Basics of Biology
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Lecture 47
Homeostasis (Part 2)

Hello, everyone. This is Dr. Vishal Trivedi from Department of Biosciences and Bioengineering, IIT, Guwahati. And what we were discussing, we were discussing about the basics of living organisms. And in this context So, far what we have discussed, we have discussed about the classification of the living organisms, we have discussed about the evolution of the living organisms, and then we have also understood how the different types of cells are present in the living organisms whether it is a prokaryotic cell or the eukaryotic cell.

Within the cell we have also discussed about the different types of organelles, what are present what are their functions and how they contribute into the overall function of the cell. And then these cells are actually been made up of the biomolecules, So, we have also discussed about the different types of biomolecules. We have discussed about the carbohydrate, proteins, lipids and the nucleic acids. And all these biomolecules are participating into one or other biological processes.

So, we have also discussed about the, some of the basic biological processes, we have discussed about the central dogma of life where we have discussed about the replication, transcription and translation. And then subsequent to that, we have also discussed about the specialized responses such as we have discussed about the immune responses and as well as the vesicular trafficking.

So, and many of these processes are extensively been utilized for running the physiology. And if you recall, in our previous lecture we have also discussed about the requirement of a living organisms. What we have said is that the requirement of a living organism is that it requires the nutrients, requires the adequate amount of oxygen, it requires the adequate amount of water, normal body temperatures in the case of the warm blood animals, and as well as it also requires the appropriate atmospheric pressures.

Now all these requirements are actually going to be accomplished by the running of the different types of physiological processes. We have discussed about the digestion, we have discussed about the circulatory system, we have discussed about the muscular system, nervous system, and as well as we have also discussed about the coordination among them, and So, on and how the nervous system is contributing into the inter acting against a particular stimuli and So, on.

Now if you recall, in our previous lecture we have also discussed about the role of these physiological processes. So, the role of these physiological processes are that they want to maintain the homeostasis. So, if you recall, in our previous lecture we discussed in detail about the homeostasis, what is mean by the homeostasis. So, homeostasis is the condition which is going to feel you like a home like environment.

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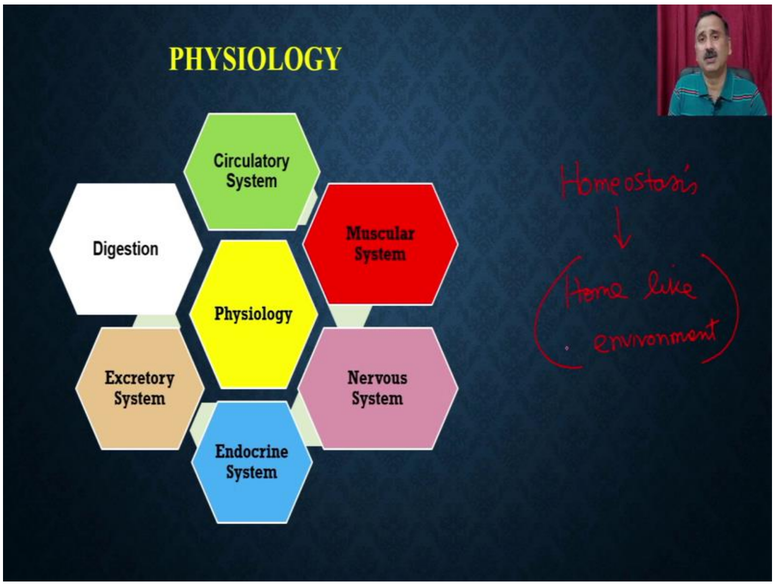

So, homeostasis is a terminology which is, which literally mean is that home like environment. And you know that you are always being feels very, very safe when you are in a home like environment because that is going to give you all sort of comforts, it is actually going to give you the protection from the dangers and So, on.

