Animal Physiology
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Module - 1
Lecture - 24

So, let us resume the lecture on NPTEL on physiology, and especially we are now dealing with endocrinal and reproduction. So, we initiated with the overall architecture of the endocrine system which consists of hypothalamus which is speaking at deep into the brain controlling the pituitary, which is one of the major endocrine gland, and we talked about the thyroid, parathyroid, adrenal and the gonads and the panetrials.

So, I give you an overall view or overall positions of these different organs, and we talked little bit about the structure of the pituitary which consists of two parts, anterior pituitary and posterior pituitary. We talked about that anterior pituitary receives the hormones from hypothalamus by our local blood vessels whereas, posterior pituitary which is also called as neuro hypotheses is another name for that, and that does not have any blood vessels to receive hormones from hypothalamus. Hypothalamus directly has neuronal projections on the posterior pituitary on the neuro hypothesis and those neuro transmitted which are secreted or those hormones, which are secreted because of the nerve signal are then transported from neuro hypotheses or posterior pituitary via blood vessels to its target organs. So, with this, what we will do? We will talk about the intercede circuit between the hypothalamus and the pituitary. So, we will talk about that circuit.

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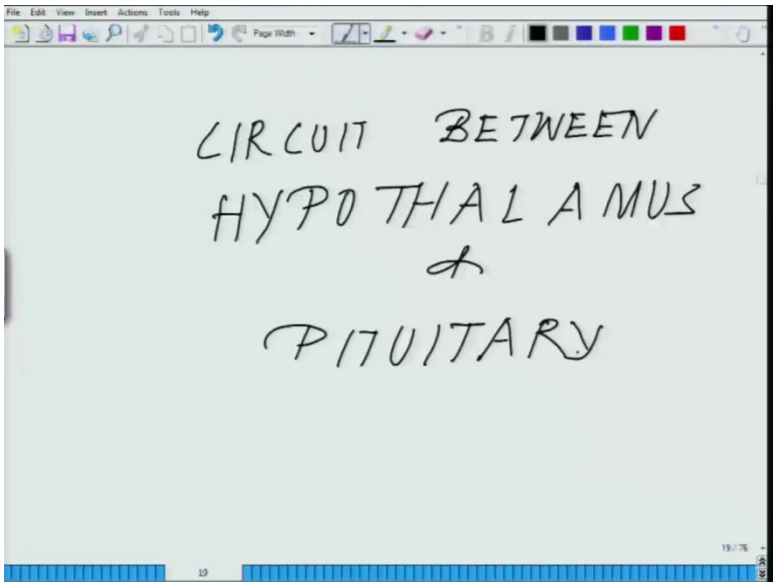

We will resume with that circuit between hypothalamus and pituitary. Here it is work mentioning that yesterday when I showed you that how the high centers of the brain are regulating hypothalamus, so hypothalamus depending upon the situation sends two kind of signals, either it will send the inhibitory signal or it will send back stimulating signal or in other words, you can also call this stimulating signal as releasing hormone or inheriting hormone.

So, say for example, it is like the pituitary has to say for example, secrete a particular hormone as x. So, the pituitary needs the signal from hypothalamus. So, when pituitary has to secrete x, then pituitary will release, will receive a signal called x releasing hormone from hypothalamus. So, when pituitary does not need to secrete that particular hormone, then pituitary from hypothalamus will receive a signal called x ileums which I stands for inhibitory hormones. So, if you say you do not secrete that particular thing, so it is kind of a very tightly controlled loop and what tells hypothalamus could be the downstream metabolites and everything which are produced because of x.

So, it is kind of very nice feedback loop. So, what we will do now? What I will enumerate our all inhibiting and releasing hormone secreted by the hypothalamus which influences pituitary or dictates pituitaries role further down the cascade. So, let us enumerate the hormones which are released.

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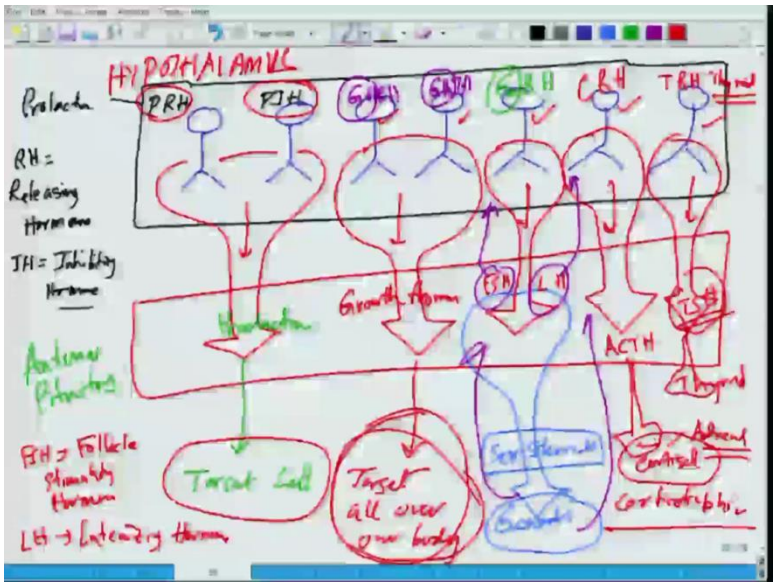

So, let us put that at two different levels. So, this is the level of hypothalamus, the first box, the second box as the pituitary box and then we will put all the downstream cascades which are there. So, these are the different neurons which are present in hypothalamus. So, now here is the blood vessel which is reaching the pituitary, this is the blood vessel. So, the first one which is releasing hormone is called PRH, prolactin releasing hormone or PIH. So, this is prolactin and RH stands for releasing hormone and I H stands for inhibiting hormone, ok.

