Human Physiology
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Lecture – 52
Pituitary gland & growth hormone secretion - Part : 1

Okay, so let us get started. If you remember in the previous lecture we introduced ourselves to the very exciting branch of biology that is endocrinology. We have spoken about it repeatedly, Nixon also covered a few points. I am going to continue with it and again amongst the family of different hormones and the endocrine glands, I will talk about some of the most important ones, it is called as the pituitary gland, what do you call it as? Pituitary gland is also known as hypophysis, hypo is below, okay. Physis is an attachment, it is an attachment below the brain, therefore the name has come hypophysis, hypophysis, I will talk about it. So let us talk about and so what I am going to do now is talk about, but remember one thing you cannot really talk about pituitary gland without talking about the hypothalamus, okay.

So hypothalamus, it is a lowermost part of the brain, okay of the thalamus, I cannot teach you anatomy there, someday I wish I can. So hypothalamus is almost very small part, about 1 percent of the brain volume is about hypothalamus. But it is very important for some of the very, very, very, very important vegetative functions like you know, remember we already talked about what? Osmo receptors are there, okay. So it is a very important area, it works, it controls to some extent, it controls autonomous nervous system and very importantly it is a, very good, excellent.

It is a centre for neuroendocrine control, that is the same thing, neuroendocrine control. So let us see what it is. But again to appreciate that I need to take you back into the development of the human brain. It is a very big topic but we will finish it in 2 minutes. You have this here somewhere, the section, this section, sagittal section, hello, are you okay? Through a human fetus which is about 2-3 months old, that one there.

And the thick blue line that you see, the thick blue line that you see is the brain under development, okay so far. Brain is developing, not fully developed, no. Then if you see some here, here, there is an opening here and that is the mouth of the baby. It is not a baby, it is still a fetus, very early development, that is the mouth, okay so far. Now if I were to take a story little ahead, if this is the mouth, then in the roof of the mouth, roof of the mouth, a pocket develops which is indicated in this diagram by red, thick red line.

Can you do that? Can you get that? Follow this, this is very interesting. Without this you would not really enjoy the endocrinology of pituitary gland. So that red pouch, that red

pocketing, out pocketing is actually part of the elementary canal, okay, is a part of what? Elementary canal. And as the development proceeds, then some part of the brain, some part of the brain indicated here by the blue line, some of the neurons send their axons and they go on the posterior side of the red out pocketing. So now you are having a composite structure in which the red part is coming from the elementary canal and the blue part is coming from the brain.

Do you appreciate that? It is a composite gland. The red part is coming from where? And the blue part is coming from where? Brain, it is a composite gland, okay. Eventually as the fetus develops, okay, you have a pituitary gland in which the anterior part used, denoted here with the same color code that is red, we will call as the anterior lobe of the pituitary gland or anterior pituitary gland and the blue one is called as the posterior pituitary gland. So what am I showing you just now? I am looking at, I am cutting the entire, even your brain, if I cut in this way, your pituitary will be split into two parts, right and left. If you look at each, there will be anterior pituitary and a posterior pituitary and you know very well that the anterior pituitary is derived from which part? Elementary canal.

And the posterior part is derived from where? Nervous part, neuro, nervous part or the brain. Is that very clear? Now I am going to talk about different neuronal groups in the hypothalamus. Neurons, neurons, hypothalamus, okay. And I think we have already, did I introduce the word nucleus to you? So what is a nucleus? It is a bunch of neurons and hypothalamus is made up of different groups of neurons or different bunches of neurons, okay so far. And if you recall, we already know that there is, there are a couple of different groups of neurons and those neurons have axons and those axons go all the way to the posterior gland and there they secrete a very familiar hormone.

What is that, what is the name of that hormone? Pasopressin. Very good. What is the name of the hormone? Pasopressin. What is the name of the hormone? So I will draw your attention to, so let us see, this is the, I am sure this is the pituitary gland, that is the hypothalamus, this is the hypothalamus, this is the pituitary gland and in the hypothalamus we have neurons, those neurons give rise to axons, go, go, go, go, they go into the posterior pituitary gland, in the posterior pituitary gland they, those axons directly terminate on capillary. And what kind of hormones do they release into the capillary, capillary, in the blood in the capillaries? You know vasopressin and I will give another name oxytocin.

