Human Physiology
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Lecture – 03
Mechanisms of Homeostasis - Part : 2

So, what is this? We make a block diagram about it. So, the sensors will detect if any change, it will go to the control center. The control center will continuously keep on talking to the set point, it will give output to the effector organ and the effector organ will make sure that the response is generated. One of the most classical examples of homeostasis, which I am going to discuss, it is a very exciting topic. You will enjoy this. It is the control of the blood pressure.

What did I say? Control of what? Control blood pressure. Okay, as we know very well that in the case of humans, the heart keeps on pumping and there is a systole, systole and diastole and when in systole, the blood pressure goes to 120 mm Hg, hello, and when the heart relaxes, it falls to about 80 mm Hg. So, if you take the blood pressure, you take the blood pressure, it oscillates between 120, 80, 120, 80, 120, 80. And this is so important.

This is so important because, because in the heart, the blood that comes from the left, left ventricle, it goes into the aorta, from the aorta it goes into the carotids and from the carotids it goes through our neck. The carotids go through our neck, they branch into internal and external carotids and then they supply the blood to the brain. The brain, so the brain is dependent on the continuous supply of blood via the carotids. Are you with me so far? And we have already seen the paramount, paramount importance of the dependence of brain on the supply of the blood. Mainly for what? For what glucose and oxygen.

And if the blood pressure falls, what will happen to the brain? It will not get that gradient, the gradient of oxygen and the gradient of glucose will not be there. If that happens, then the brain will cease to get the supply of these two most essential ingredients and then you go in coma. Very simple.

It is so important. So, you need to make sure that the blood pressure is maintained. So brain has made sure that it knows the pressure with which the heart is pumping blood to me. In this particular case me means what? the Brain.

As a brain, as a brain, I know that. I should monitor what? The pressure. Okay? Who is building the pressure? Heart. Who is conveying the blood? The carotids.

I have to know as brain, I have to know at what pressure the blood is being pumped. Am I receiving the blood? How does, how would brain do that? Very simple. It will put a nerve there. So what brain does is, so that is the brain at the top. Okay? And then here is the heart and from the heart here somewhere is the left ventricle. When it goes into systole or squeezes or it pumps, the blood is pumped here and it goes into the aorta.

So in the aorta it can go, in the aorta when the heart has squeezed or systole 120 mm Hg. Relaxed 80, 120, 80. We will see that when we study the heart. So what brain has done is, it has put nerve terminals on the aorta and it has put the nerve terminals on the carotid. And these nerves are passing through cranial nerve number 9 and 10.

Are you with me? Cranial nerves? 9 and 10. Who will tell me the name of the 10th cranial nerve? Vagus. Very good. What is it? Vagus.

9th is glossopharyngeal. What is 9th? Glossopharyngeal. 9th is glossopharyngeal, 10th is vagus. I will not let you forget. Okay? Through these nerves, through these nerves, the information is being taken from the aorta and from the carotid to the part of the brain which we call as medulla oblongata.

Now these fibers are sensory or motor? These are sensory fibers. What are they? They are, they are sensory fibers. Okay? Because they are picking up the information from the receptor. Okay? And where are those receptors located? The receptors are located here and here, the 10th, these are in the Vagus, and carrying sensory fibers, yes or no? Yeah. What kind of information is carried? Pressure related.

Pressure related information. So from where, from the aorta, the information is being taken in terms of, in forms of action potential being taken where? Medulla oblongata. Medulla oblongata. Are we good so far? Yes.

Good. Now in the wall, okay, so what would happen to the wall? This is a tube. This is the wall of the tube. Okay? Aorta is a tube. It is an elastic tube. So actually every time the heart squeezes or goes into systole and when the pressure mounts to 120 mm Hg, what is happening to the tube? Stretching.

It is what? Stretching. So just as heart goes into systole and diastole, the aorta also, are you with me? It expands and it has elasticity. That is very important, I will talk about it sometime later. But the wall of the aorta is getting stretched. So those terminals of the vagus sensory nerve which are sitting in the aorta have stretch receptors.

What receptors? They are mechanosensory, they are mechanosensory. So every time the wall of the aorta stretches, okay, they send action potentials, certain number of action potentials to the brain, medulla oblongata. So what do you have? Here, we have here a sensory component. Sensory component is feeding information to the medulla oblongata. Now supposing you are, suddenly you are being chased by a dog and you want to run away, okay and then as a result, of that excitement the heart starts pumping very fast and as a result of that the blood pressure starts mounting.

