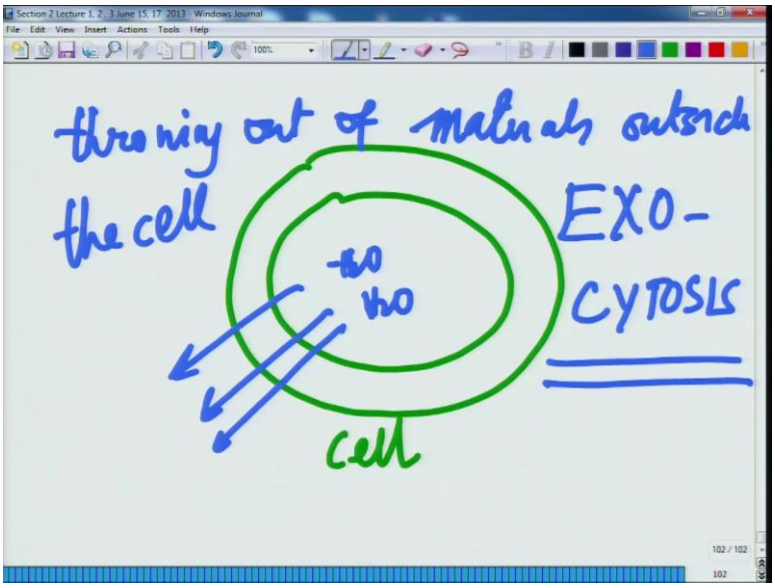
Because, this is energy, I am just putting it energy independent phenomenon, whereas the one I am now putting them as green are energy independent phenomenon. And within this broad heading you have some phenomenon called exocytosis, endocytosis and we will come in depth into endocytosis. So, these are the broad broad ways of classifying the different transport phenomenon which takes place across the different membrane.

(Refer Slide Time: 14:28)



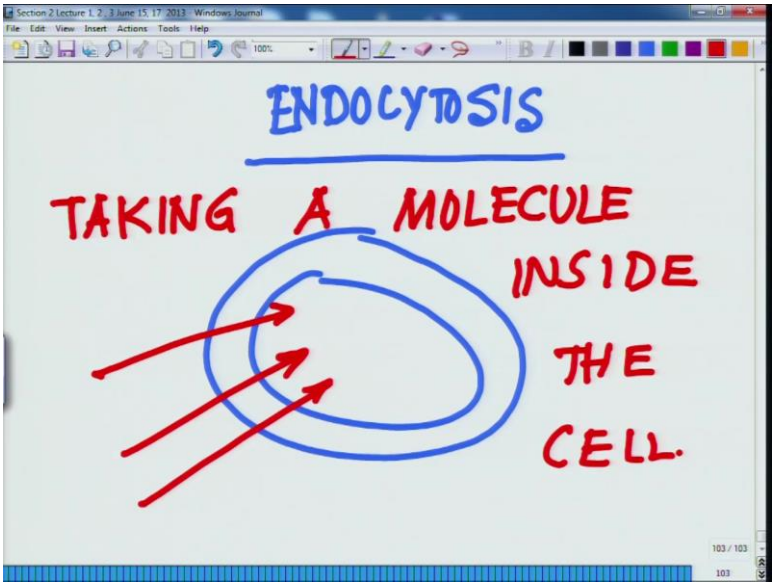
So, now we will do again we will redraw that, transport phenomenon, transport across membrane under the broad heading and first we will be dealing with a process called exocytosis, these are some of the key and endocytosis. What is exocytosis and what is endocytosis, exocytosis exo as the name indicates, you look at it exo, exo means you are throwing out something outside the cell.

(Refer Slide Time: 15:22)



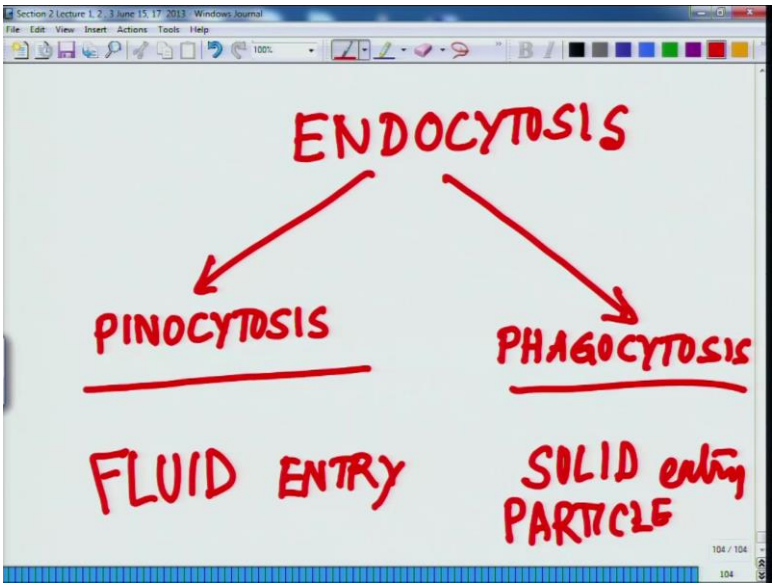
Say for example, a cell has, so this is a cell and it has excess water it has a lot of, so this is a cell and it has lot of water molecules, so it has to throw away this water molecule. So, throwing out of this water molecules of throwing out of materials outside the cell falls under exocytosis, this is one of the key phenomenon which dictates the regulation of several fluids across the membrane.

(Refer Slide Time: 16:16)



Next is endocytosis which is just the reverse of it endocytosis, endocytosis is of two kinds, so first of all endocytosis, so if this is your cell and you are taking something inside the cell, taking a molecule inside the cell that is what endocytosis means.

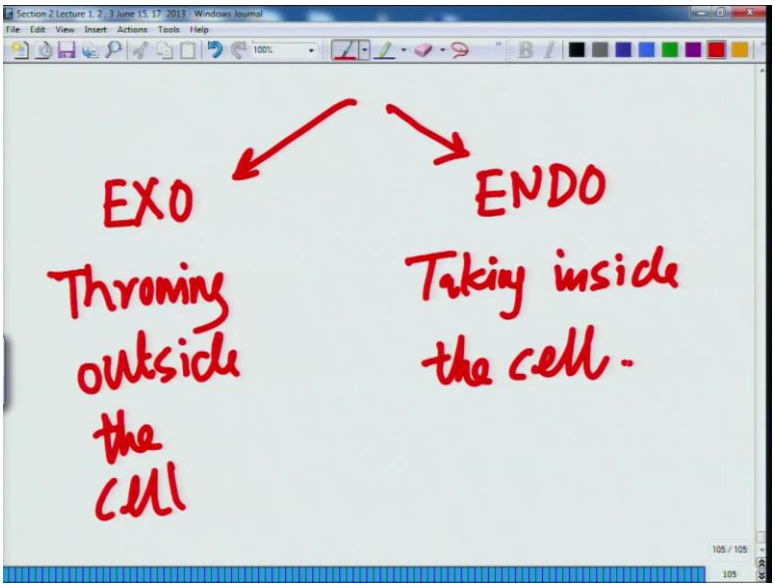
(Refer Slide Time: 17:01)



Endocytosis could be of two kinds, endocytosis it could be called pinocytosis or phagocytosis, what is pinocytosis and what is phagocytosis, pinocytosis is a process by which a lot of fluid material is taken inside the cell fluid entry. And whereas, in phagocytosis solid particle entry, this is the basic difference between pinocytosis and phagocytosis, this is under the broad heading of pinocytosis and phagocytosis and they have a profound role to play.

