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

Lecture – 04
Positive feedback loop in homeostasis

Welcome back to the fourth lecture on Animal Physiology. In the previous lecture, we talked about the negative feedback system. So, if you recollect to we talk about if the temperature of the body rises, how we act on it, what are the sequence of events. Similarly, if the temperature of the body falls how we act to it I wish you guys should be able to an explore that if the temperature falls what are the reactions we have one of the reactions is if the surrounding temperature is very low you know we do this kind of motion like you know what does that mean it generates heat and what all are the other things it will be just the reverse of what you have just seen what happens when the temperature rises.

So, this is the way I wish that you should develop your physiological thinking or logical thinking of the events which happens in your own body and in the surrounding and based on the surrounding even how your body reacts of course, when you talk about the surroundings we mean surrounding inside the body surrounding outside the body it means even if there is a change inside your body how your body is going to compensate for itself suppose you take a food which is very acidic how your body is going to react to it or you take very alkaline how it is going to react it.

So, overall when we concluded the last class that take home message which I conveyed to you is it is a dynamic system and the dynamic system interacts with the surrounding and based on the surrounding changes this dynamic system which is our body it recalibrate itself in order to adjust to the newer settings. So, keep this thumb rule in mind and basic physiology is nothing, but understanding the structure of these dynamic system and its corresponding functions of these different structures which come together to form a complete system what is a human body or a animal body or any kind of microbes or any kind of living systems.

So, today we what we will explore we will just talk about a reverse situation a positive feedback which are very few which happens positive feedback in our body with; there is

one example which I will give you, but detail molecular mechanism we will be talking about it when we will talk about the blood clotting it, it is something to do with blood clotting and from there we will move on to the different sectioning of the body before we move on to the overall layout of chemical organization tissue level organization and the cellular level of organization; sorry it should have been molecular level or chemical level organization cellular level organization followed by the tissue level of organization.

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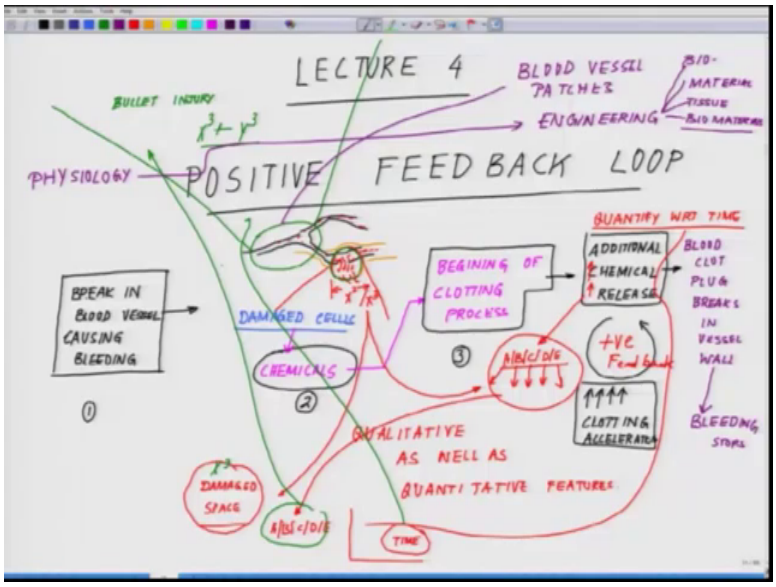

So, coming to this class which is so, this is our lecture four here we will be talking about positive feedback loop positive feedback loop and this positive feedback loop what we will be dealing today will be mostly related to the situation of blood clotting. So, say for example, I will tell you a situation say for example, there is a break in the blood vessels. So, let us think of the real life situation what happens when there is a break in the blood vessel you fell down or you have a scarve; you see the blood whose as out from that place right, because the blood vessels gets ruptured capillary is gets ruptured soon after that what you see after while in the blood do not come out from that mode slowly the blood is stops to come out and eventually you see some form of a small semis.

So, solids kind of you know structure which is formed there which we call as a clot and over period of time as days passes by that clot becomes harder and harder and as all the tissues of the damaged location kind of repair itself the colt at tissue which has become already very hard sluft off from the layer or it kind of you know falls out from there. So,

this is what you see whenever there is a rupture of the blood vessel due to any injury due to any accident due to any scarve or whatever you know this whole process you can translate in terms of engineering in a simple way as if there is a pipe which is carrying water and there is a leakage in it and somebody has repaired the leakage it is almost similar to that. So, in your body there are blood vessels which are carrying blood all over your body for some x y z impact those blood vessels at some a specific location got ruptured and itself heal itself. So, this process is called a clotting process.

