Bio-electrochemistry
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Lecture – 14
Concept of Concentration Cell-II

Welcome back to the 14 lecture of the Bio-electrochemistry series. So, in the last class, what we talked about is a Concentration Cell and I told you that from Concentration Cell, we will move on to the Bio-electrochemistry of nerves and ion channels. So, having said this, just a small recap; what we talked about with the Concentration Cell. So, what we talked about is something like this.

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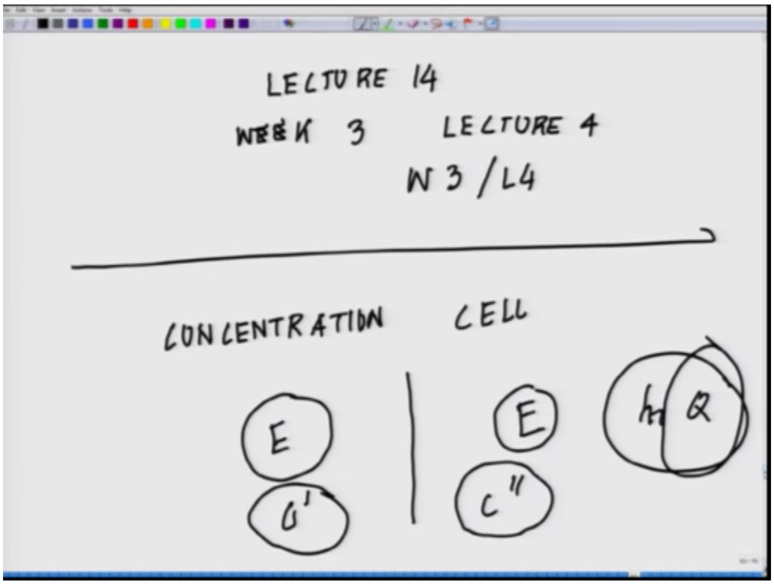

So, this is our overall lecture 14; week 3, lecture 4. Now when we talked about the concentration cells, we talked about that your Electrode on the left side, Electrode on the right side are same. It is only the concentration are different; based on that the value which is going to change is l n Q.

Because this is the function of concentration in 2 different half cells. That is what brings us to the point where is the relevance of such situation in biology. Now before we get into that, just talk about a little bit about the relevance the principle underlying the concentration cell in particularly important where solutions of electrolyte with different concentrations.

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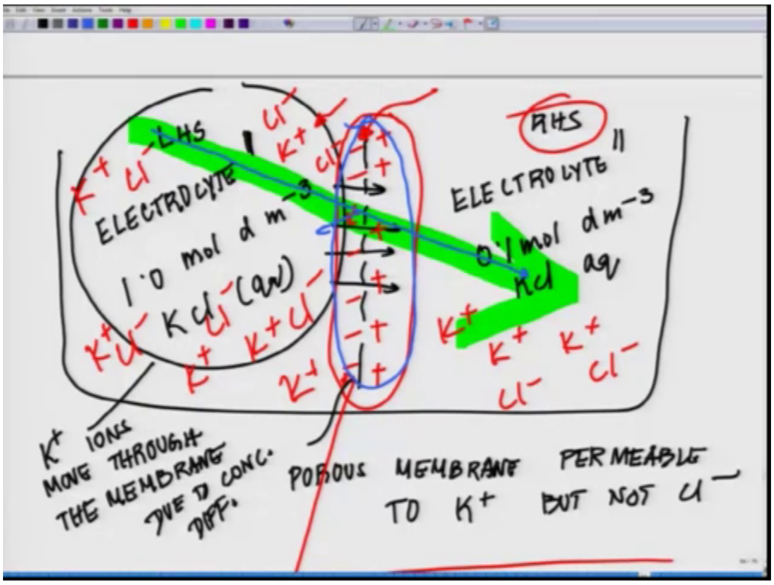

Say for example, you have solutions of electrolyte on Left Hand Side as well as Right Hand Side, they are separated. So, you have electrolyte on this side. Electrolyte of this, I am just showing this as concentration. electrolyte of a different concentration. The different concentration are separated by a porous membrane.

So, here you have a porous membrane which is separating the electrolytes on both sides. If 1 of the ions say a positive ion can pass through the Membrane, but the other cannot; then, the passage of ions will occur to try to equalize the concentration that leads to an excess of these ions on one side of the membrane.

What does that mean? That means, say for example, if I create something like this; with a Porous Membrane and this Membrane I say this porous membrane is a permeable to potassium ions or cat ions, but not to Chloride ions. This is a situation I am creating.