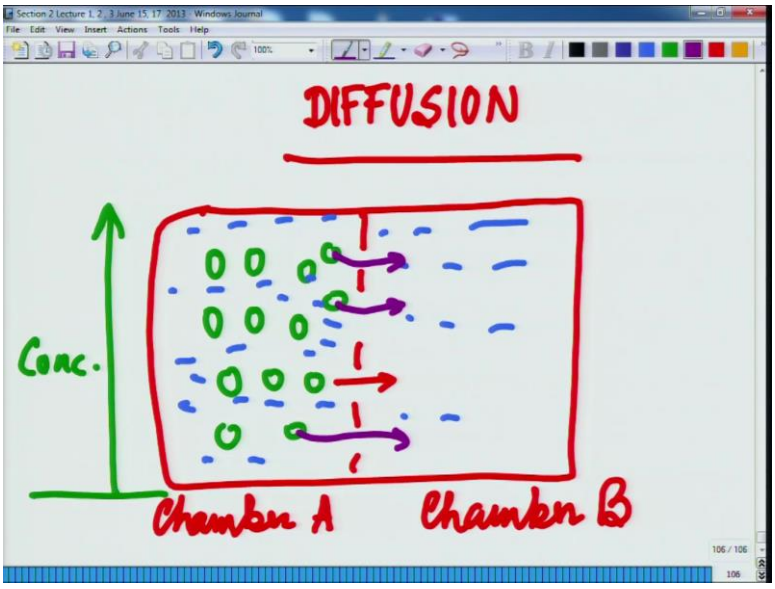
Whereas, in exocytosis, exocytosis is one of the regulated mechanism by which a cell gives away neurotransmitter, the nervous signal the way the cell send the neurotransmitter it is by an exocytosis process, where is in endocytosis takes it is stuff inside it.

(Refer Slide Time: 18:26)



So, I expect that you people should be very clear about these two words, exo and endo cytosis, throwing outside the cell, taking inside the cell this is exceptionally important.

(Refer Slide Time: 18:56)

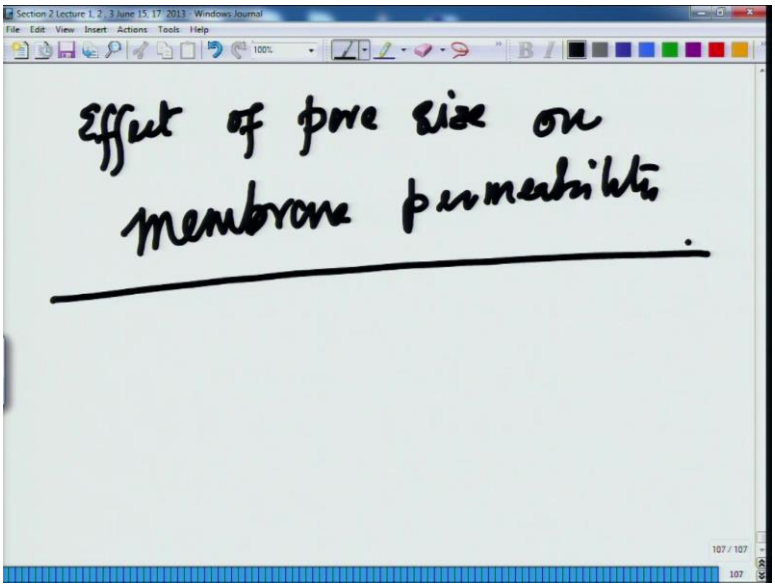


After this we move to the next, which is the diffusion process simple diffusion, so I have to, so this diffusion process is governed by the concentration area. So, there are two or three factors which dictates diffusions say for example, let us think of a situation out here, there are two chambers out here say this is say for example, chamber A, this is chamber B.

So, within chamber A you have a white number of these greens are the molecules which are present in chamber A and along with you have lot of water molecules, there some kind of a solvent out there. So, what is happening in this, in this site the concentration of this green molecule, we have to see the concentration of the green molecule is very high. So, invariably what happen, these green molecule will try to diffuse to the other site into the chamber B they will move like this.

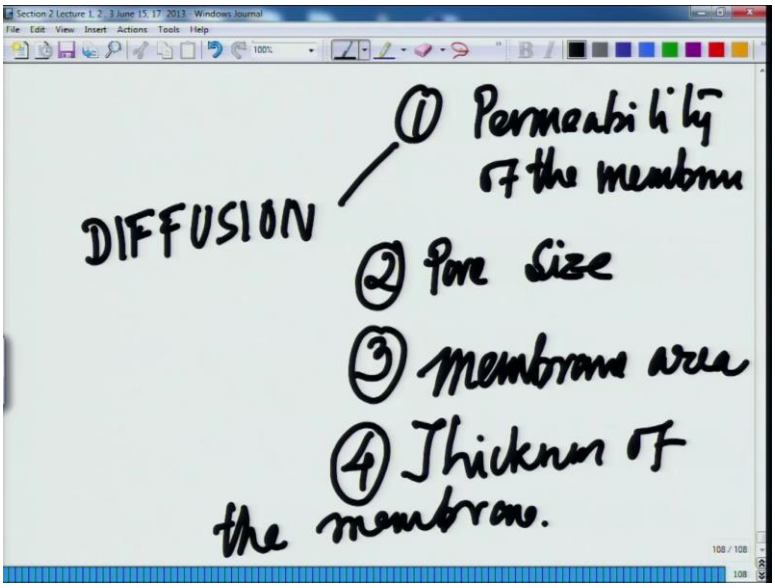
So, this green molecules will try to diffuse and equilibrate on both side, so there will be intermediate situation and eventually you will see this B side will have equal number of green molecules from one side, from side A to side B and vice versa. This is the basic understanding of diffusion which is extremely important for you people to understand that, this is one of the process is transport phenomenon which is simplest of all.

(Refer Slide Time: 20:52)



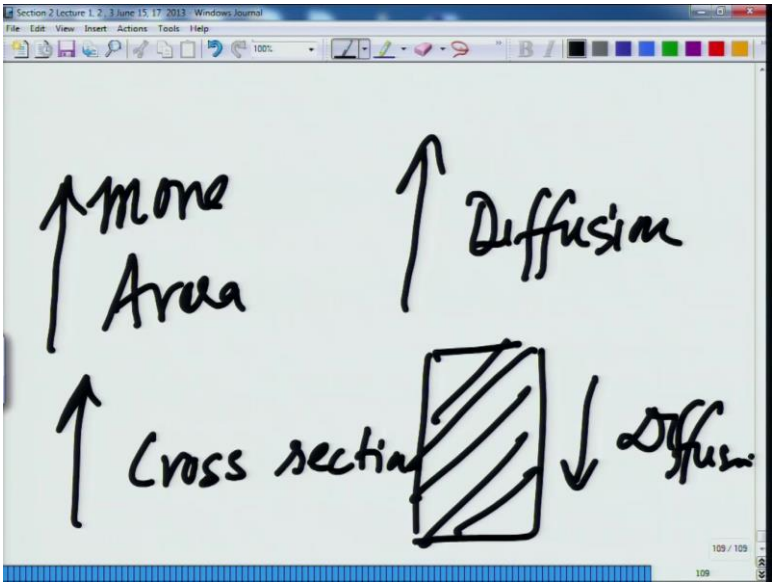
So, what are the factors which affects, so for example let us put it like this effect of pore size on membrane permeability, other word what we are going to deal in this situation is what are the factors which dictates your diffusion.

(Refer Slide Time: 21:17)



Diffusion is being governed by permeability, how much the membrane is permeable, permeability of the membrane pore size, this is extremely important what is the size of the pore. Third is the membrane area or what is the area covered by the membrane, fourth one is thickness of the membrane.

(Refer Slide Time: 22:06)



So, if your area is more say for example, you have more area than I am just putting into upward arrows, so that possibility that the diffusion will be more, provided the pore size support set. Say for example, you have more cross section to travel or in other word, the

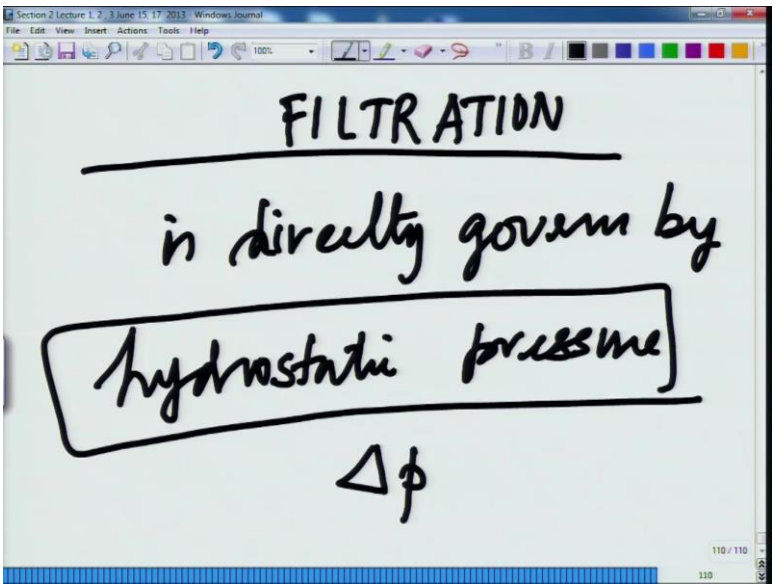
membrane is very thick say for example, something like this, so there will be a slower diffusion.