Blood clots, but then this is what you observed, now let us break the problem of what call even which takes place. So, let us put them in the way we put earlier. So, break in the blood vessel which is the first event what you observe break in break or rupture you can put it break or rupture in blood vessel causing bleeding at a specific location in your body which leads. So, say for example, in a real life what is happening these are the blood vessels which are supplying blood all over your body and say for example, there is some rupture which happens here. So, the blood started to ooze out from that location. So, this is the blood which is falling now as soon as the blood started oozing out from this location.

So, this part is the damaged tissue what we are talking about the this location which is your damaged tissue or damaged blood vessels as well as the surrounding tissues surrounding tissues means all this location these are all surrounding zones what I am drawing is in the orange coloured. So, these damaged cells they secrete certain specific chemicals I am not getting into the details at this time well we will talk about the blood clotting I will tell you what are those chemicals they fall under intrinsic and extrinsic process of clotting these chemicals leads to the process of clotting to begin beginning of clotting process.

So, as we are breaking down from the problem you see this one was the step one, this is step two and these kind of secretion of chemicals happen both from the damaged blood vessel as well as from the damaged tissue around it because when you get an impact. Say for example, on your body it is not only the blood vessels which gets ruptured it is the mussel it is the endothelial it is the epithelial cell it is the endothelial cells they also get damaged. So, these are the once which secrete those x y z chemicals what do you see out here what has been highlighted out here in the in the picture.

So, these chemicals start the process of clotting which is the step three followed by clot this clotting process initiate a positive feedback it means this clotting demands for more clotting reagents to come into the place additional chemical release and this additional chemical release accelerates, because the process of clotting I am showing the acceleration with this four upward arrows clotting accelerates and eventually this leads to the final goal blood clot plug breaks in vessel wall and the bleeding stop and this process what is happening is here is a positive feedback.

To summarise the process we got an impact at the impact zone there is the rupture of the blood vessel as well as the damage of the surrounding tissue. So, now this vessel has to repair itself the first reaction who takes place is the blood vessel the damaged blood vessel as well as the surrounding tissue starts secreting certain x y z chemicals these chemicals initiate the process of clotting and it sense a forward message or in other word a positive support that you secret more chemicals. In order to completely seal the vessel where the rupture has happened and this positive feedback leads to the sealing of the vessel. And final result is the bleeding stops and followed by as I was telling in the beginning the surrounding tissue and everything appears and we seal it and the body functions normally.

Now, we have two examples one of negative feedback in terms of thermo regulation in the other one is the positive feedback in terms of blood clotting. So, now I will recommend you people look for other positive feedback loops which are existing in our system which that is almost like think of it that. You know there is whenever you remember these kind of things or visualise it is almost like at a zone there is a war zone there a small platoon or a small number or small regiment which is fighting against it and they ask for more reinforcement you send us more reinforcement, because we have injuries positive feedback exactly works like that that you know you send us more and more reinforcement we need to you know recover out, because we are out of our resources.

So, with this I wish to highlight another very interesting aspect of physiology is that our whole body actually function on negative and positive feedback loops and these loops are very important whenever you have to dissect out a situation the first thing you should do you should be able to draw them in like a blog diagram and it should be able to make the connectivity what all are happening and at different point you will have different

measuring technique to see whether this output is increasing over period of time or this output is decreasing over period of time say for example.

If you look at this picture what just now I draw how we can really quantify is it a positive feedback or a negative feedback. So, at every level say for example, at this level we have to quantify if you quantify with respect to w r t with respect to time you will see that these factors are all increasing. It means there is a positive feed forward loop which is functioning. So, you see in this simple diagram there are lot of not only qualitative feature, but there are lot of qualitative as well as quantitative features involved in it. So, as a matter of fact tomorrow's physiology is more of a quantitative physiology because everybody wants to know that how much say for example, I want to emulate the situation. Again, let us get back to the in diagram say for example, there are I say there are say chemicals these chemical release may be say A B C D E just for your understanding say there are five different chemicals which are secreted.

Now, I will be came to know what will be the concentration of these chemicals which will be secreted at this specific zone. So, you know the damaged area say for example, I know x x square or x cube unit in terms of vessel if I have to go I have talk to the volume in that volume how much of these chemicals are released. In other way what you are trying to figure out is the space out here is the space what we are talking about and release of chemicals second thing. So, this is the space damaged space the types of chemicals and the most important out here is this part with respect to time. So, you realise all the phenomena are function of space and time.