What is it? So oxytocin and vasopressin are two hormones which are released, which are synthesized in the brain, transported all the way along with the axons, okay and discharged into the blood capillary at the level of posterior pituitary gland. Okay so far? Yeah. Anatomically does this happen near medial eminence? Yeah, I am coming to that. This is the median eminence. This is the median eminence.

I will come to that in the next slide. That is two groups actually in the hypothalamus. Now there are other groups, actually several groups are there. Some of the other groups, they are also there in the hypothalamus. They also have, they also give rise to axons.

Those axons are relatively short and they end in what you call as the, at the interface, at the interface of the pituitary and the hypothalamus and that interface is called as median eminence. What do you call it as? Say that loudly? Median eminence. Now if you recall our previous lecture in which somebody asked, somebody had asked me as to what is the blood brain barrier and how do some of the peptides in the periphery enter into the brain? You remember somebody asked? Who asked? Who asked? Who asked? Good. You remember that question? Okay. The answer to that question is in the median eminence there are capillaries, okay and the median eminence is a part of brain, okay.

But those capillaries which pass through the median eminence, okay are devoid of blood brain barrier. Are what? Devoid of blood brain barrier. Okay. Now let us see, why did nature provide them, why did, why did, that is a very interesting question. Let us try to find out if we know, if we can get the answer.

Okay. So now I am talking about other groups of neurons which all means what? Not oxytocin, not vasoprostin secreting, not NOT, not. Those neurons they go and terminate right in the median eminence on the capillaries. So those neurons are secreting what? Their own secretion which is not oxytocin, vasoprostin and that secretion, so where is it going? In the capillaries in the median eminence, okay and there is no blood brain barrier. So even those hormones which are relatively large peptide hormones they can still enter into the blood. Now comes a very interesting part.

The capillaries in the median eminence which have taken the secretion from some of the neurons in the hypothalamus, are you with me? Okay they go down, those capillaries they go down into the anterior pituitary gland, into the anterior pituitary gland and again capillaries. So a capillary network comes together and again capillaries, what do we call it as? Portal, very good, who said that? That is a correct answer. What is the answer? It is written there, portal system. So in our studies so far this word is coming for the second time. When did we hear the word for the first time? Hepatic portal.

So hepatic portal means what? The blood goes through a tissue, comes together in a blood vessel. Normally we expect that it will go back to the heart but instead of going back to the heart it goes to another organ. Again capillaries portal. What is the word? Portal and here we are encountering. So if I ask you just in the human system there are two portal systems.

One is hepatic portal system and this is called as hypoth, no get the correct name, hypothalamo, hypophycial portal system. Hypothalamo is hypothalamo, hypophycial I already told you. What is hypophyse? It is pituitary. But the name has evolved like this. What has the evolved name? So what you are seeing here is a hypothalamus.

Everybody should say. Hypothalamo, hypophycial portal system. So I will say that a large number of peptidergic hormones which are again synthesized by the neurons of the hypothalamus are discharged at the level of capillaries in the median eminence and those hormones travel from the median eminence to the anterior pituitary gland by way of the hypothalamo-hypophycial portal system and then those hormones control the secretions of the anterior pituitary gland. So how is the, who controls the anterior pituitary gland? Hypothalamus controls. Who controls? Hypothalamus controls.

Go back, step back. So the posterior pituitary gland is simple. The hypothalamus sends exons. There is no control. Of course the control is in the hypothalamus. It goes directly into the blood.

Toxitocin, vasopressin. Done. Antirepituitary gland. And there are several such factors which are coming from the hypothalamus and we call them as releasing factors. Releasing, you know let us understand what I mean by the releasing factor. Before that, now I will do, I will take you a step ahead and I will introduce you to something, reintroduce you to something that you already know. What am I going to talk about? I am going to talk about the, so I am absolutely sure in this I am pointing out at anterior pituitary or posterior pituitary and what is this? And the author has given us symbolically the different hormones which are secreted by the anterior pituitary gland.