So, based on this several kind of equation could be derived that how the membrane is, what are the pores sizes and what are the selective things and based on that certain things can pass, certain things may not be able to pass. So, it is kind of a very, very dynamic process and this helps us to look at cells, look at natural things where they become selectively permeable.

Because, it allow say for example, a membrane may carbon dioxide to pass may not allow a bigger molecule to pass through or it may allow water to pass, it may not allow some other gas through it likewise. So, there are several variations across nature and this is exceptionally important us to understand, this whole diffusion is governed by the simple factors permeability, pore size, cross sectional area, over all area the surface area and all these different parameters.

And based on that one can develop any form of equations by which you can really understand the whole process of the whole membrane dynamics how the molecules are crisscrossing across the membrane.

(Refer Slide Time: 23:54)



From here we move on to the next phase that is called filtration, filtration is a much more simple process, so for example filtration is a function of the hydrogen static pressure. So,

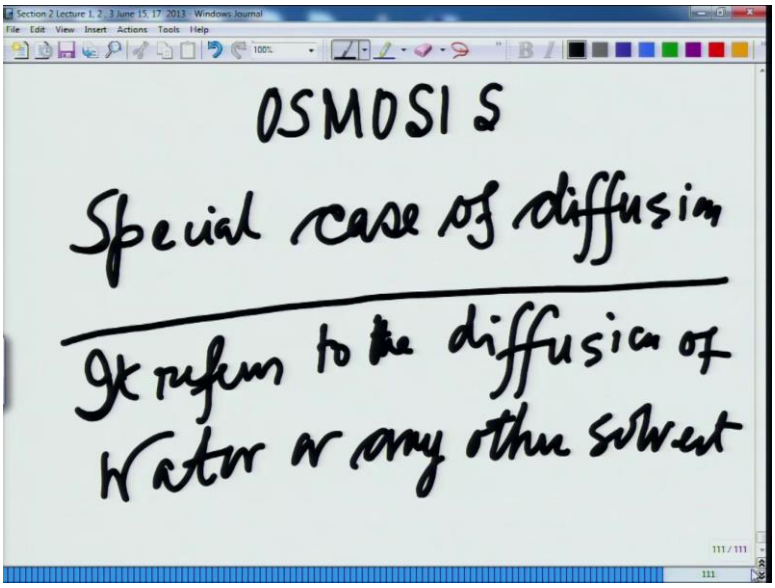
you can filter something from one side to another side provided there is a pressure difference and that will flow through. So, it is a direct function, filtration is a directly governed by hydrostatic pressure, in other word this hydrostatic pressure is the governing force in taking care of the filtration.

So, if I say this difference in hydrostatic pressure is shown by delta p, that this decides what will filter through apart from this, there is another factor that what are the pore sizes which dictate what will filter through. Say for example, if your filter size is say 2 micron and you have molecule which is 4 micron, so whatever pressure you give most unlikely would have four micron molecule will pass through to 2 micron, unless the otherwise the molecule can shrink through and get through by some way, some things or other.

Or say for example, you have pore size of 0.2 micron and you have molecule which is like 10 micron, there is no way that 10 micron molecule which is so huge can pass through point 2 micron filter. So, the pore size is exceptional important, the pressure you are putting across the two side it is exceptional important, so one of the key role is played by the hydrogen static pressure and the pore size.

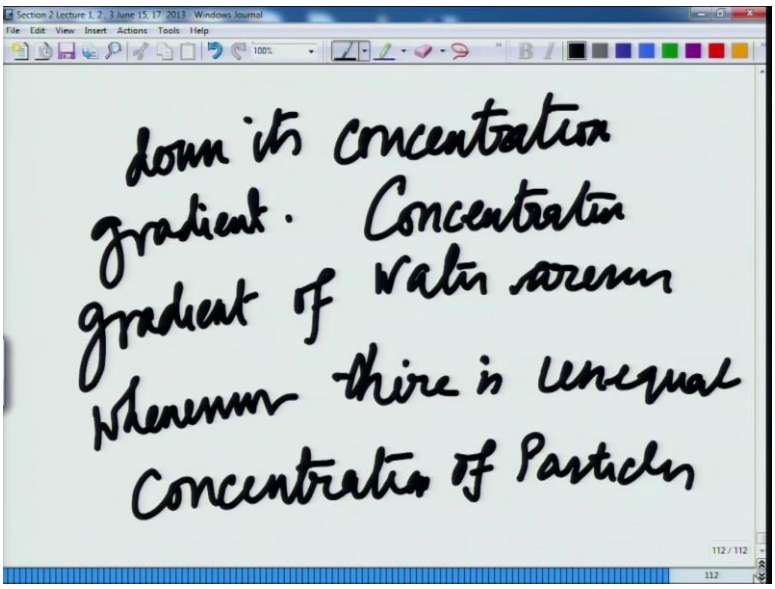
And of course, again all the parameters will come into play the surface, the amount of surface which is exposed with the filter and the cross section of the filter and all these things. And it is a very hot area to research where several innovative filters are getting inspiration from biological components, they see natural phenomenon, natural filtration as simply and they get inspiration to get next generation of filters.

(Refer Slide Time: 26:17)



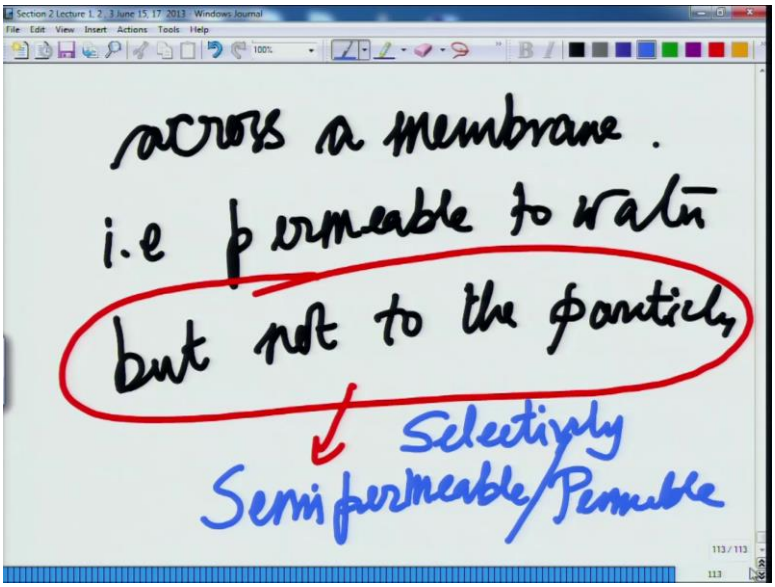
So, third thing we are going to deal with is called osmosis, which is a very specialized form of diffusion, if I had to it is basically called a special case of diffusion, special case be very careful on this, because many people kind of get confused with what osmosis is all about. If have to put it refers to the diffusion of water or any other solvent, I will move to the next page.

(Refer Slide Time: 27:03)



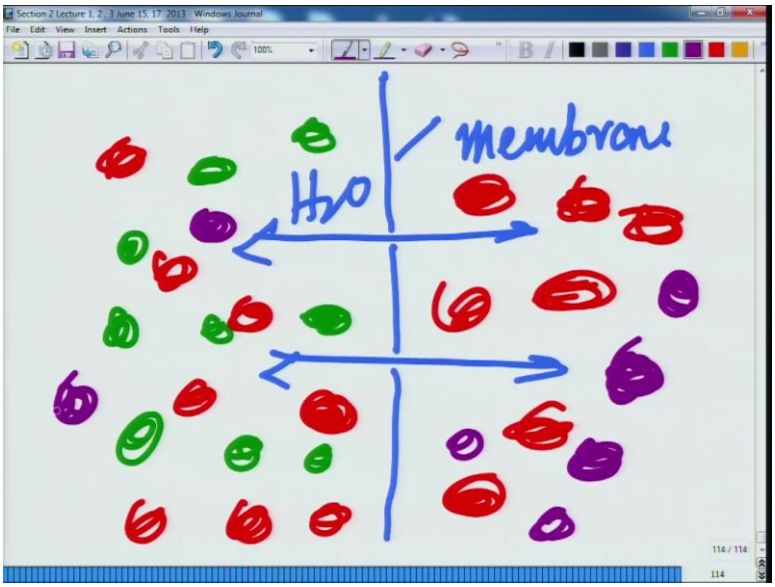
Any other solvent down it is concentration gradient, this is exceptionally important, concentration gradient of water, one second of water arises, whenever there is unequal concentration of particles.