So, when one can quantify a phenomena with respect to space and time then one can say with certainty the limits of a system why this is important you might ask the question other way why really we needed to find out these details or the find prints these find prints are very important say for example, you have heard that soldiers getting injured in the ballet fields and they get hit by bullets or shells. So, what happens those; those situation the first thing which have most of them have suffered from heavy wounds heavy wound means there is a huge amount of blood vessel which gets ruptured say for example, out here.

Let us again come back to the picture for you to visualise say for example; here I showed a very small zone with the red with a red circle. Now imagine in this blood vessel the

damage is this big this is the amount of damage which I am showing in green huge say for example, ambulate injury or huge shell hit out there bullet injury or you know now for this injury now this is space constrains now what you see in terms of damage the space what we talked about x cube. Now this becomes x plus x cube plus a huge area some you know y cube and the chemical concentration what will be coming out what you say will also have to change and not only that time which will take. So, the more bigger the injury site is the more complex this equation, because if you know for this much unit area or this much unit volume this is the amount which is release could we recalibrate it what is the limit of the system is it repairable within that period of time that the person will on die and what are our therapies.

So, there are people who work on several bio materials who try to you know seal those big raptures in the blood vessels specifically for deference applications specifically for those heavy injuries which takes place because a shell and all those kind of things. So, you see a small problem, but you can think you can stretch your imagination to a different level to see where it go all impact us. So, this is what I wanted you people to think beyond whenever I say think beyond I mean I can teach certain things in the class, but that you have to think that will it be possible to make this repair that they are or will this forward feedback loop or a negative feedback loop we will act for a bigger area because this is where comes from physiology to you. So, this is what you see whenever people talk about making patches you know blood vessel patches and all these things which is essentially.

One second that me write down blood vessel patch is. So, this is what we are talking about physiology to what I call it as engineering or material science material engineering or bio engineering which. So, you will like to you know address yourself it could be a bio engineering it could be a material engineering or tissue engineering or bio materials. So, in order to understand any of these things one has to have a clear idea how the physiology is taking its own course and what are the limits of a system.

So, as I told you in the very beginning like this four courses I will try to kind of you know pin point certain things that where I expect you people to think much bigger much broader. So, these are some of those points where you should be able to think that where I can apply this where this information is important, because you know we teach many things, but many a times we forget to make our students aware that where you really can

apply it because you know just importing a piece of information is not sufficient what are the implications of it.

Next what we will do after this. So, as of now we talked about a system and I say for example, I say like you know this is the system I wanted study and this is the anatomic system how I am going to study it what are the reference points today we will talk about all the reference points of the study references of studying a body reference point mention it.

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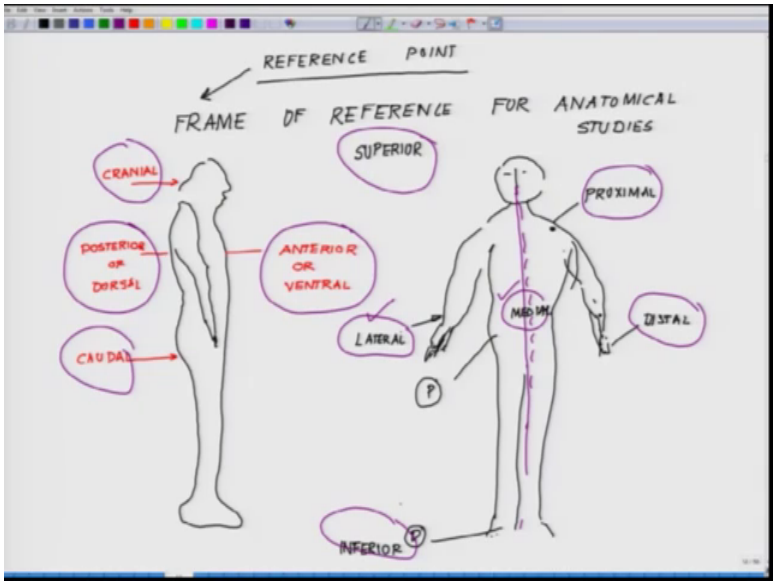

So, what are the reference points? So, say for example, or in other word you can call it a frame of reference for anatomical studies frame of reference for anatomical studies. So, say for example, you are standing sideways. So, this is your standing. So, this part, for example, if it if you look at me. So, I am standing like I am standing now sideways now if you look at the side ways you can see this picture.