It is going beyond limit – homeostasis - we have to maintain the limit but if it is going too high, the medulla oblongata starts getting information in the terms of action potentials per unit time. Medulla oblongata certainly knows that the heart is pumping a bit too fast, okay. That information feeds into certain circuits in the medulla oblongata, neurons, a group A, group B talking to one another. They were talking to one another at a particular frequency.

Now suddenly that frequency has gone up, and that circuit is getting information at a higher frequency from the receptors in the aorta. Now what has happened is the central processor knows, knows what that the heart is beating at a higher rate, okay. I (Brain) should better do something about it. Then it will decide, okay, okay, (it is going, it is not too good,) it is getting too fast, okay. Then it will send the information, (it will send the information) via the, which I have not shown here, by the motor information or the effector organ, that information may go to the heart, go to the heart and the heart may be asked to slow down, okay.

Are you with me? So that particular message which will be taken from the medulla oblongata to the heart, it will be via the sensory fiber or the motor fiber? Motor fiber. What fiber? Motor fiber. So, it is taking information that motor fiber will release (the, will release the,) release what? Very good. Will release acetylcholine, what neurotransmitter? Acetylcholine and in response to acetylcholine - the heart, (the rate at which heart) is inhibited, okay, slows down. Inhibited is a big word, heart slows down, okay.

So what have we been able to do? We have been able to restore, okay, the homeostasis with reference to the rate at which the heart is beating. Let us remember (that with) the discussion we have had so far and let us not form an idea or a concept that these values are (or the set point values) cast in stone. No, no. There is a certain elasticity which is given to these physiological processes. Now what do I mean by that? Sounds a little complicated.

But, please never forget one point that we do not live in absolutely constant world. We live in a world, there is a 12 hour day and 12 hour night and in these two durations - there is a difference of day and night, okay, as I can figuratively call, there is so much difference. And if we have to live in the world, our biology has to adjust. Okay, so the set point that I am talking about, you cannot have absolutely same set point for different parameters on your body that are good for the day are also good for the night. Therefore the nature has provided with a good deal of elasticity so that our set points can change.

So, are our set points absolutely cast in stone? No. Okay, the set points may change and now let me give you an example as to how the set points can change. We are taking a very simple example of the human body temperature. What am I talking about? Human body temperature and on this scale we have the temperature and on this scale we have the time.

So, this is 12 in the night. Hello, are you okay so far? And then 2 and (2 and) 3 and 4 and what is your body temperature, so at 4 in the morning. Are you okay so far? And what is the temperature like about 97.3 maybe? And then by the time you go to 11, which is something like now, what is the temperature like? That is a substantial difference. So the temperature remains like this and by about 6 in the evening it starts dropping. This is your and my body temperature and then it goes down and then again down and we go through that. Surprisingly in a large number of nocturnal animals these changes are found.

So obviously the biology has emerged in such a way that when we are active for a large number of biochemical reactions to happen in our body, a higher temperature is slightly better for our physiology. And then when we are asleep and when a large number of physiological process can really go down, then at that time. (it is okay and then) There is one very fine point. Try to appreciate that point. See in the night time the temperature is say 70 degrees F. Are you with me? And then if your body is, if your body temperature at that time is say 99, you will lose heat at a particular rate.

But if your temperature is 97 degrees F, you will lose heat at a lower rate. Are you getting the biological importance of why we drop our body temperature so that we reduce the gradient so that we do not lose the body heat? (What am I,) What are we doing right now? We are trying to understand a very basic example of what you call as the diurnal rhythm. Our physiology shows variations over a period of 24 hours. This phenomenon is called as diurnal variations. This is just one of the examples, sleep, wake cycle, our body temperature.

There are *n* number of hormones that show changes across a period of 24 h. They are all diurnal changes. Why am I talking about diurnal changes now? Because the set point changes according to the time of the day. Not that the set point is absolute, no, the set point can change and it does change over a period of, (over a period of,) over a period of time. In this particular case over a period of 24 hours. This is a, (this is a) radical example as far as the diurnal variation is concerned.