(Refer Slide Time: 27:58)



Across a membrane, this is extremely important that is permeable and this is another important aspect of osmosis that is permeable to water, but please highlight it, but not to the particles. In other word, I am highlighting this word not to the particles, in other word we are talking about semi permeable or selectively permeable membrane.

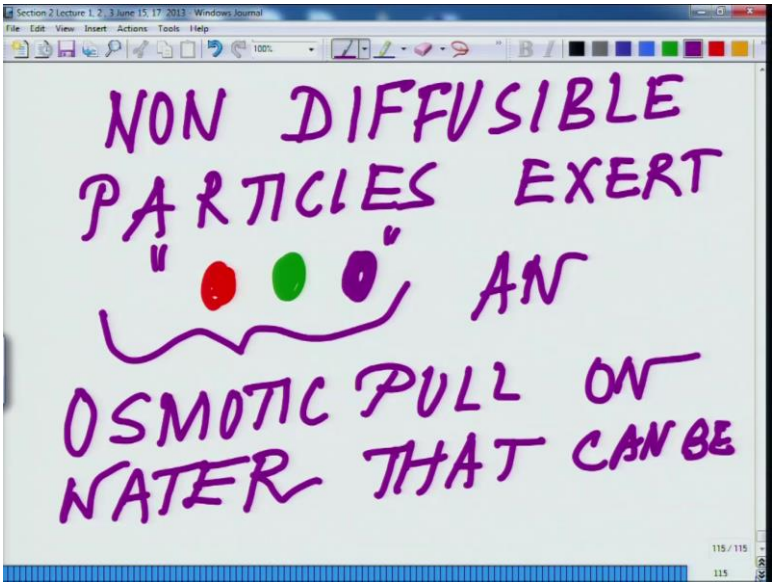
(Refer Slide Time: 28:54)



So, if I have to draw this it is something like say for example, I think this is not the right way to draw it, say for example here is a membrane and this is the membrane, this membrane will allow water to flow on both sides. Likewise, but if say for example, you have these particles, different kind of particles or say for example, this red and green balls of which you could see out here.

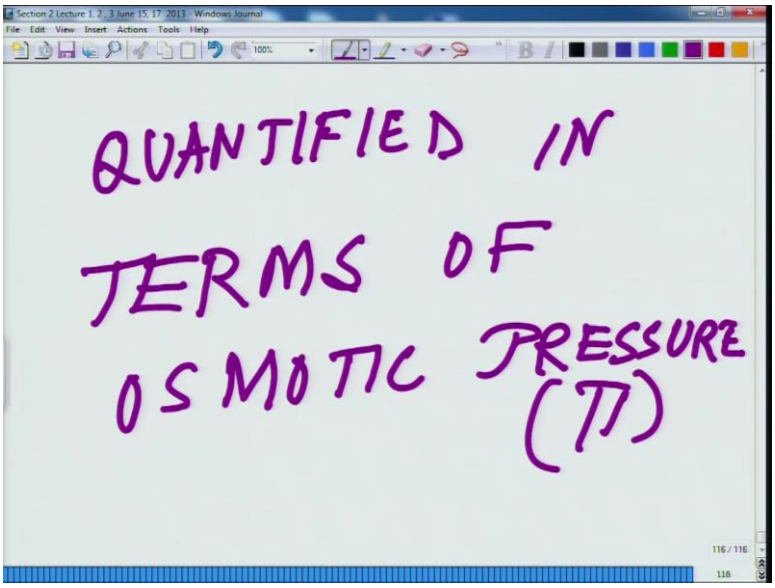
It would not allow the red or the green balls or any other kind of particles which are present, these are different particles, it would not allow any of those to pass through it. So, the mobility of these, this red, green or these magenta color balls and everything will be concentrated, they would not be allowed to pass through it and this is the situation when you will see osmosis phenomenon taking place.

(Refer Slide Time: 30:05)



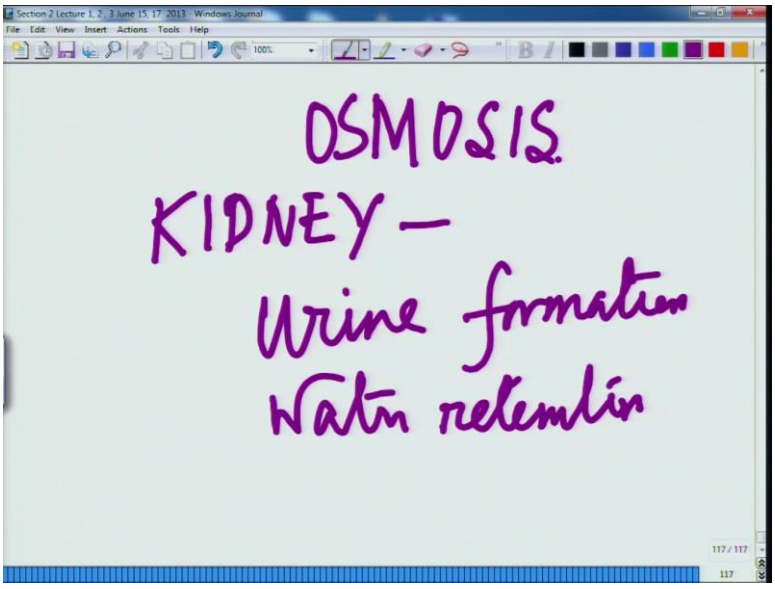
And if I had to put it in terms of word, then will say the non-diffusible, the what I showed you the non-diffusible particles, this is extremely important, please get your basics very right on this. Non-diffusible particles which I was drawing like the red and then the green and magenta and all those, non-diffusible particles exert an osmotic pool, osmotic pool on water just have to 1 second I will just missing a track. Just kindly [FL] me, because I just missed just missed a slide, osmotic pool on water that can be...

(Refer Slide Time: 31:31)



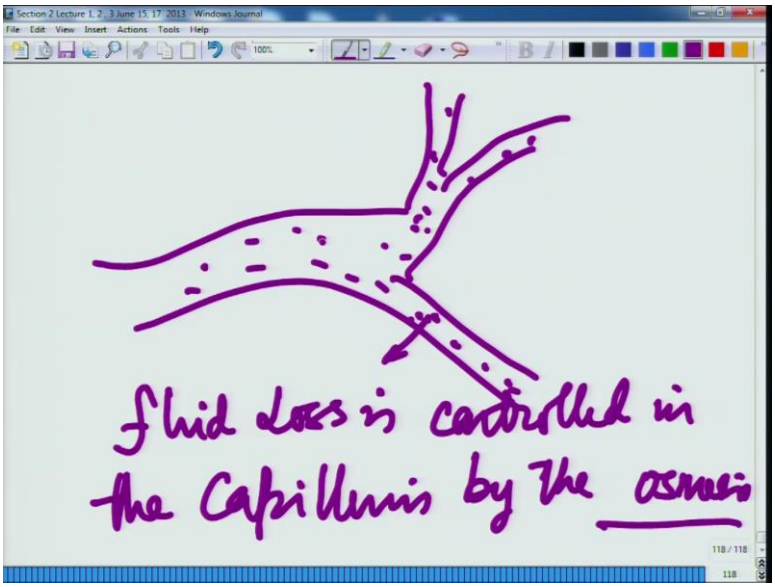
That can be quantified, in terms of osmotic pressure this is extremely important for you people to understand, which is some time denoted with pi the sign. That this osmosis phenomenon it is an specializes diffusion process, which is dictated by the gradient of water. But, this diffusion phenomenon takes place through a selectively permeable membrane, this selectively permeable membrane does not allow the solutes to pass through, it only allow certain solvents to pass through them. And this phenomenon is so very important, that this is the same phenomenon by which some of the most important example we all urinate, we do not lose a lot of water from the kidney.