And we are very familiar with them. And some of them, can you read here? TSH, it is not very clear but it is TSH. What do you call it as? TSH.

TSH. What does? Thyroid. Very good, very good. What do you call it as? Thyroid. Thyroid stimulating hormone. Excellent.

Thyroid stimulating hormone. As the name indicates, these cells here will secrete TSH that will go to the thyroid, stimulate the thyroid and in response the thyroid will secrete its hormones which are T3, T4 I will talk about. Second, second, second. Second is called as ACTH. Say everybody to repeat after me, adrenocorticotropic hormone. Again keeping your mouth shut is not an option.

So tell me the whole name. Adrenocorticotropic hormone. Abbreviated as? ACTH. And this hormone has a direct stimulatory action on the adrenal cortex which is sitting above the kidney. The third hormone here is the growth hormone.

What is it? Growth hormone. Growth hormone. There are several hormones we are going to focus on six hormones. Make life simple. How many hormones? Three.

What is the source? Antirepteric gland. Antirepteric gland. And they are all being controlled by what? Hypothalamus. How? By way of certain stimulatory factors. Actually there are inhibitory factors also but I will not talk about it now. We are good so far? The third hormone I am going to talk about is the growth hormone.

So growth hormone again comes from the growth hormone secreting cells in the pitaric gland. It goes from the pitaric it goes everywhere along with the blood and has a profound effect on almost everywhere. It is a strongly anabolic hormone. It will build up protein synthesis in the skeletal muscle cells into the bones everywhere other than nervous system it has stimulatory effect everywhere, growth hormone. So how many hormones have I told you so far? The other two hormones are linked together and we will call them as LH and FSH.

What do we call them as? LH and FSH. What does LH stand for? FSH. What does FSH stand for? And these two hormones play a major role in the regulation of what? Gonads. Gonads. regulation of what? Gonads.

Male, female whatever it is. It is a control. So how many hormones have we covered so far? Just mentioned we will talk in details. How many hormones we have covered so far? Five. The sixth hormone I am going to talk about is called as prolactin.

What do you call it as? Prolactin. Prolactin. Okay it has lot of regulatory activities. One of the most important is to bring about the generation of milk in the mammary gland after the birth of the baby. So now this picture you have to remember. Throughout, throughout. You see this is actually the basis of neuro, this is actually a very elaborate science which is a sub-branch of endocrinology.

We call it as science of neuroendocrinology. Science of what science it is? Neuroendocrinology. That is essentially where we learn as to how the hypothalamus by way of different secretory substances regulates the anti-reputary gland and brings about the release of hormones on posterior pituitary gland. Done so far? Now most of the substances which come from the hypothalamus, mostly peptides.

Mostly what? Peptides. Only one dopamine is there. You see biology is funny. Make a rule, cite an exception. So most of them are what? Peptides, peptides but, but dopamine is also there. Okay we will talk about it little later.

So if we are okay so far I will move on. So this is on the left column we have the different cell types, in the second the hormones they release, the chemistry of each and the physiological significance of each has been abbreviated. You can read about it. I will talk. In this class I am going to focus on the growth hormone. Now in this class I will not talk about TSH and ACTH and LH and FSH because I will talk about it when I talk about the adrenocorticoid, adrenal, so when I talk about thyroid I will talk about TSH, talk about adrenal cortex I will talk about ACTH and when I talk about gonads I will talk about the L- and FSH.

Okay so far? So, but so today we are going to focus on one of the most important hormones from the pit-ter gland and important every hormone is important there is no point in emphasizing it 100 times. But growth hormone because almost one third of the pit-ter is secreting is containing growth hormone secreting cells. What did I say? So why do I call that? Can you see those green round circles there? It is a section through the pit-ter of rat. And what am I showing you a huge number of what cells? Growth hormone secreting cells. How did I label them? We can get antibody against growth hormone.