So, prolactin is involved in different kind of milk production in all those kind of situations. So, then this provokes pituitary to release prolactin. This is all about anti. So, we are talking about anterior pituitary. This prolactin then reaches its target and (( )) does its function target same way. The next very important hormone is called growth hormone. GHRH stands for growth hormone releasing hormone and GHIH stands for growth hormone inhibiting hormone. So, these hormones, when growth hormone releasing hormone when it reaches the pituitary, it promotes pituitary to secrete growth hormone. Growth hormone has wide range of function in all our growth related activity, and it target pretty much all over our body. So, there is really such place where you would not find a growth hormone releasing hormone a growth hormone receptors, ok.

Then, comes the next set of hormones which are extremely tightly regulated in terms of a reproductive maturity, and these are called GNRH, gonadotrofen releasing hormone. GN

stands for gonadotrofen and the hormones which are secreted by the pituitary in response to gonadotrofen releasing hormone are FSCH. FSH stands for follicle stimulating hormone, and LH stands for luteinizing hormone. We will talk about this hormone while we will be talking about the reproductive aspect of human system, and these FSH and LH which are secreted by the pituitary, LH to the secretion of the different sex steroids by the gonads.

So, they are the major targets of gonads. There are other targets, but at this point we will only talk about gonads as not to make things complex, and here you will see there is a gonadotrofen releasing hormone, but I am not showing any gonadotrofen inhibiting hormone because this is under the feedback loop. Some of these have different feedback loops at different level, and apart from it the secret sex steroids which produce have feedback loop. Then, we talked about corticoid troffen releasing hormone, and all the three hormones. Now, what I will be talking about is they do not have any inhibiting hormone here. This is called CRH, corticoid troffen. Spelling is corticoidtroffen releasing hormone and corticoidtroffen releasing hormone leads to the secretion of ACTH, adrenal corticotrophin by the antier pituitary and then this leads to the secretion of cortisol, and cortisol secretion takes place in adrenal which you will be covering very soon, ok.

Adrenal gland which is present in the kidney on the top of the kidney, then you has something called TRH, thyroid releasing hormone. T stands for thyroid. So, this thyroid releasing hormone reaches the pituitary and pituitary release something called thyroid stimulating hormone. SH is the stimulating hormone. Then, thyroid stimulating hormone reaches the thyroid gland and leads to the secretion of T3 and T4 and all other thyroid hormones.

So, now if I summarize it, so at the level of hypothalamus, this is the hypothalamus level. So, hypothalamus is secreting almost seven different kinds of inhibiting and releasing hormone, prolactin releasing hormone, prolactin inhibiting hormone, growth hormone releasing hormone, growth hormone inhibiting hormone, gonadotrofen and the reproductive releasing hormone, corticotrofen releasing hormone. Then, TRH, thyroid releasing hormone and the anti-rerpituitary secretion. I am not talking about posterioril. We will talk about it later because these are the situation where all the signals are coming through the blood vessel. Those are local blood vessels. So, anti-rerpitutary secreting

prolactin growth hormone, follicle stimulating hormone, luteinizing hormone, ACTH and TSH thyroid stimulating hormone.

Now, prolactin has its target is a very specific hormone which is involved in kind of milk production and everything, whereas growth hormone has a wide target all over the body whereas, GNRH has a major target through a secretion of FSA follicle stimulating hormone. And luteinizing hormone to the gonads which are mostly responsible for all our sexual behavior and sexual development whereas, CRH is corticoid releasing hormone leads to the release to the act h from the adreno corticotrofen from the antirerpitutary which act on the adrenal gland, where the cortisol is being released and this cortisol has wide range of function which will be coming very soon. Whereas the TRH, thyroid releasing hormone which leads to the secretion of thyroid stimulating hormone from the anti-rerpitutary thyroid stimulating hormone goes to the thyroid, where pyroxene is being synthesized and that pyroxene then shows its function all over the body if you look at it over all.

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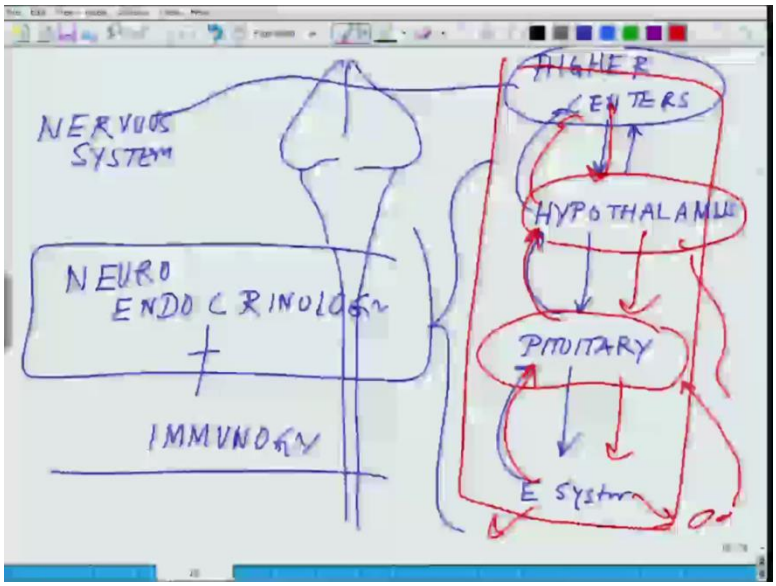

So, if you come to this particular slide again, you see at every level there is the feedback loop which is functioning. So, higher centers of the brain which receives signals from all over the body, they ask hypothalamus to secrete inhibiting or releasing hormone. Then, this acts on pituitary, from pituitary it acts either directly on different systems or act different, second or third TR of endocrine systems which again sends feedback loop. So,

it is a complete feedback loop of neuro endocrine. So, you can pretty much call this kind of situation as neuro endocrine access. It is a long access where these higher centers of the brain are the neural component of it and the whole endocrine.