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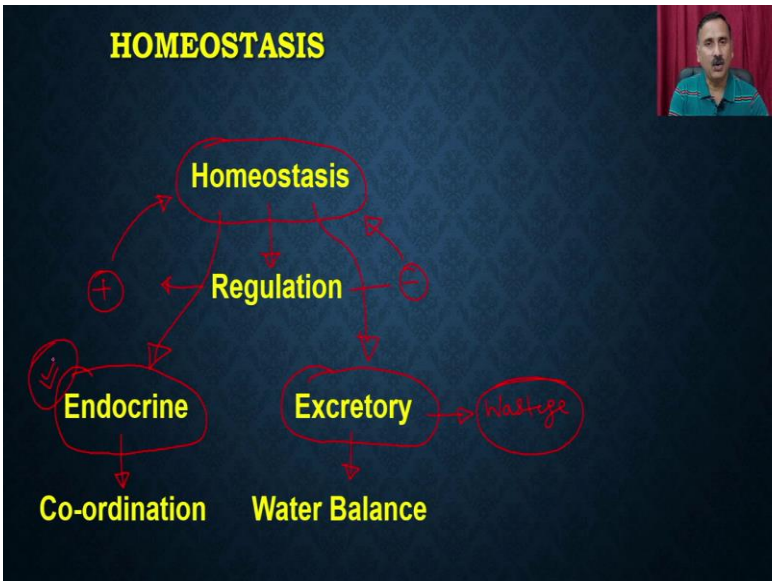

And in the previous lecture we have also discussed about how the homeostasis is actually going to be maintained. So, there are regulatory mechanisms which are actually been operating within the body, and these are these regulations could be of the positive regulations or the negative feedback regulations. And both of these positive feedback regulation as well as the negative feedback regulations are mainly been meant to maintain the homeostasis.

But homeostasis largely been depend on the two main processes. One, it is actually going to be dependent on to the endocrine system, and the other it is actually going to be dependent on the excretory systems. So, the function of the endocrine system is that it is actually going to coordinate the activities among the different types of physiological processes, or it is actually going to be a kind of a information system in which the, you will actually going to know what is happening in the other part of the body.

So, endocrine system along with the nervous system is actually going to work together to provide the ability of a human body to respond, whereas in the case of excretory system, it is actually going to be contributed into the water balance, excretory system is also going to be used for removal of the wastage or the waste material and So, on. So, in today's lecture, we are actually going to discuss about the endocrine system and how the endocrine system is contributing into the homeostasis.

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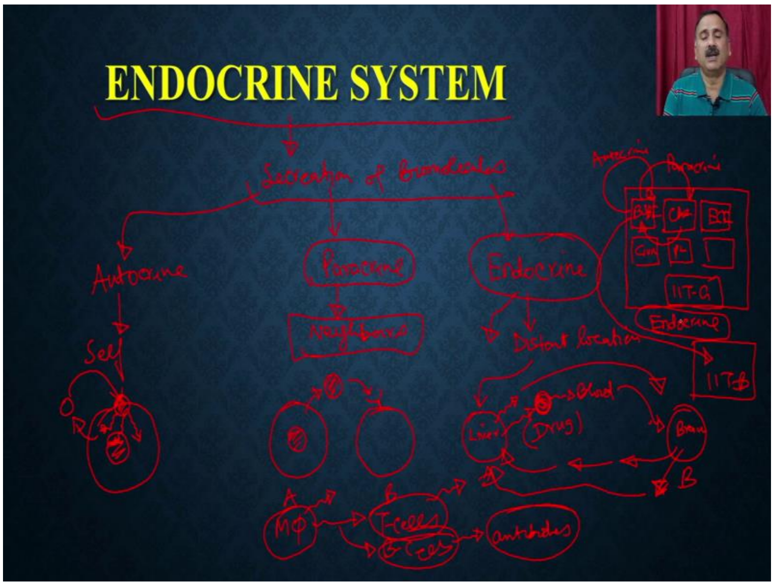

So, when we say about the endocrine system, we are talking about the secretion of the biomolecules and their role in conveying the message. So, when you talk about the conveying the message, the message can be conveyed in three different ways. It could be autocrine, it could be paracrine, and it could be endocrine. So, what is mean by all these parameters?

Autocrine means when you are going to give the message to the self, which means if you have, if there is a cell, if cell is under the stress, it is actually going to send the molecules out, and then these molecules are actually going to bind to the receptors what are present on to the cell surface and that is how it is actually going to give the signal to themselves.

What is the advantage? The advantage is that this cell is under the stress So, it actually wants to activate the stress responsive signaling So, that the required machinery within the cellular nucleus can be activated. But that, it cannot do directly because it requires some type of stimulus.

So, to provide the stimulus to themselves, what you are going to do is, you are, they are actually going to send a molecule and these molecules are actually going to be received by the same cell, and it is actually going to do the downstream signaling and that is how it is actually going to activate these different parts of the body, different parts of the cell and that is how it is actually going to generate the appropriate signal.

