Human Physiology
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Lecture – 01
Introduction to Homeostasis - Part: 1

The entire science of Physiology is based on a very interesting concept. I will first give you the name and then try to understand what the concept really is. I am sure you have heard of it, nothing very mysterious about it. How many of you have heard the word homeostasis? Everybody? Very good, very good. That is very good.

That makes sense. So let us, we are going to visit the concept once again. Let us try to understand because every question in physiology can be more or less asked in terms of what does it mean to homeostasis? That helps you to understand. So let us talk about what is homeostasis.

Now instead of going into the definition of homeostasis, let us directly dive into an example and try to understand what homeostasis really is. I am going to do a very simple experiment. I am going to take a pen and then I am going to prick your finger, not a great idea, and then you bleed a little in your finger, and then I am going to collect that sample on a tiny instrument that I have called which I call a glucometer, and then when I take it there, I try to evaluate and it tells me what your blood sugar level is. And surprisingly, if you have, all of you have had your breakfast about one and a half hours back and if you are all here, most likely I will find that your blood sugar level is about 90 milligrams per 100 ml, 95, 100, 105; that is all the range in which most of you will be. So you ask yourself a question, why is it that so many people, so many genes, so many different in spite of these variations, how is it that all of you have more or less your blood glucose level in a very narrow range? Can it go down? Of course, it can go down.

How far can it go down? Well, it can go from 90 to 80 milligrams per 100 ml, remember 100 ml of blood, we are measuring that. Find that if it goes below 80 milligrams per 100 ml, you may still be okay, but if it goes to 75 you may faint. And then if you go below, then we have a very typical condition which Dr. Kaul has, hypoglycemic coma. So it is so dangerous, it is very dangerous.

You cannot allow the blood glucose level to go lower than that. At the other end, I mean you have had a carbohydrate rich, sugar we all like, you all like, we see we have too much of that, then we find that the blood sugar level may go up. How far it may go up? Well, it may go as far as 120, 130 milligrams per 100 ml. Okay, but after that, it goes, then it is also not a great idea because a higher level of glucose for a persistent time, you all know diabetes, okay, it can give rise to damaging heart, damaging kidney, damaging brain, so there are lots and lots of, so it is very necessary for our biological system to

maintain the blood glucose level within a narrow limit. What is the limit? What did I tell you? Lower side you can go as far as 80, higher side we can go as far as 120 or so.

That lower limit is absolutely important because your brain needs a continuous and steady supply of glucose through the blood. You know something, your brain continuously needs two things, you know steady supply, and for that steady supply, you need a steady gradient, okay, and the two most important things are number one is oxygen and number two is glucose, okay, and these two things have to be in blood, always in a sufficient concentration so that it flows from the blood into the cells, particularly those of the brain. If it falls down, the brain neurons use only glucose as a source of energy and if you reduce the gradient, the brain cells will simply stop their functioning, you are going to coma. It is very important. So you need to, okay.

It also means that, see it is, see if you, this is so far okay, it is okay, you need blood glucose level, it has to be there, but for monitoring or for making sure that I always have in my blood glucose, which is narrow, within the narrow limits of 80, 120, I can go, I can go in this range but not beyond that range. It also means that I need to have in my body a sensor which will keep on monitoring the amount of glucose that is present, okay. There has to be a sensor, are you getting the argument? Without, I mean, otherwise how would the body know that okay, okay, you are going below 80, how does the body know? It has to have a sensor. Similarly, if you have too much of, and then if it goes too much, if you have too much of sugar or if I just inject, okay, 50 grams of glucose in your system, the blood glucose level will start rising and then it will go beyond 120 and that is not good for you. But for determining that you need a sensor, okay.

So the point that I want to make is for n number of substances you need, I will talk more about the sensors in due course of time. So let us see what homeostasis is. See for the, we know that every cell is continuously engaged in performing n number of series of biochemical reactions, be it enzymatically, be it whatever it is, okay, there. And it is also necessary that for the cell to perform those reactions, mitochondria to do their role, endoplasmic reticulum, Golgi, whatever, they need certain assurance of a guaranteed environment. What am I talking about, environment of a cell? What am I talking about? Environment of the cell and it is a condition, obviously, the cell cannot function.

Your brain cell is functioning optimally because your body temperature assures that your body temperature is 97.6 degrees Fahrenheit, okay, are you done? Any difference of opinion? No, it has to be, it has to be, the temperature has to be how much? 97.6 Fahrenheit, okay. Can the brain tolerate that? Tolerate what? Tolerate any disturbance in that? No, it cannot, it cannot. It goes 100, 102, you are already in bad shape, you are febrile, your brain is not functioning.