So, this whole neuro endocrine access plays a key role in almost all the physiology processes which happens in any of these living systems, especially human being or any other mammals or life, and it is very well coordinated system and they get affected by several ways as before I move into it.

So, say for example, you people must have heard this that the faces of pesticides in the crops which we eat leads to endocrine misfunction or endocrine disrupter or endocrine enhancer. You see sometimes people have hair growths in unusual places or some kind of other ailment because there are several compounds which are currently used in food products or during food production in the form of pesticides, insecticides or some other you know growth stimulants or anything which we are not even aware of how they are influencing this neuro endocrine access, and it is so tightly regulated that those pecomolar and nano molar traces, once they enter inside our body, they create havoc and all our endocrine system comes under intense stress because of this.

So, with this I will move on with this just kind of giving a bit idea that why we are now kind of you know why FDA or any other food drug administration of any country is kind of very concern about what we are adding in to the food because that is the major source. So, ever we eat, it is eventually from the blood vessel and those are absorbed by the different parts of the body, and that is what eventually influences all your functions. So, these are some of the things which I appreciate you people go online and check what are these. You know endocrine disrupters how they kind of you know influences and sometimes, they can even lead to diseases like cancer or other neuro diseases and slowly we are trying to understand how different factors are influencing different endocrine or neuro endocrine function.

So, from here let us move on to the posturer pituitary and as I have already told you the posturer pituitary is directly under the neuronal control of the hypothalamus, so it does not unlike the antirer pituitary which is being supplied from a local blood vessel from hypothalamus. In case of posturer pituitary, it is not. So, the two hormone which are involved in posturer pituitary are one of the oxytocin and the other one is ADH.

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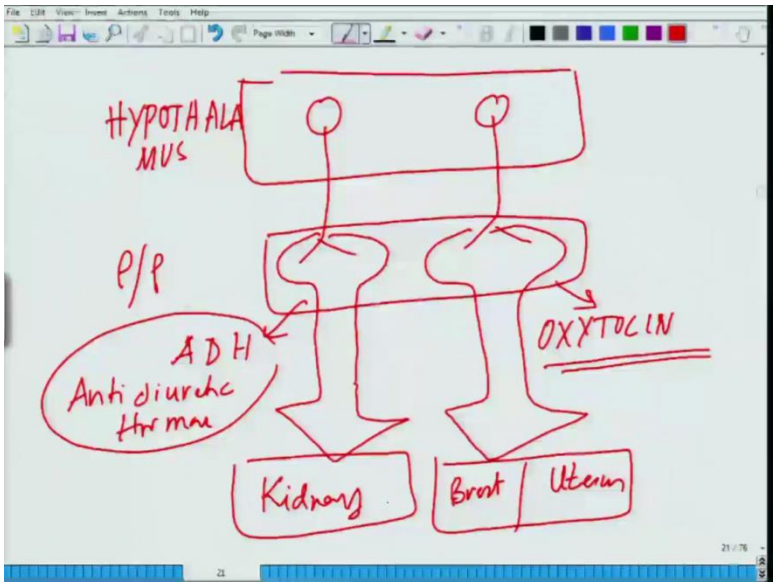

So, now let us draw the circuit for posturer pituitary. So, here we have the hypothalamus and here, you have posturer pituitary. I am just putting it PP for you. So, here is the direct neuronal connection, from here this is the blood vessel which carries the secretion or hormonal secretion by the pituitary. So, one of them is oxytocin and the other one is ADH, anti-diurche hormone. These are the two hormones which are secreted by the posturer pituitary. Oxytocin has two major targets. One is the breast and the other one is uterus. These are the two places were oxytocin majorly acts and ADH has one of the major target is kidney. What it does in the kidney as well as in western uterus, now let us come to that.

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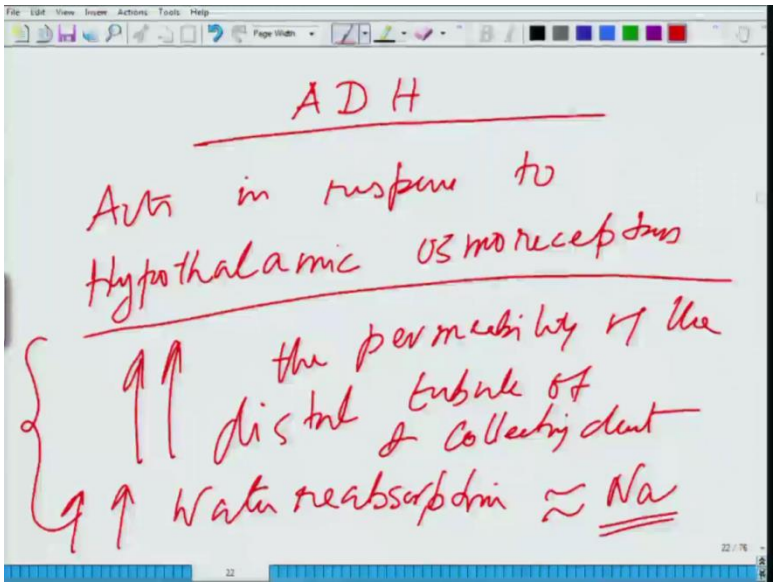

The function of ADH is, it acts in response to hypothalamic osmo receptors. In other words, when the osmolarity changes in the body or there is an excess loss of say water or some kind of metabolites, this leads to the activation of ADH, specifically in a situation where there is the increase concentration of sodium. So, what basically happens is that it once again ADH leads to the increase, the permeability. I will come to this. This (( )) distal tubule kidney distal tubule and collecting that and ensures more water re absorption and there by maintaining the optimal level of sodium. Mine is been maintained by hormone, and it basically ensures when the body is running out of water, it ensures that you know it is being restored.