Okay it is a large protein it is about can you tell me growth hormone is made up of how many amino acids there? 191 amino acids. The peptide looks something like this each circle here is an amino acid are you getting the argument? It is a huge big molecule okay and then it is secreted into the from the pit-ter it will get into the blood okay and from the blood it will get it will go everywhere and have its profound effect. Just to show you the what a profound effect growth hormone has on growth as the name indicates okay a very simple experiment has been done. So we have rat we take rat from same litter are you with me? So this little rat has given birth to 6 of its pups okay I am going to divide 6 into 2 groups 3 into 3 whereas 1 group I am going to treat with growth hormone okay. How do I know the dose of growth hormone which I should inject? As a biology student I try to answer my question.

How do I how can I determine today if I ask you do this experiment how will you determine the dose of growth hormone? Literature come on scientist now how would you go to the literature okay hundreds before you have used growth hormone okay so just look there okay go to the references do not do any experiment without seeing the references okay do not do that never do. You are the first one who are doing this experiment then? Then you have the freedom to do whatever choose you choose okay of course he is absolutely correct somebody has to be first okay then I will tell you there is answer for that also if this is a peptide hormone I will find out what are the other peptide hormones try to get a clue from the parallel work get the answer oh yeah there is also an answer okay. So what have I done I

have divided the pups I had how many in beginning? 6 3 into 3 now this group has been injected with a dose of growth hormone every day for let us begin with the control so control group has been injected with what saline let us give saline okay every day okay every day some saline and every day you weigh the animal and keep on doing the experiment and our experiment continues for how many days? 600 days 600 days and what do you find that there is increase in the weight increase in the weight and more or less after 300 days the weight of the animal is constant and the weight of the animal is constant at about how much you can read there 250 grams or something now the group of other three rats I am going to inject with what? growth hormone and the dose I have got from the literature okay right and then and then do and what do I find at the end of 600 days? How much? Double okay okay just double just see the and now this is about 20 years old but this is quite an excitement this is a when we were very when the science of transgenic animals were just coming about 25 years back okay so in the mouse they had introduced the growth hormone gene so whereas this is the control this was what? The yeah yeah yeah the knock in where the growth hormone was introduced into the animal so now we are looking at the so growth hormone growth hormone binding protein is composed of okay okay then let us talk about the structure of the growth hormone half life of growth hormone in blood is about how much? It is 20 minutes let us move on okay so growth hormone is released on the pituitary gland and it acts on its target the moment I say target what do I mean by that all the skeletal muscles they have growth hormone okay all the cells which either which okay bone what did I say? Bone there are cells okay the bone is traversed by very fine canals called as haversinian canals I will not talk about it and there are cells which help to deposit the calcium salts into the base so that so that the bone can grow bone can grow okay so far those cells are called as osteoblasts what do you call them as? Osteoblasts Osteoblasts have receptors for growth hormone okay so far and then liver okay and then adipose tissue okay and then name it you see almost every tissue will have receptors for growth hormone and this is the so this is the there is a there are two proteins okay identical proteins and when the growth hormone combines okay they dimerize and they take a signal inside and then this JAK2 is phosphorylated and then downstream it takes its and then and then the signal goes into the nucleus and n number of enzymes are up regulated and most of the most of those several of those enzymes are anabolic hormones are what? So those those those enzymes okay which will indulge into building up of larger proteins okay or so they are all I do not know how many but a large number of enzymes are up regulated under the under the influence of so this gives us a catalog of the different of the different so it has action on protein anabolism it has action on building of a large number of the it has effect on the carbohydrate metabolism it has effect on the fat metabolism and this is a so let us see what is happening here. I am going to talk about it because this is a summary and go gives a good I am reminded of something very interesting when I see this slide. Tell me two sources where I can hope to have somatostatin, somatostatin tell me two sources pancreas and stomach okay the third source is hypothalamus.