If it goes to 105, you are quite dead, okay. Similarly, if the brain temperature goes from 97 to about 95, 94, finished, your brain cells just refuse to function. So what is the message here? It is very necessary that for every neuron to function optimally, you have to provide your brain with the temperature of about 97.6, absolutely basic condition for

life. Now, I will move on and I will ask you, well, you just now we talked about glucose, so look at this table, look at the bottom line.

The bottom line is extremely familiar, what are we talking about? Glucose 70 to 100 according to this table, that is fine, that is the normal range we get. But is it only the glucose that is, no, no, no, no, no, look at sodium in the blood. What about sodium in the blood, 135 to 155 milliequivalents per liter? You just cannot allow the sodium either to fall, okay. If it falls, you will faint, okay. Very serious, look at the potassium, it is very low but it is between a very narrow limit 3 to 5.

5, chloride 95 to 100, bicarbonate, total plasma albumin, you look at this range. So it is not only the story of glucose, almost each and every parameter in your blood has to be within a narrow, narrow limit and that goes beyond. You see, this is very interesting, how many of you, I am absolutely sure, but still, how many of you have heard of, you see, children will learn to do, the migration of salmon? Everybody, good, good, good, good. So we know that this fish, it is a fish, okay, salmon, okay. It is born after the union of the male and female somewhere in the northern part of Canada or North America in some tiny stream and there the eggs will hatch and then the young one will come out and it is in the river water where the salt, it is fresh water so salt concentration is extremely low, it will grow there for about 6 months, then it will flow down, flow down along with the water current and finally, finally, finally, it will enter into the sea.

Once it enters into the sea, if I want you to compare the chloride ion concentration, the fresh water and the sea water, the sea water is 100 times more, 100 times more. I just want you to appreciate the two different worlds, the fresh water and the sea water and the difference between at least 100, 100 times, okay. And as a result of that, what would happen to the chloride ion concentration in the blood of the animal? Well, it is in the water, okay. So it is very likely that chloride ion concentration will go up, but if it goes the fish will die, okay, because in life the brain cells of the fish have to be assured that the chloride ion concentration in its environment which means what the fluid around the brain cell has to be in the narrow remit. So in spite of the massive change outside, the fish is still capable of maintaining the chloride, okay, I will take this slide here.

Okay, this is the slide I missed, okay.

So here we have the salmon and the salmon is in as it goes from fresh water to sea water but if you keep on, so what do you do? What have you done here? You keep on collecting the fish from the fresh water, take one ml of blood, try to find out what is the concentration of chloride ion, let the fish go to, let the fish go to sea water, again take this amount of blood and what do you find? Chloride ion concentration, look at that horizontal line, it is almost 100 times, which means what the animal is able to do what? The animal is able to in spite of the massive change, 100 times, 100 fold change across the animal is still able to maintain the, we cannot really start any lecture in physiology without reference to this brilliant professor from France, his name is Claude Bernard, okay in about what was the time? You see, 1813 to 98, one of the most brilliant. As you go ahead in biology, now I am not talking physiology, I am talking general biology, as

you go ahead you will find that, so as not to bias your results, okay. You see whenever you are doing an experiment, in my heart there is a suppressed desire that I want my results to work out in a particular direction, am I right there? Yes or no? Okay and that may bias my results, that may bias my data. So what do I do, what does your professor do it? He makes you blind.

Do you understand what I mean by blind? He gives you two samples and one sample is control, one sample is experimental and you do not really know what is experimental, what is control. So you just do it and whatever is the data you shoot the professor and the professor tells okay, if it is still meaningful it is meaningful. Are you getting it? He was the first man who said that in biological sciences for doing an experiment one thing that is very necessary to do the experiment in a blind manner. Are you getting my argument? The importance of what? Doing an experiment, not knowing what you are doing so that your likes and dislikes, okay your perceptions are not only enforced on your data. So that was just an incidental point about Claude Bernard, great biologist.

He said that for the efficient functioning of any system, biological system it is very necessary that the environment of a cell is kept constant. In French he called it as milieu interior, milieu is environment, internal environment. Okay so your internal environment has to be constant if you want your cells to function optimally. This was the first and then this another professor of Harvard after about 50 years or so, his name is Walter Cannon, he came up with a wonderful word which we call as homeostasis. What is the word, what are we doing now? Okay so what is it? A physiological system functions to maintain or regulate the condition of the internal environment within relatively narrow limits.

So this was a beautiful concept enunciated by what, okay we have done this, let us go ahead.