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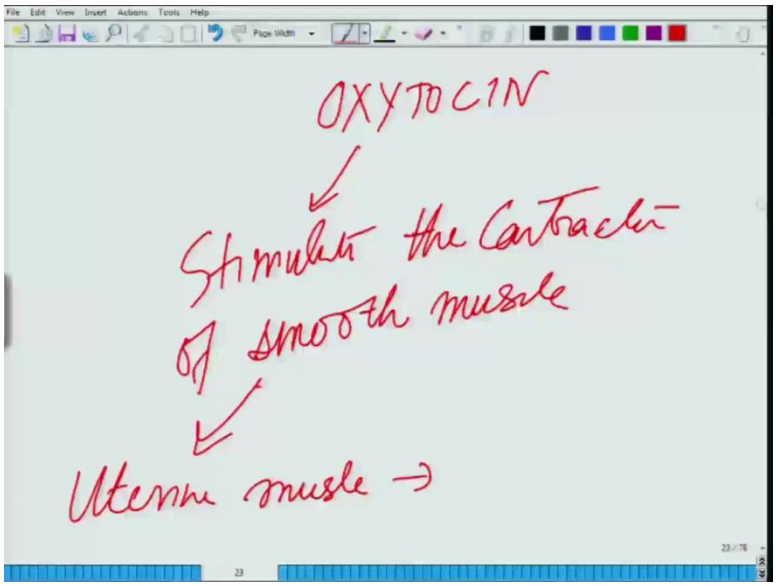

So, this is one of the major functions. What is the function of oxytocin? Oxytocin stimulates the contraction of smooth muscle and this is essential during child birth when the fetus has to come out. This is especially in the uterine muscle. Sometimes oxytocin injections are given because that leads to the movement of the fetus from the uterus and especially, it is done in cows, buffalos or even in human being where there is small dose of oxytocin helps the women to you know allow the fetus to come out slowly. Oxytocin also help in milk release from the breast during the time of breast feeding because it increases the contraction of the muscle because of its action. So, they response to that how basically it gets regulated. So, these are the two major functions of oxytocin and ADH whereas, ADH is regulating the water concentration and there by maintaining the right sodium concentration.

Kidney plays a very critical role and once we will be talking about kidney, and again touch this point. ADH is playing this role and oxytocin in which directly acts on the uterus as well as in the breast. In the breast it ensures that the milk is being released properly during breast feeding and uterus, it ensures that the fetus slowly and gradually moves out of the women body during child birth. These two are very critical for our development now from here after. So, now we have kind of covered the hypothalamus and the pituitary, and we have talked about neuro endocrine access. From here I will move on to the adrenal which is under the regulations.

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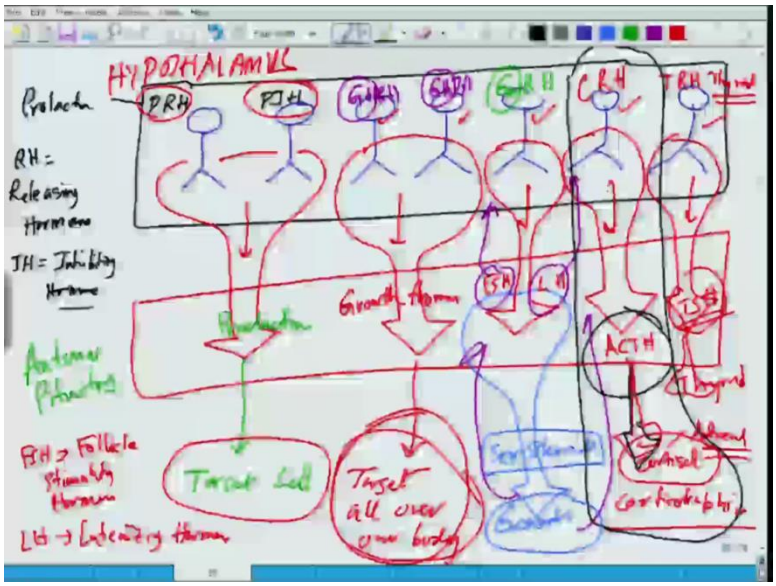

So, if you go back, I just, so this is the part I am going to try now to talk to you. This is the part of circle where corticotrofen realizing the hormone leading to the secretion of ACTH by the pituitary antiter pituitary, and then this anti-pituitary working on the adrenal gland which is the location of the adrenal gland out here. So, I try this. So, this is the kidney.

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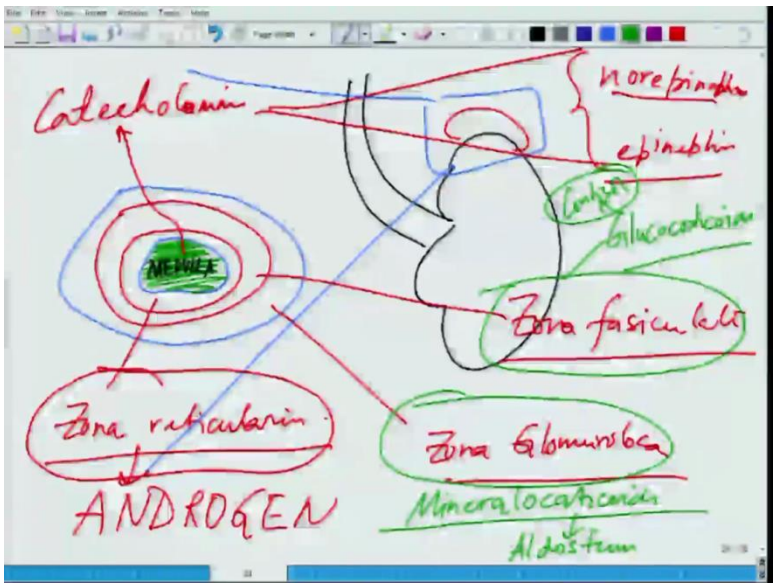

So, here is the adrenal gland setting. So, this particular gland have a very interesting structure. If you look at this structure, if you see the cross-section of this, this is

something like this. It has outer core and it has inner core. If you take just cross section like this and the outer core, if this is the inner core and this inner core is called medulla. So, this is called the medulla whereas, the outer core consists of three layers i.e. outer most layer, middle layer and the inner layer and all the three layers have different functions.