So please tell me fill in the blank tell me three sources where I can find somatostatin, pancreas, stomach and hypothalamus okay are you with me and very interestingly where is this somatostatin coming from? It is coming from hypothalamus what hypothalamus? Neurons they are one group in the hypothalamus many synthesizes somatostatin okay 28 or

so amino acid is the size of the size of the somatostatin molecule okay. Now somato world refers to body refers to what? Refers to body okay now okay listen to this there are two groups of neurons many I am focusing on two groups of neurons where in the hypothalamus one group of neuron releases a common sense question is coming pay attention one group of neurons release the hormone called as I will call it as somatotrophin and another cell group of neurons release another peptide hormone which is called so called a somatostatin. Tell me what would each hormone do to the growth hormone when it goes there to the anti-repetory gland? Antagonistic so somatotrophin means what? Stimulate so whenever somatotrophin comes so whenever somatotrophin comes okay it will go to the pitric gland stimulate the growth hormone and whenever somatostatin comes it will go down it will go down. Now that D cell in the pancreas or somatostatin cell in the stomach that meaning is name is meaningless what is somatostatin got to do with it? But now you know why somatostatin is called as somatostatin hello you got the logic behind it so logic comes from this is we discovered this peptide we called it somatostatin I find it in the in the islets of pancreas same peptide somatostatin there it does not make any sense why it is it is just controlling some carbohydrate metabolism okay or somatostatin it is it is what is it doing it is inhibiting H cells hello it is inhibiting parietal cells nothing to do somato but the name has come and the name comes from here okay. So if you remember the name okay logically you will know what it does okay alright so so hypothalamus read the first block GHGHRH secretion okay okay can somebody please decipher me for me the abbreviation GHRH growth hormone releasing hormone what is it called as very good growth hormone releasing hormone which is same as somatotrophin good and this is somatostatin and arrow goes down they come from the pit area depending on it is for the brain to decide as to when I am going to when I need to stimulate the growth hormones accordingly the hypothalamus secret it will go to the anterior pit ugula and the ugula any question ask me? Yeah like isn't GH called somatotrophin? Which one? Growth hormone is called somatotrophin right and not the growth hormone releasing hormone.

Am I making a mistake there? Yeah growth hormone I made a mistake you are right thanks for correcting growth hormone itself is somatotrophin yeah yeah yeah yeah and and and you are correct and the agent that comes from the hypothalamus is the first one what is written there? GHRH this is a 14 amino acid containing peptide so we will not I am sorry that we will not call it as somatotrophin we will call it as GHRH it acts on you are right it acts where where where? Growth. Growth hormone okay so growth hormone will have receptors for both somatostatin and and and and and and GHRH okay okay and both of them are G protein coupled systems okay. So then anti-repertory growth hormone okay now let us see what growth hormone does it acts on the liver now this is interesting follow the story it is a beautiful story one of the main targets for growth hormone coming from the pitiragland or somatotrophin is the liver okay how it acts that we have seen the receptor we have already seen acts on the liver okay in turn of course it it promotes lot of anabolic hormones in the liver also but one thing that interesting does is it instructs the liver to secrete yet another hormone it is called as IGF what do you call it as? It is called as or it is called as insulin and growth factor or IGF 14 and IGF 16 there are two of them it is called as insulin like growth factor. Now in some way this molecule is similar to insulin but it has no action with reference to of regulation of blood glucose hello so do not be misled by the use of the word

insulin what am I talking about I am talking about a peptide that peptide is being secreted by what liver under the influence of what? Growth hormone what is the name of that factor? Insulin like growth factor but it has nothing to do with it has no I tell you the structurally whereas insulin is made up of 51 amino acids yes 51 amino acids insulin like growth factor has about 70 amino acids and there is lot of similarity in the sequence of amino acids but whereas insulin has a trademark what is it reduced blood glucose level insulin like growth factor does not have that function it has a function which is very much like growth hormone means what it promotes growth it promotes growth of bone it promotes growth of so a lot of action of the growth hormone is either directly on the target organ or it is via the insulin like growth factor are you getting the story now are you getting it on many targets the growth hormone will act directly on certain organs it will act to the liver from the liver insulin growth factor and then act on that but in either case it is to promote the growth is the message fully taken. So let us see insulin growth factor many tissues cell division other growth promoting events then the growth hormone protein synthesis insulin like growth factor adipose tissue the glucose uptake goes down lipolysis goes up muscle cell lose uptake and etc etc we will see.

Yes, it is a separate receptor that is correct it has a separate receptor means the receptor for growth hormone no separate okay yes please. Yes. I mean you are saying that therefore it is not anabolic is that your argument you are clear about it good. Thank you.