(Refer Slide Time: 32:47)



This does not happen, because kidney, role of osmosis you see in kidney urine formation, we retain a lot of water we have a very concentrated urine, this is called water retention; this water retention in kidney is an example, classic example of osmosis phenomenon.

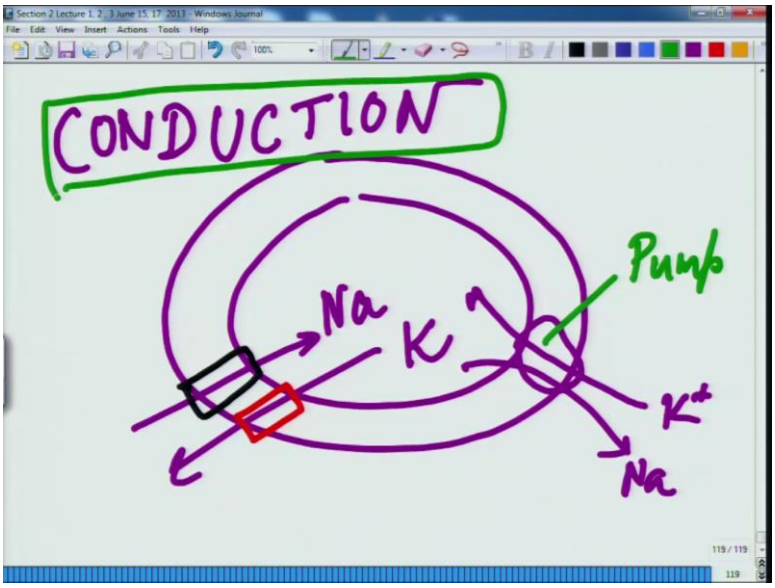
(Refer Slide Time: 33:09)



Then, we know these blood capillaries which are carrying blood all over or body, they do not lose a lot of fluid, fluid loss is controlled in the capillaries by the osmosis process. And this is governed by several proteins, which are present and I am showing in the dot, these are the several proteins and same way in the kidney there are whole bunch of proteins which are present, which pulls back the water and does not allow the water to be lost.

So, this is the importance of this whole process of osmosis, which is especially utilize diffusion and please be careful, it is the force exerted by the non-diffusible particle and on water. And that is called osmotic pressure, is exceptionally important for you people to understand and clarify this process.

(Refer Slide Time: 34:17)



From here we move on to let us classify all the different, so before we classify, let us talk about another form of transport phenomenon that is called conduction. Anyway this conduction phenomenon we are going to come in bigger detail very soon, while will be talking about the nervous system, conduction. Conduction phenomenon is like this, the flow of these sodium, potassium and using different kind of forms where, the sodium is being thrown away and potassium is gets in.

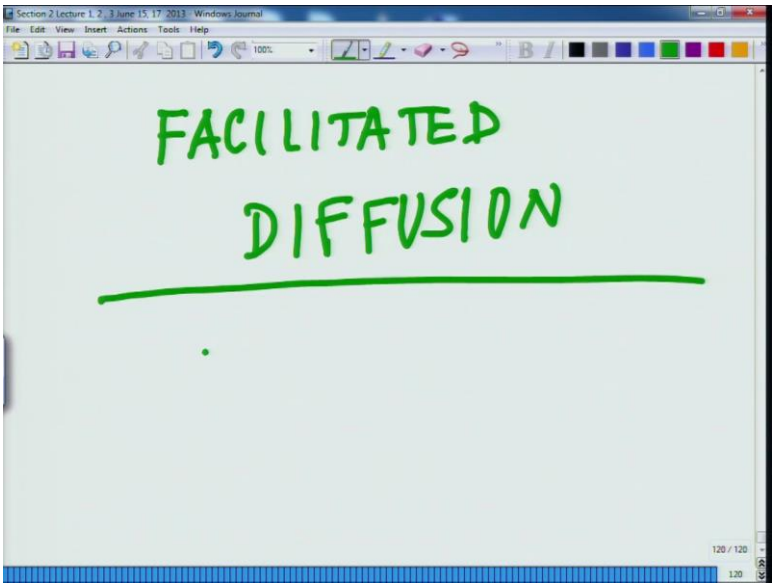
So, these are the channels let me put them in red, ((Refer Time: 34:55)) some kind of channels, so these are the channels, these are the pumps, so this kind of process where electrical ionic conduction taking place. The ions are moving and those ions leads to the generation of electrical in pulses, which is our life line like in the heart which will be our next topic actually, where the heart impulses are regulating the heart beating.

Then the nerve and pulses which helps first to communicate with or send any form of information from outside our body to the brain, and even from inside our body to the brain, and ask the brain to respond back. These are all taken care by the specialized membranes or the nerves and the muscles and under the muscle of course, you have the smooth muscles from the gastro intestinal track.

You have the cardiac muscles from the heart and you have this sculptural muscles from all over your body, so these are specialized membranes and we will be talking about this membranes. As well we are talking about the nervous nerves and their function and

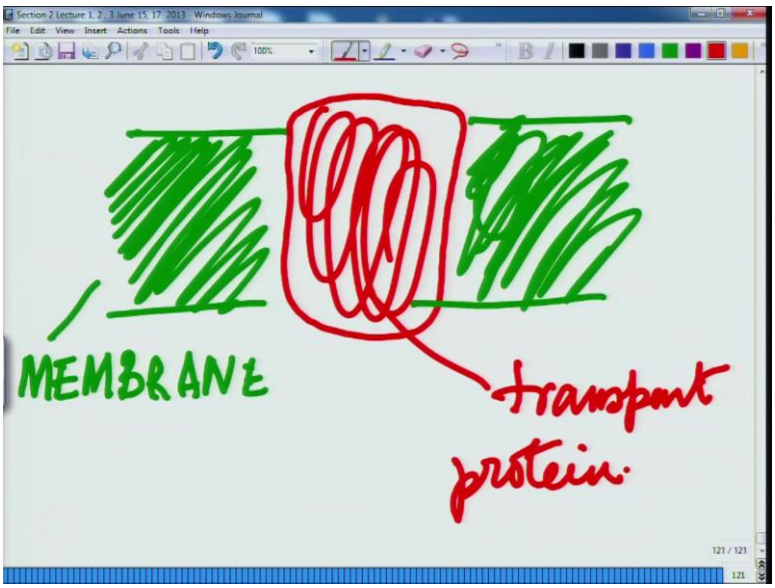
everything we will be talking about in depth about it, so at this stage I am not getting far into that. So, next one there is another term, we talked about osmosis, we talked about diffusion and then under diffusion we talked about osmosis.

(Refer Slide Time: 36:24)



Then will talk about another word, which will come across called facilitated diffusion, what does this mean, the word itself is self explanatory is something which facilitates it across, something which it promotes this process it is something like this.

(Refer Slide Time: 36:42)



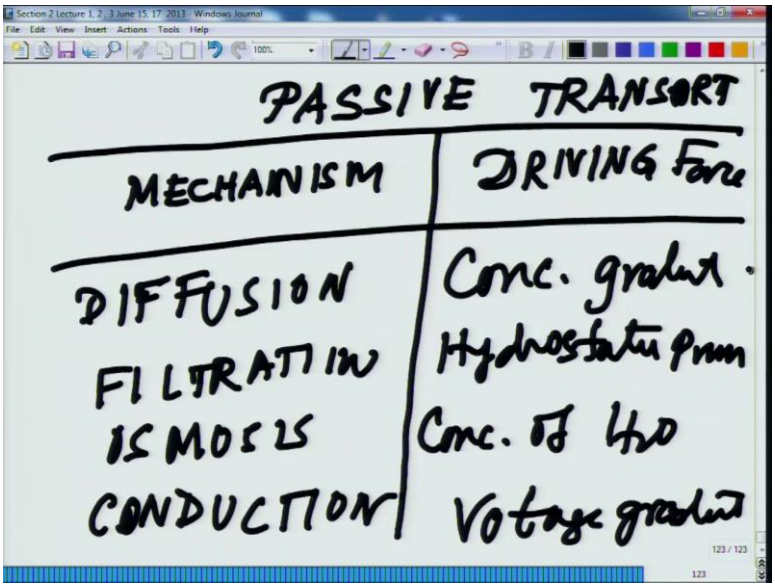
Let me draw it that will make it say for example, this is the membrane there and there is a transport protein sitting like this say for example, and this is your membrane what I have drawn. Let me just put color the membrane in green, this is the membrane and in red you see a transport protein.