We will come to that. The inner most layers is called zona reticular, the outer most layer is called zona glomuroloa and the middle layer is called zona faciculata. These three layers have three different secretions and inner layer has again different secretions. So, the medulla is involved in the secretion of catecholamine. Catecholamine means I have introduced the term catecholamine, but catecholamine is what you have studied in the autonomic nervous system. So, I told you that aprin and noreaprin also function as hormone. So, the medulla is involved in the secretion of apeaprin and noreaprin, where the other three layers zona faciculata, zona glomurolroza and zona reticularis are involved in other different other secretions.

So, the inner most layer which is your zona reticularis, this layer zona reticularis is involved in the secretion of androgen. I will come to the individual function of it whereas, zona the middle layer, the zona faciculata, this zona faciculata is involved in the secretion of glucocorticoids, and the outer most layer which is zona glomurolroza is involved in the secretion of mineralocorticoids, and major mineralocorticoids is secreted by the glomurolroza is aldosterone, and the major glucocorticoids secreted is cortisone.

So, this is the kind of structural cum functional distribution of the different layer of adrenal. In most layer, the medulla first layer which is the adjacent layer to the medulla which is the zona reticularis which secretes androgen, then the middle layer which is called faciculata which is secreting gluco corticoids or cortisols. First cortisols, yeah and then the outer most layer which is known as a glomurolroza which is secreting our mineralocorticoids or aldosterone. So, now, what we will do is, we talk individually about that different corticoids. So, another important thing for you people to realize is this.

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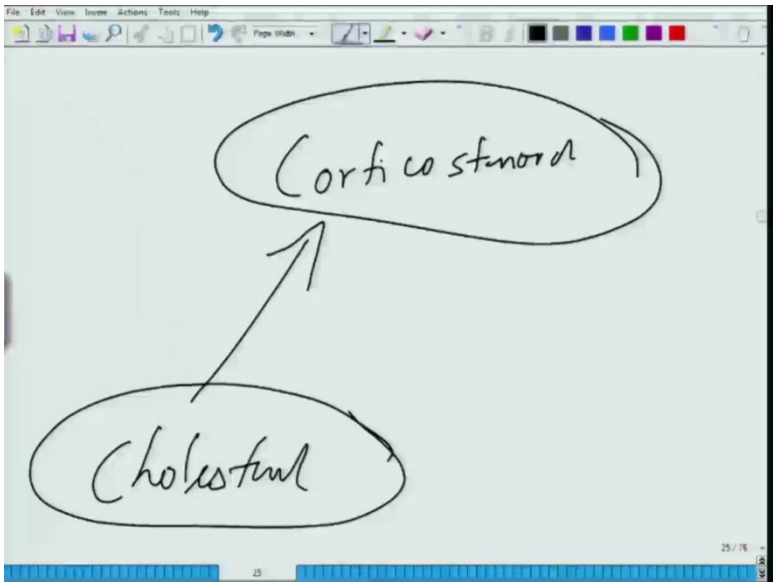

Corticosteroids are all synthesized from one of the very molecule called cholesterol. They are all synthesized for cholesterol and then if you remember well I was talking about the membrane structure, we talked about the cholesterol and I told it is a very important molecule and it has multitude of functions starting from modulating the fluidity of the membrane and other things. It has one of the major function is that it is involved in the synthesis of corticosteroids, ok. So, now we will move on to the mineralocorticoids. So, the mineralocorticoids, we will be talking about the aldosterone.

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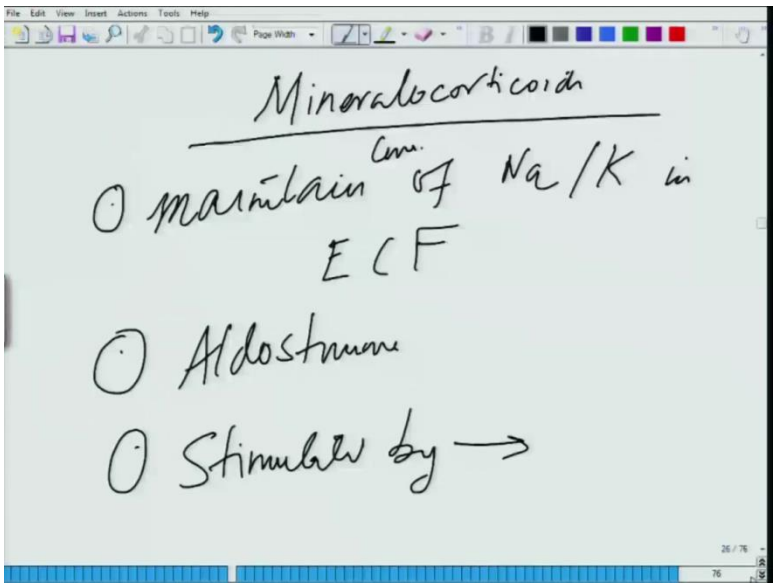

What mineralocorticoids are? So, in the outer most layer, mineralocorticoids are one of the major function of mineralocorticoids is that it maintains the normal concentration of sodium and potassium in an extracellular fluid concentration of sodium and potassium, in ECF extracellular fluid. The next major function is that then I already told you aldosterone is the major aldosterone, is a major mineralocorticoid.