So, if you stand in a sideways this is how it will look like how we put the reference this is the cranial part the front of your body this is called anterior or ventral part for body the back of your body is called the posterior or the dorsal part or the dorsal part and lower part which is called the caudle part of the body now if the same person instead of standing sideways is standing to the front ways. So, for example, hand. So, if you are.

Now, in that situation the upper part of your hands say for example, this part of my hand as you look at me this is the part which is called the proximal end you can see this. So, this is called the proximal end and where you have the digits and everything this is called the distal end. So, we will come across these words and this part of the bodies called the medial part similarly the side walls which is the arms and everything these are called the lateral part. So, these 2 are opposing each other lateral and the medial is basically anything to do with the central part of the out here whereas, the lateral are on the sides. And now, similarly lower part of the body you have in terms of the legs this is the proximal part p and this one is the distal part and there is 2 more words which are used upper part of the body is called the superior and the lower part is called the inferior. So, the words which will you come across very commonly will be the proximal end the distal end.

So, always remember proximal is this part distal is the this part central part of the body which is the medial part and side which is the lateral part lateral now back of you is the posterior front of you is the ventral or the anterior part remember this much this is good enough the cranial part and the caudle part. So, this is how you remember and then we will come to the different planes by which you can do a sectioning of a system so for that; move on to the next slide.

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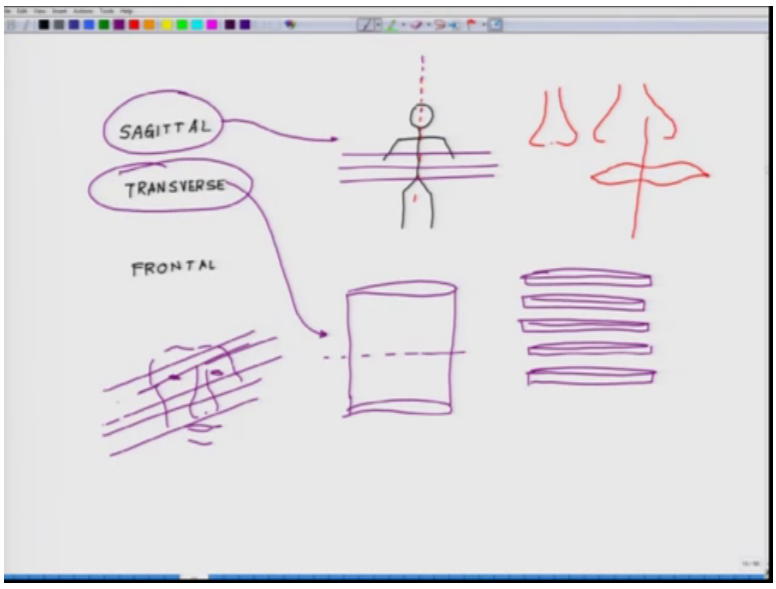

The different kind of sectioning what you can follow the sectioning, I will only talk about three different sections which are a major importance to you people sagittal section transverse plane and frontal plane. So, say for example, what is sagittal section? So, sagittal section is essentially say for example, I am standing here you make a cut like this like this. So, part of you make the nose into half one half on the; this side another half on this side you make a straight cut like this on my body right, so that is called a sagittal section. So, half mouth on one side half mouth other side ear one this side another ear on this side you make the cut of the brains like this like this; this is called a sagittal section. So, draw it, it will be something like say for example; so you are cutting the body like this. So, this is your nose in a sagittal section part of the nose on this side part of the nose on this side, this is your lips. So, it will be cut like this. So, this is called a sagittal plane.

Next is the transverse plane transverse plane is that it you are cutting the system like this say for example, this is the whole body in your cutting it like this. So, that is called the transverse cuts like this in other word it say for example, this is the cylinder and I give a transverse cut. So, these are the transverse cuts which are coming out. So, this is the transverse cut then comes a frontal cut frontal cut is; is very interesting frontal cut is something like area of cut it like this. So, in the frontal cut you are cutting this system in a its something like this hold on your sagittal cut is coming like this and when you are doing a frontal cut it will be something like this you are cutting it like this these are. So, for you what is the important is the sagittal cut and the transverse cut and on the other side what you needed to remember is the proximal distal medial lateral and ventral and the dorsal and of course, the crenel caudle superior inferior.

So, these are few words of reference point which I wish you people to remember for a rest of the course because that is good enough we do not need go to the in the detail of medical anatomy because we do not need that for this course, but as long as you could remember the reference frames right it we are good to go.

Thank you.