(Refer Slide Time: 37:27)

Now, what happens say for example, something has to be transported across it by a process of diffusion what happens is this and this is the protein out here, the molecules say for example is denoted by black these molecules. So, these molecules bind here likewise, so once they bind here and they adhere on this surface and then this particular changes it is conformation and what you see next is this.

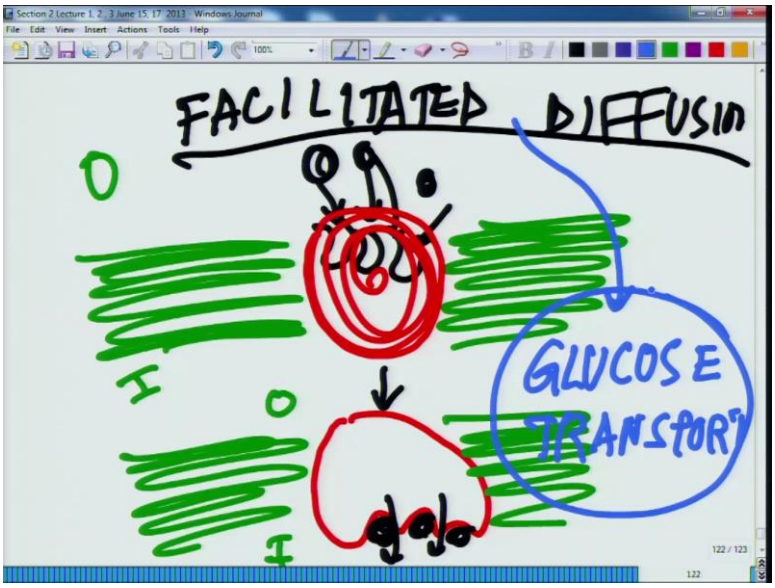
And so this is outside and this is inside, this is again outside and this is inside, now you have transported those molecules inside, which is taken by a facilitated by this is falling under facilitated diffusion, they fall under a bigger heading of facilitated diffusion.

(Refer Slide Time: 38:34)



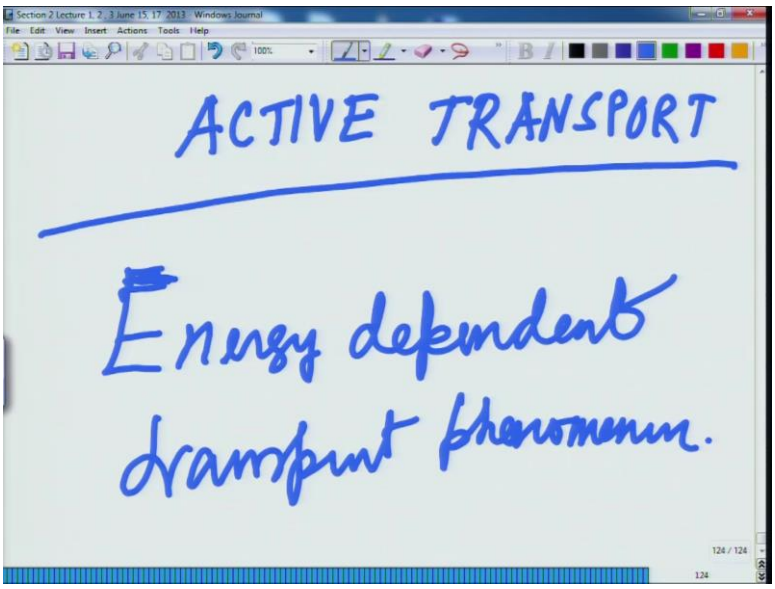
So, if I had to kind of classify the mechanism and the driving force which I am going to do for the passive transport. So, this is what I will do before I move on to active transport, passive transport and I am classifying passive transport as mechanism and the driving force. So, you have diffusion, you have filtration, you have osmosis, you have conduction these are the major ones and conduction is taken care by the voltage gradient. Osmosis is taken care by the concentration gradient of water, filtration is by hydrostatic, so this is the summery hydrostatic pressure and diffusion is by concentration gradient of both solute and solvent. So, these are some of the overall outline and talking about the facilitated diffusion, let me just go back.

(Refer Slide Time: 39:59)



So, this facilitated diffusion is extensively used in glucose transport will come back to all these things as we will be going through the course. Glucose transport in our body in intestine and other places is being taken care by facilitated diffusion process.

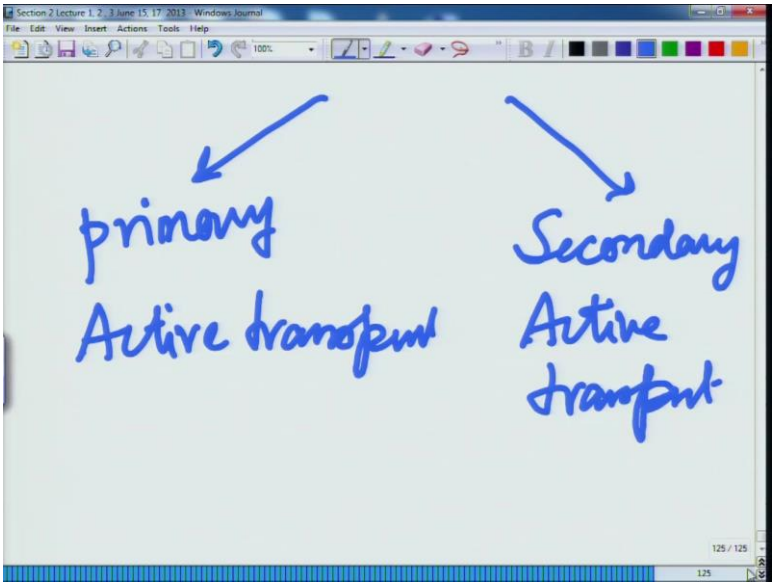
(Refer Slide Time: 40:22)



So now, from here we will move on to the active transport process, so now we are moving from as of now we talked about all the processes, which are non energy dependents, they do not need any energy. So, active transport, active transport needs

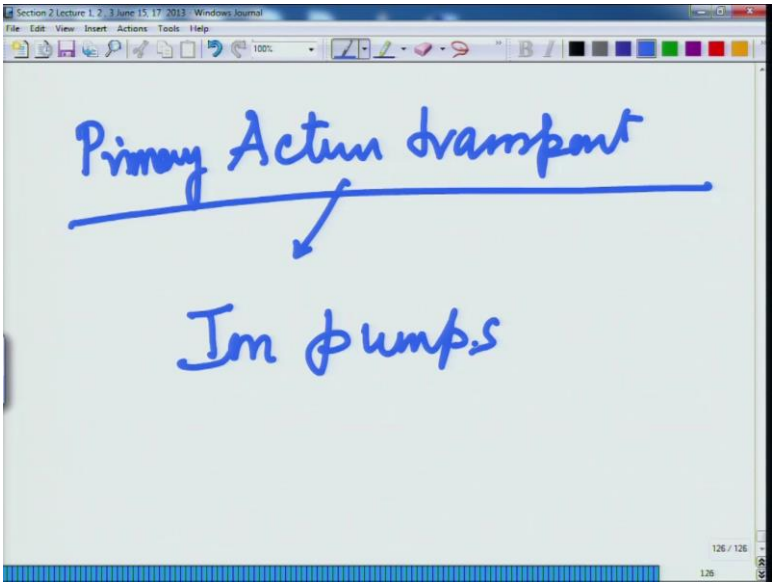
active participation of energy rich molecules like ATP's, so these are the energy dependent transport phenomenon.