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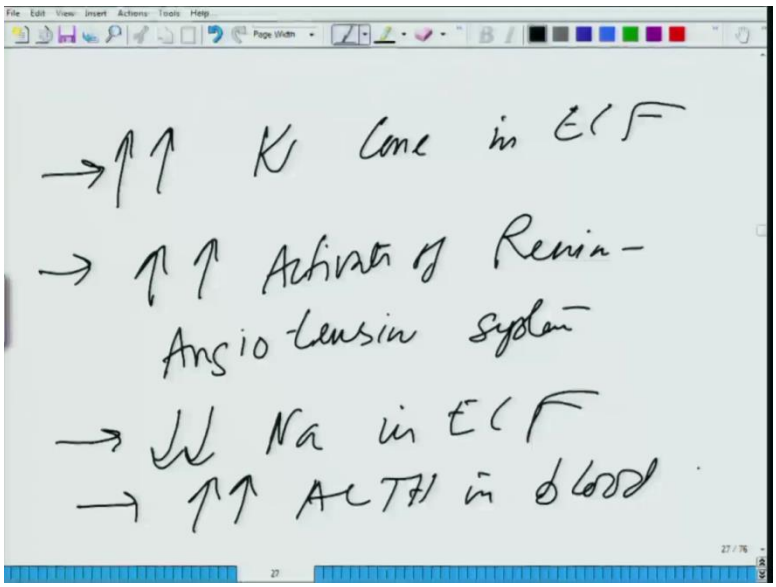

It is stimulated by first increase potassium concentration in extracellular fluid. This is one factor. The second factor is increase activation and I will come back to this system. Well, I will be talking about the kidney and this time I am just by passing it and then when there is decrease in sodium in ECF extra cellular fluid, then when there is increase in ACTH in blood. These are the four situations when aldosterone secretion is being enhanced.

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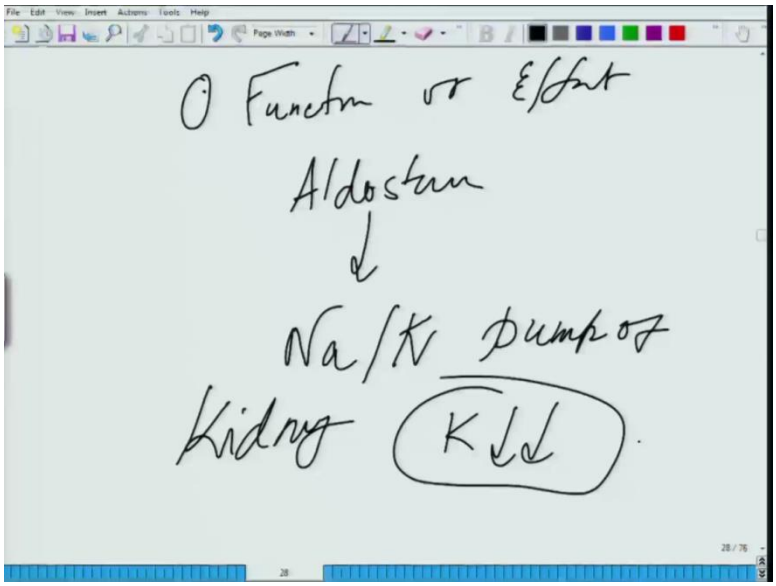

What is the function of this? How it works, functions or effect? We call it effect. So, what it does essentially is that again coming back to the membrane what I taught you, it affects the sodium potassium pump of kidney and in other words, what it does during that situation, it helps by regulating this, pump it. As I told you just before this slide, there is increase concentration of that ensures that kidney get rid of brings down the potassium concentration and maintain the sodium concentration. So, this is the way mineralocorticoid work.

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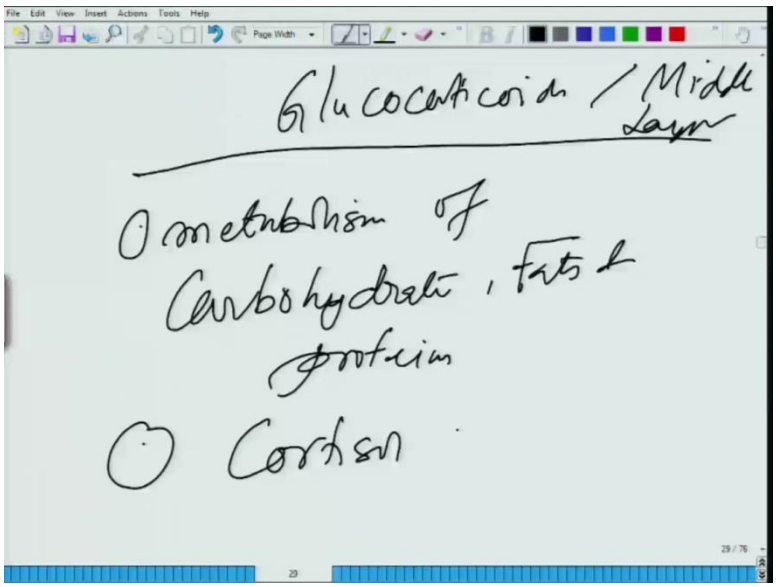

From here we will move on to the glucocorticoid which is the middle layer of the adrenal. Glucocorticoid is involved in the metabolism of this extrinsically important term of metabolism of carbohydrates, fats and proteins and it is cortisol. I have already told you cortisol is the major glucocorticoid which is present and it is stimulated by…