On the left hand side, I have 1 mole K Cl which is aqueous and on the right hand side I have mole K Cl aqueous. Now out here, the Potassium ions move through the membrane due to the concentration difference; because on this side you are having a higher potassium.

So, theoretically speaking by concentration gradient, they should move on this direction. Due to concentration difference or gradient which so ever way you want to put it, whereas on the left hand side, the movement of the ions results in a small charge on the membrane. So, what will happen these? So, on this side if you look at it, you are having K plus Cl minus; on this side you have K plus K plus K plus Cl minus on both sides same.

It's only on this side you have lot more K plus as compared to the K plus on the other side. And automatically you will have Cl minus, but we are not bothered about Cl minus at this point because Cl cannot move. So now, based on the gradient, say for example, I have 100 atoms of or 100 ions of potassium on this side. And say 50 ions of potassium on the right hand side. So, automatically by the gradient, the flow will be more like, the flow will be in this direction, by the gradient difference. So, potassium ions will try to migrate from left hand side to the right hand side.

But if that happens, what will be the situation? There will be a positive charge buildup out here. And of course, there will be certain degree of reduction of charges; there will be a kind of a peculiar charge buildup which is going to happen the membrane permeable to potassium; but not to chloride.

So, that will lead to; so, if we again repeat the whole situation. The principle underlying the concentration cell is particularly important; where, solutions of electrolytes with different concentrations are separated by a porous membrane. This is the porous membrane, we talked about the arrow out here showing the porous membrane.

If one of the ions say the positive ion or potassium ion can pass through the membrane, but others cannot; then, passage of ion will occur to try to equalize the concentration and this leads to an excess of these ions on one side of the membrane.

Now, the development of a membrane potential.

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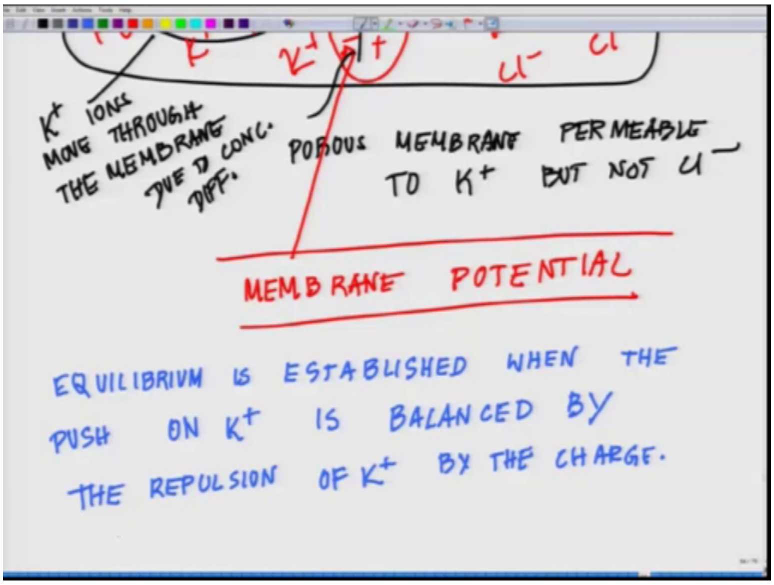

So, this is, is the Genesis of what we call as membrane potential. And this word is our entry port to the world of Biology or world of Biological cells. As of now, we have talked about half cells, which is electrochemical cells. Now we will talk about very soon few minutes, we will talk about Biological cells; the real life cells which are made by nature.

So, this is the genesis of what we call as membrane potential the development of membrane potentials because of the potassium ion move through the membrane, due to difference in concentration. This puts a small positive charge on the right hand side of the membrane. The equilibrium is established when the push.

So, this part is important for you people to understand equilibrium is established when the push on potassium is balanced by the repulsion of potassium by the charge.

So, what will happen? Say for example, there is a movement of the potassium taking place here. So, eventually a time will come where, the potassium ions here are going to repel each other because of the same charge and there some of them will bounce back and they will create a dynamic equilibrium across this membrane; in which we call as the membrane potential.

So, only a very small fraction of potassium ion takes part in this process. So, the concentrations do not noticeably change. So, that brings us to a interesting situation. The imbalance of ion on each side leads to a potential difference across the membrane.