(Refer Slide Time: 41:03)



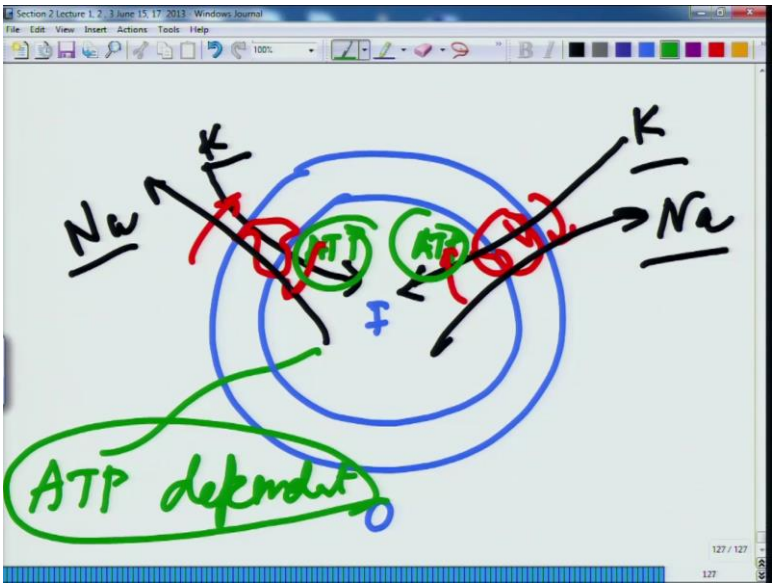
In energy dependent transport phenomenon, you have two kind of active transport, one is called primary active transport and you have secondary active transport, so what is primary and what is secondary.

(Refer Slide Time: 41:31)



So, now you will next slide we will talk about the primary active transport, so primary active transport are taken care by ion pumps.

(Refer Slide Time: 41:51)



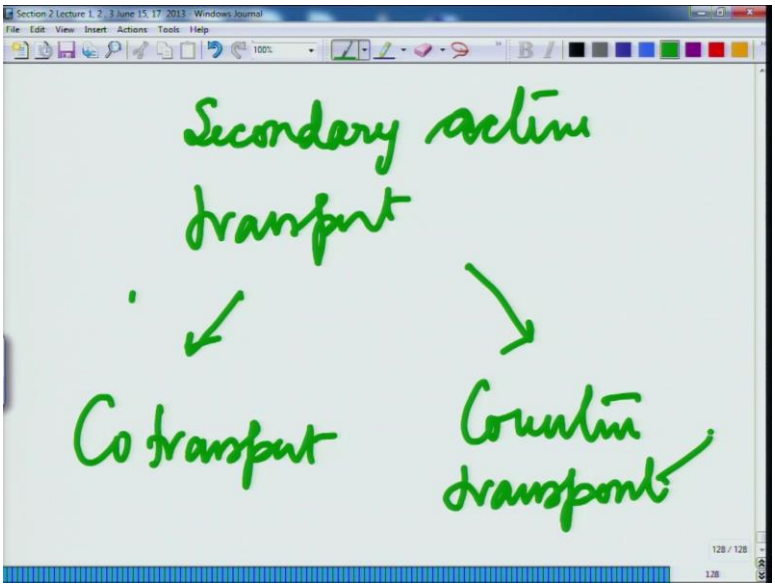
Let me give you a example, in will talk about the ion pumps, you remember I was telling you in the last class, so if this is the cell and this is the inside and this is the outside. So, there are bunch of pumps which takes care of likewise, which has sitting there which changes their conformation and ensures that the flow of potassium and throwing away of sodium from the cell; and there by maintaining the homeostasis of the cell.

These ion pumps are primary active transporters, they help in and they are completely is tell you ATP dependent, if you remember in the last class I told you they are ATP dependent and ATP has to be present inside the cell, ATP dependent. And I talked about one of the molecules called oben which blocks these ion pumps, so these ion pumps are extremely crucial Nobel Laureate ensica, which actually discovered the structure of them, got a Nobel prize for it.

Realize that these ion pumps are the ones, which decides the potential difference across a cell, across especially across as a matter of any cell, so they ensure inside the cell we have lesser amount sodium, we have lesser amount of glucose. We have higher amount of potassium, we have higher amount of few other molecules, as compared to outside where the glucose is higher your sodium is higher, amino acids is lower where as amino acid inside the cell is higher.

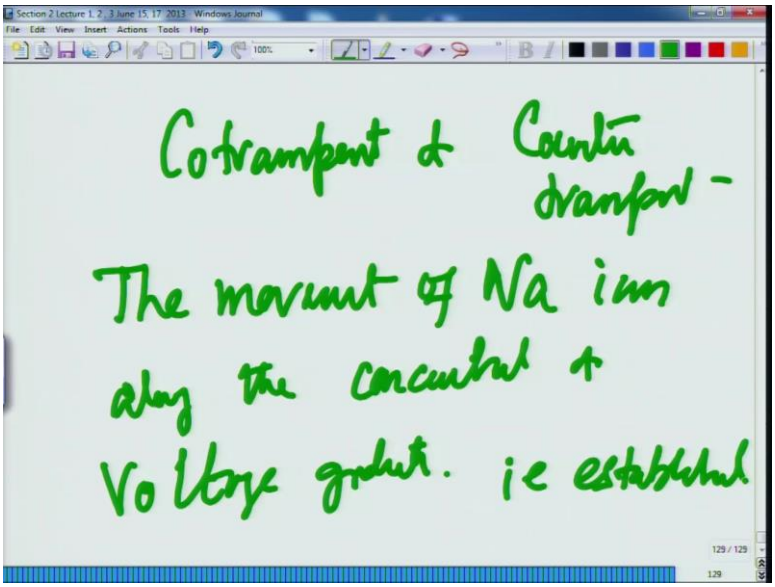
So, all these different kind of phenomenon or all these different kind of variations, specially with the sodium and potassium is being governed by the primary active transport, which uses these kinds of pumps.

(Refer Slide Time: 44:09)



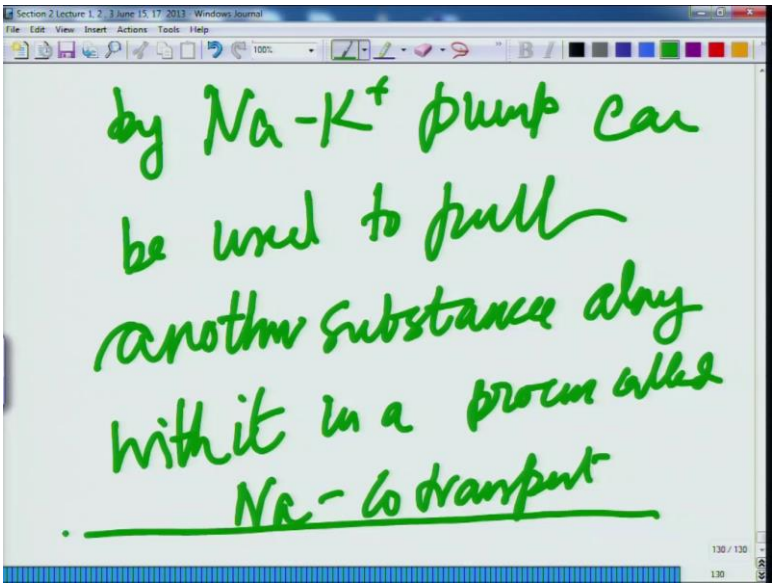
So, now from here we will talk about this secondary active transport, secondary active transport are of two types, one is called co-transport, the other one is called counter transport. So, and as we will move into the course will come across several situation of co-transport and counter transport.