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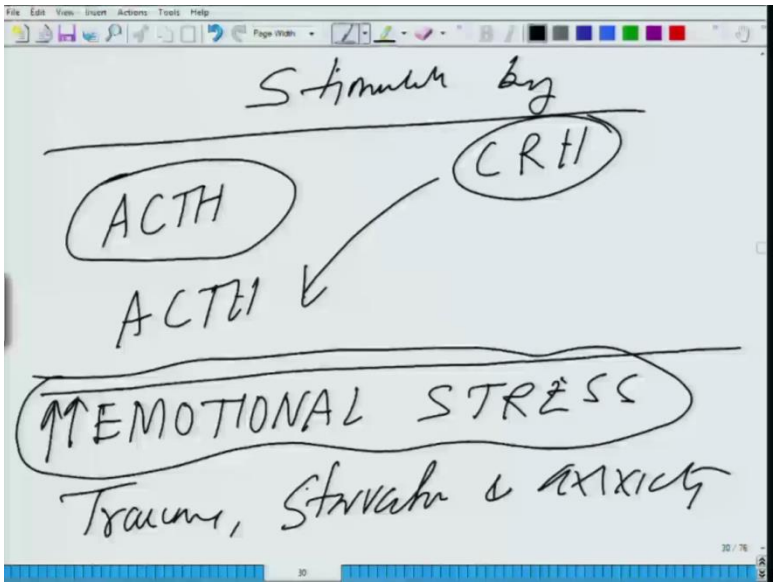

This is very important. It is stimulated by first situation. When it is stimulated, the ACTH level in the blood is again regulated by pituitary. Thus, ACTH is regulated by corticotrofen releasing hormone which is coming all the way from the hypothalamus, and this response happens during some specific situation and this is very interesting. It mostly happen during extreme emotional stress. This is very interesting to understand when there is an extreme emotional stress, especially in the situation of trauma starvation and anxiety.

So, coming back now try to look at it very holistically, so here is a situation when a person is in extreme stress in terms of some kind of trauma or anxiety or fear or something. For example, that is the time when some of the areas like amygdale or other higher centers of the brain gets affected. So, those center sends a signal to the hypothalamus, hypothalamus leads to the secretion of corticotrofen releasing hormone, corticotrofen releasing hormone travels along the blood vessel comes to pituitary, from anti-pituitary ACTH is secreted, this ACTH comes all the way to the adrenal, from

adrenal the second other middle layer of the cortex of the adrenal, the glucocorticoids are been secreted.

So, it is a kind of very interesting loop. It is a fantastic chemical circuit which is regulating all these processes and any deviation. From this just because of some kind of stray chemical which is entering your human body, some other situation could really hamper this very neatly balanced chemical machinery which is functioning for ages now, and it has been adapted to the changes of human life in a very interesting manner. So, let us talk about the function or the effect how it works on them, works on the body.

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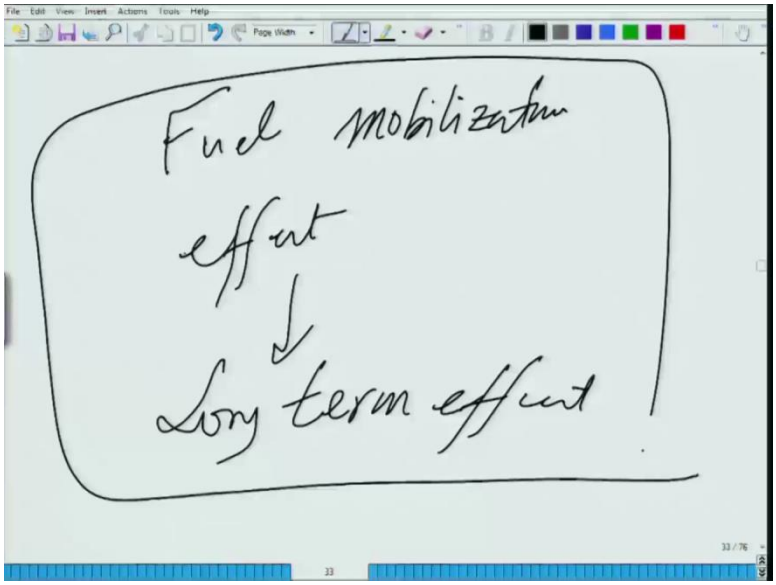

So, what essentially is does is that increase level of cortisol leading to the skeletal muscle to break down the protein and releases the amino acids into the blood. This is the first thing which happens once again track of the slides. The next thing happens is it dictates the liver to increase the glucose production through a process called gluconeogenesis, ok. This is the second thing which happens. We will talk about gluconeogenesis as I will be talking about the digestive system and this in other words, we can call it as a fuel mobilization process and this fuel mobilization effect is a very long term effect. This is not something as short term effect, very long term effect. This glucose mobilization effect then comes within the medulla. You have this.