We are talking about a hormone. Okay, we have all heard of pituitary gland. Hello. Yes or no? So we have heard of pituitary or not? Yes. Good. We have also heard of yet another gland in our brain which is called as pineal.

Have you heard of pineal or pineal or whatever? Yes or no? Yes. Great. Good, good. Now I am convinced that you know. Okay, so there is pineal gland which is at the top of our thalamus and that pineal gland is the source for a hormone called as melatonin.

Do you call it as? Melatonin. Say that again. So melatonin comes from where? Pineal gland. Where is pineal gland? In the brain. What is the, what is the hormone it is secreting? Melatonin.

Melatonin. Okay. And we find that, (and we find that) in here you must look at the diagram and tell me where is the pineal in your brain, and what you are doing is you are taking, drawing the blood every two hours. Draw the blood every two hours and then separate the plasma and from the same and analyze that plasma for the amount of melatonin in it. Okay. And draw the graph. And look at the graph and tell me as to what time of the day or night do you have a peak in the surge of melatonin in your, in your, in your, in your blood.

Look at the diagram and tell me. Night. Night. It is what? It is, it is, it is night. So, so, so when we say that, so is it actually strictly following, strictly following homeostasis? (It is, it,) The answer to that question is yes it is. Yes it is. But, but, but we have, we have to modify our concept of melatonin. The aim is not to make sure that everything is absolutely constant.

No, no. Because do not forget we live on the earth. Have you forgotten? Live on the earth. Okay. We live, we live in this atmosphere and we live in an atmosphere where it is 12 hours day and 12 hours night. There is huge difference between the two.

And we better adjust our physiology to that. Night and day do not care about, they do not care. We have to care. Okay. So, so, so, so over, over in evolutionary terms for millions of years our physiology is tuned to the day and night cycle and, and, and the tuning is in many ways.

Okay. So, we will say that it is still homeostasis. Okay. But the homeostasis, but the, but the homeostasis is, the set point in the homeostasis can change depending on, depending on the time of the day in this and, and so, so these are homeostasis. So, so what I can say is homeostasis is set here in the daytime, homeostasis is set there in the night time, so and homeostasis keeps on, keeps on fluctuating, (keeps on within,) within narrow limits. I think I will stop now. I have only one problem with the entire batch.

Nobody asked me a single question. Good. Good. Is there a correlation between the heat, the molecular events at the temperature level, at the same time? It is, it is, the, the, it is more related to time of the day. I mean, even if you have, whatever the temperature it follows, it is, it is dictated by the time of the day, not by the temperature, not by the temperature. Okay. Go ahead. Are the set points in the body decided based only on biological heat or entirely based on biological heat? Oh, no, no, no, no.

They are, they are, they are, they are a part of our biological system. It is, it is, it is genetic. It is genetic. So let us say I take a nap, what will happen to the melatonin? Oh, that is a very interesting question. If I take a nap, what will happen to the melatonin? The answer to that question is just for a one or two hour nap melatonin will not react at all.

It will, it will not. Because if you have developed a habit of taking a nap four hour every day for a very long time, eventually you may find some change, but most likely no. Then, these are largely governed, these are, I will ask another question, I will not answer it now. What would happen to your melatonin? What happens to the melatonin of the people who work in the shift, who work in the shift? You get the question? I will answer it sometime. But think about that. You get the point? Those people who work in the night and day and then what happens to their melatonin? Yeah, anything else? Yeah.

What do you think of their Melatonin(and the Melatonin)? That is another interesting question. What do you, here is a very interesting question and what do you think is the answer? It is absolutely same. Very good. It is absolutely same, whether you are Nocturnal or not.

You see, they have a very nice phrase in Circadian Biology. Melatonin is the king of the night. It is always high, no matter whether you are Nocturnal or Diurnal, it is always high in the night time. Okay? Yeah, go ahead.

I mean, you see the fish for example, they have a very similar example as alpha cells and beta cells. Okay? So, they have and eventually when the mammals evolved homeothermy, then they also developed thermo receptors and thermo receptors lower all mammals also have, not that they do not. Of course, they have to be sensitive to temperature. But when we evolved homeothermy, okay, then the homeostasis with reference to that came after that. You cannot have, it is an integral part, homeostasis of homeothermy will be an integral part of evolution of the homeothermy.