(Refer Slide Time: 44:51)



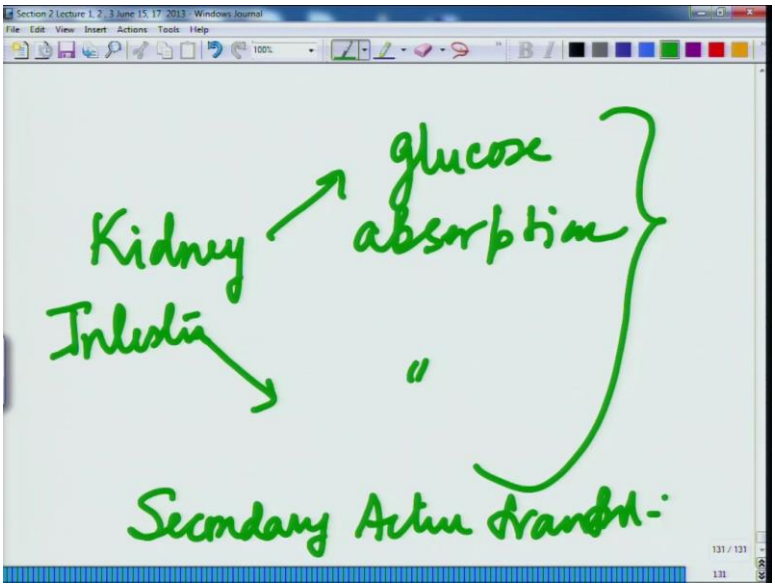
So, at this stage what I will do is, will give you an brief idea about co-transport and counter transport, so one of the simple example is that the movement of sodium ions along the concentration and voltage gradient.

(Refer Slide Time: 45:36)



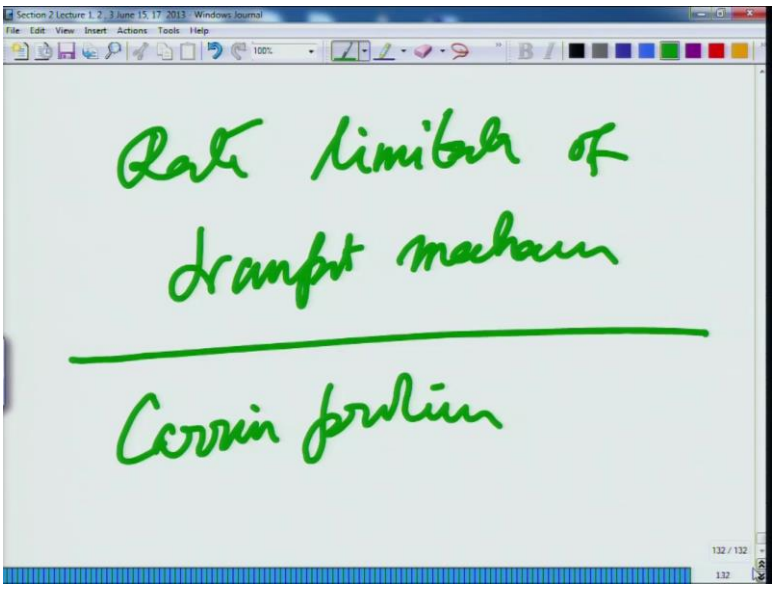
That is established by sodium potassium pumps can be used to pull another substance along with it in a process called sodium, I just miss the slide just bare with me, in a process called sodium co-transport. So, along with this another substance is being carried, this falls under sodium co-transport, so will come in depth about many of these, so some of the examples where these co-transport and counter transport phenomenon are been used.

(Refer Slide Time: 46:43)



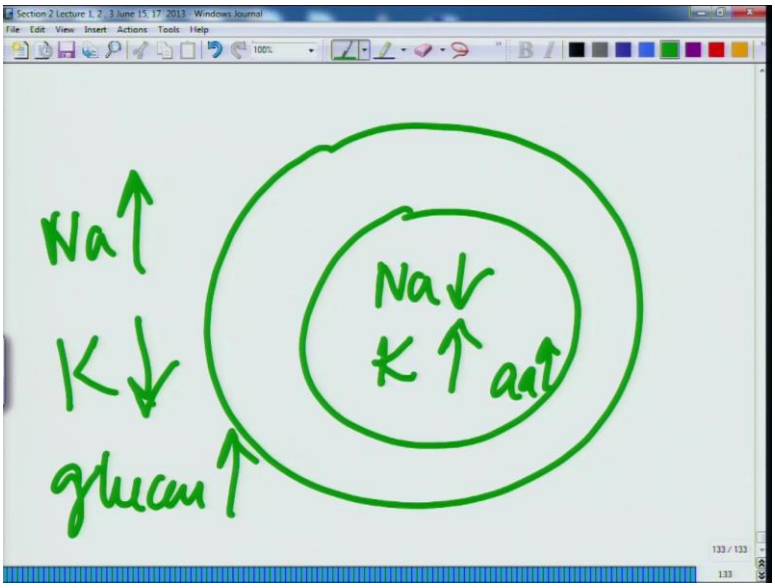
I need it to highlight is in specially in the kidney glucose absorption, so that we do not lose absorption, then in the intestine glucose absorption, these are all secondary active transport phenomenon.

(Refer Slide Time: 47:27)



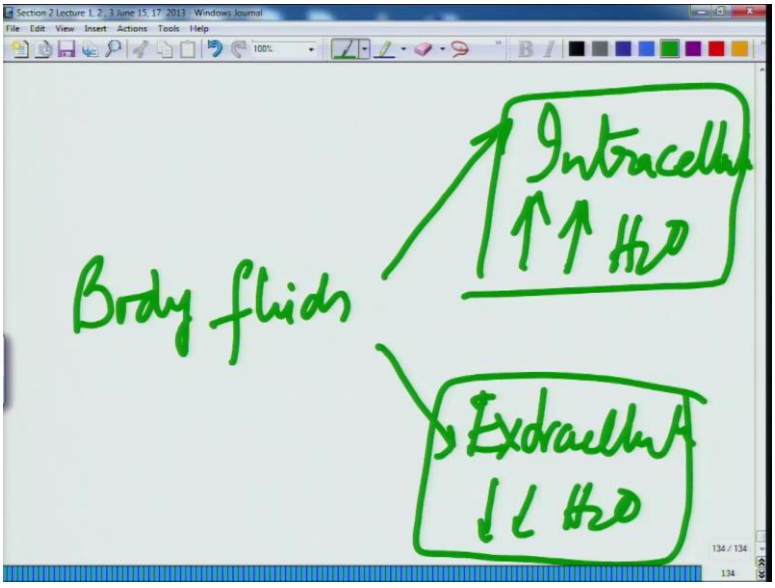
The rate limitations of these transport phenomenon, rate limitations of transport mechanisms is with the depending on the carrier proteins.

(Refer Slide Time: 47:45)



And the overall composition if you look at it inside and outside the cell, so you will see sodium will be lower inside the cell, potassium will be higher, amino acids will be higher. Outside sodium will be lower, sodium will be higher, potassium will be lower, glucose will be higher outside the cell, glucose will be far more higher outside the cell.

(Refer Slide Time: 48:17)



And among the total body fluid there are, these body fluids are being distributed in two compartments either it could be intracellular or extra cellular. So, major concentration of water is in the intra cellular fluid and lower concentration is outside into the extra

cellular fluid. So, this brings us to an conclusion about our second section of the topic, which is membrane physiology of nerve and muscle.

What I expect is that, you should have very clear idea about the structure of the membrane, the different components of the membrane which includes the lipids, which is a major component including the glycol lipids and the phosphor lipids. Apart from it you should understand that the lipids are classified as storage lipids and membrane lipids, and we are talking about the membrane lipids.

You should have a fare understanding about the role of cholesterol, then you should under the role of the proteins, membrane proteins, how they were embedded and how within the lipid bilayer with the non covalent interactions. And the examples I said about valinomycin and gramicidin which are proof to understand how the probably these proteins have evolved; and several toxins which are the channel forming ability, I will give you an example of an carrier antibiotic.

Apart from it I expect you to have an understanding about the carbohydrate molecules which are decorating the outer surface of the cell membrane, which helps the cells to identify, they gave an identification mark to the cell, they help in whole bunch of chemotaxis and whole other techniques. And you should have a fair idea of understanding about the different techniques, which are being used, which are you talked about lipid vesicle, lipid bilayer studies.

And freeze fracture technique, fluorescence technique understand the mobility of the lipids and the proteins across the membrane and from there it should have a over view about the different dynamic processes. Or the transport phenomenon, which includes a passive transport and active transport across the membrane, which include diffusion, osmosis, conduction, facilitated diffusion and exocytosis, endocytosis.

And in the active transport you have primary active transport and secondary active transport, within the secondary active transport you should have there is co-transport, there is counter transport. So, over all with this basic understanding, I assume we will enter into our next topics which will be much in depth, but the whole basis lies here, so with this I will closing the lecture and will start with the next topic next day.

Thanks.