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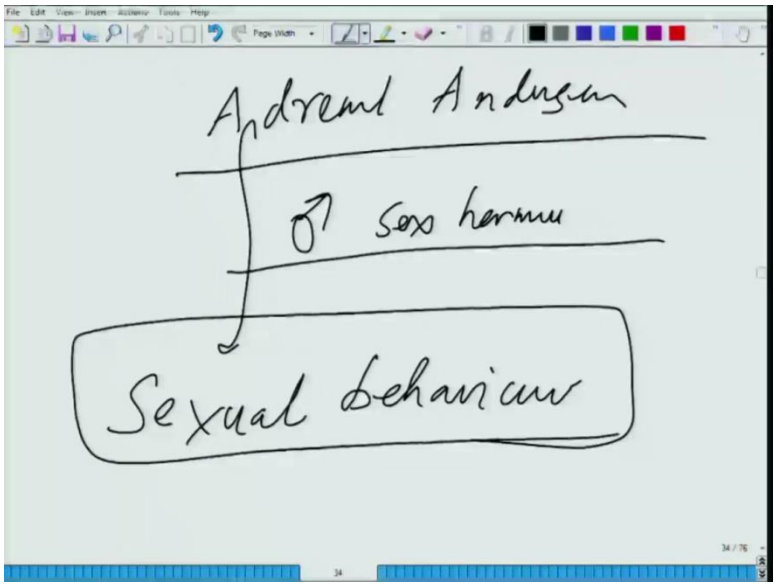

Sorry, before the medulla, you have this adrenal androgen which is secreted by the inner most layer. This is basically a sex hormone, a male sex hormone, and it is not as important as pure like testosterone which is secreted by the gonads, but this has a role plays in sexual behavior, not in sexual development, but especially in the sexual behavior. This particular hormone has a role to play. So, this is very important to realize and then we talk about we can go back there will be easy talking about the medulla which is catecholamine, aprein and noreaprin.

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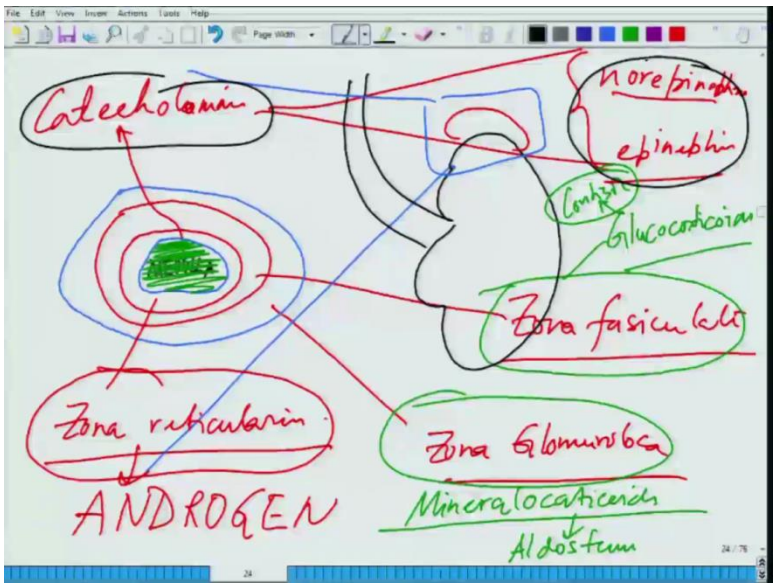

We have already discussed about the function of apinaprin and nore perin in terms of they are involved in increasing the heart rate, involved in my cardinal contractility. They are involved in other different kinds of lipolysis function or the breakdown of the lipids.

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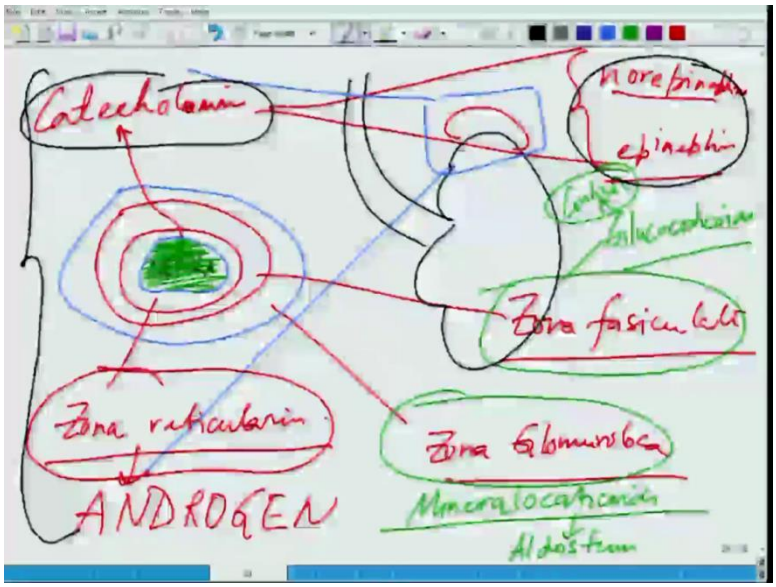

So, if I have to summarize this whole process if you look at it, this adrenal is playing very extraordinary role under the influence at four levels of influence higher centers of the brains which are controlling your anxiety, fear, energy requirements. They dictate hypothalamus, hypothalamus dictate pituitary, pituitary dictates adrenal and then adrenal from its four different layers including the medulla, outer cortex, inner most cortex and the middle cortex which secretes glucocorticoids, mineralocorticoid and the adrenal androgen and the apinaprinand. The noreaprin secreted by the medulla dictates of activities all over your body starting from regulating your body under stress, extreme stress regulating your water mobilization in the body by regulating absorbing the irons and water of the kidney, and to a totally divorce area from this regulating the sexual behavior.

So, on top of that the apeaprin and noreaprin as a dual function in terms of, they are involved in the heart rate, increasing the heart rate and lipolysis process. They increase my cardinal rate, contraction rate. So, you see I mean it is covering a very wide range of small organs sitting on top of kidney plays a very critical role, and this is what I wish you

people appreciate that this whole system, this whole neuro endocrine access along with as we will proceed further.

As we were talking about the immune system is a very interesting loop where things are happening in a very well controlled manner, and with this I will close on this lecture and I will request you people to go through some of the nice pictures which are given online in terms of neuro endocrine access. I will give you a better feel about it, and I expect you people to go through some of the endocrine destructors or pesticide residues or insect side residues which are fairly damaging to our endocrine system. That will help you to appreciate what we eat and where we should be careful enough.

Thanks a lot.