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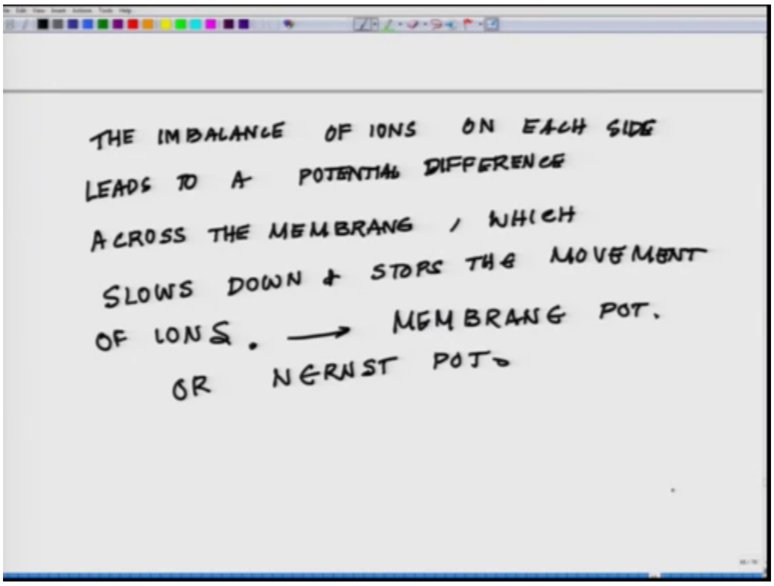

So, the imbalance of ions on each side leads to a potential difference across the membrans, which slows down and stops movement of ion, which slows down and stops the movement of ions. This is known as MEMBRANE Potential and sometimes called NERNST Potential.

This is what is called as Membrane potential or Nernst potential. Membrane potential are often found in biological cells; where, the concentration of now, we will introduce potassium sodium and chloride and other ions are different inside and outside the cell.

The situation can be ala analyzed in same manner as concentration cell to show that for any ion M. Now this is where the important part is coming.

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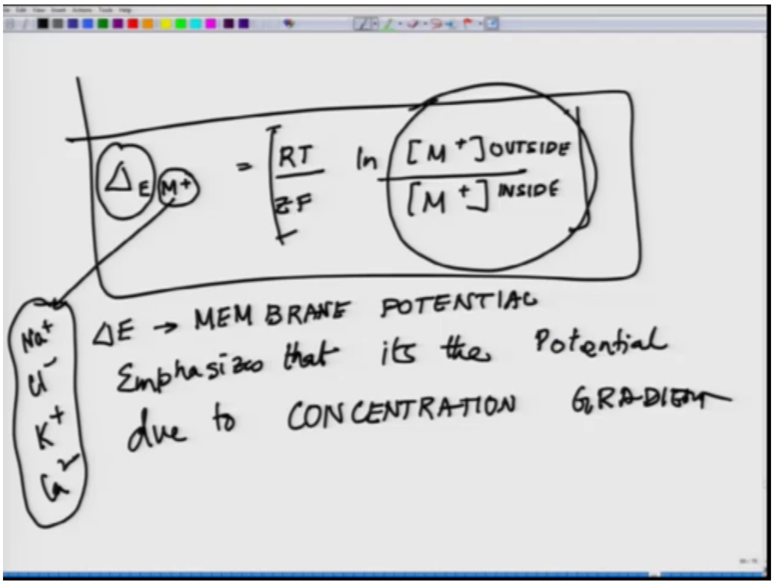

Delta E for M plus say for example, any ion M is given by RT ZF ln; where, your M, M plus inside the cell M plus, outside the cell. So, in other word, your symbol delta E for the membrane potential emphasize that it is the difference in this symbol what you see, the symbol delta e emphasizes that which is for the membrane potential .

So, this is emphasizing that it is the difference in potential due to concentration gradient. Emphasizes that it is the Potential due to concentration difference or concentration gradient, as I showed earlier into the picture. This gradient out here. This is what is being emphasized here; value delta E and you could see that we are not putting the E 0 because E 0 becomes 0 in a concentration cell.

So, the situation can be analyzed in the same manner as a concentration cell to show that for any ion M plus, it could be anything. It could be Sodium, it could be Chloride, it could be Potassium, it could be any anything. It could be a Calcium, whatever ion is involved in it. Depending on the ion type for any ion M plus the membrane potential delta E M is given by RT upon ZF by a natural log, you can translate it into log to the base 10 of course, M outside to M inside.

The reason to put this M outside to M inside is because now, we are switching gear for a biological cell; where you have different concentration outside and inside the cell. So, I will close in here. In the next class, what we are going to do? We are going to now talk about a real life cell and we will appreciate where you can apply Nernst equation to understand the gradient potential and the movement of ions across the cellular membrane. And what are the techniques, which are being used as a as we will move across it. Let me close in here.

Thank you.