Now, let us talk about the paracrine signaling. Paracrine signaling means you are talking about you are going to talk to your neighbors. Which means, once the autocrine signaling is not sufficient, you also require the support from the neighbors. So, in that case what will happen is that you have the two cells which are neighbor to each other, So, you have a cell A and cell B.

So, the cell A is actually going to send the signal and then this is going to be received by the cell B. And in that process the cell A is actually going to provide the required signal what is being also been done by the A themselves also in the case of autocrine signaling. So, that is the way the cell is actually going to provide the additional support to the cell B.

The classical example is that if you are, I think if you remember, when we were talking about the immune responses we said that the macrophages, So, macrophages are actually going to provide the signal to the T-cell or they are also going to provide the signal to the B-cell, and that is how they are, So, macrophages are actually going to express the proteins or the antigens along like as, and that is how they, or they can actually be able to secrete some cytokines and that is actually going to be received by the T-cell and B-cell.

And they will actually going to secrete the additional amount of the antibodies, they will be actually going to provide the antibodies and So, on. And all these responses are only possible when they will get a signal from the macrophages or they will get a signal from the T-cells. So, this is just a simple example where the paracrine signaling is actually going to be very crucial in terms of providing the necessarily responses.

Then, let us talk about the endocrine signaling. So, endocrine signaling is going to be not within the neighbor but it is actually going to be the distant locations. So, endocrine signaling is for the distant locations. So, for example you have a cell A and then you also have a cell B, and then, this is, this distance is going to be pretty far. For example, a cell A is a liver cell and the cell B is a brain cell.

So, in this case, the cell A is actually going to send the sample, like the molecules, and that will travel into the blood, and through the blood it will actually reach to the brain, and that is how it is actually going to provide the signal to the brain. And what is the fun, what is the role? Role is that cell A, which is present in the liver wants to either provide the, its own condition to the brain So, that the brain is also going to provide the necessary responses back to the liver cell and that is how the liver cell is actually going to act accordingly.

The other point is that it also can, the, it can be sent the warning signals like that some toxicant is accumulating into the liver and something is happening and So, on. One of the classical examples could be that if you are suppose taking a drug, for example, So, although the drugs are not part of the endocrine signaling, but if you suppose the drugs are being metabolized from the liver, the liver is actually going to send the metabolic byproducts, and these metabolic byproducts are actually going to be received by the distant organ.

So, that is not a part of the endocrine signaling, but endocrine signaling could be like where the signal could be coming from the brain. For example, the hypothalamus, hypothalamus is a part of the brain which can actually be able to send So, many different types of signal. And that is how it is actually going to induce the liver cells to express or to release some of the biomolecules. You can easily understand this by a simple example.

For example, I am working in IIT Guwahati. So, what is mean by the autocrine, endocrine, parakline and endocrine signaling is, that suppose I am working in IIT Guwahati. So, within the IIT Guwahati, we have the many different types of departments. For example, am working in BSB, Biosciences and Bioengineering department. BSB's neighbor is the Chemistry. Then after Chemistry, you have the ECE and So, on. You also have the Civil department, you also have the Physics department and So, on.

So, now imagine that I want to send a letter, I want to send a letter to myself. So, if I send a letter to myself then, it is actually going to be called as autocrine signaling because want to send the letter to my students So, that they will be able to follow the content and they will be able to follow my instructions. So, that is going to be called as autocrine signaling.

But suppose have my friend in the Chemistry department where I want to send research articles or something, then will send it to my friend in the Chemistry department. Or suppose I have generated some research data which want to share with my Chemistry, department So, I will send that. And accordingly, the Chemistry people are actually going to respond to that. Because if send them a very good data they will be very, very happy and excited about that.

So, that is going to be called as the paracrine signaling because when I do so, the chemistry people may also send me the response, they may actually send me the manuscripts, they may send me the research data from themselves also because based on my feedback they may actually be able to plan the different experiment and So, on. So, that is going to be a paracrine signaling.

Now imagine that if have, I may be working in at IIT Guwahati and my friend is also my friend is working in IIT Bombay. So, I if send a something from my lab to his lab, that is going to be called as the endocrine signaling. So, that is going to be endocrine because that is going to induce the responses into the IIT Bombay. This, you can imagine even in any other circumstances.

Like suppose you want to send or you want to give your greeting cards to your own family, then it is going to be autocrine. If you want to send some kind of invitation card to your neighbor, then it is going to be a paracrine, and suppose I want to give the invitation card to my relatives in the, into the next city, then it is going to be called as endocrine. So, what is the basic properties of the endocrine system?

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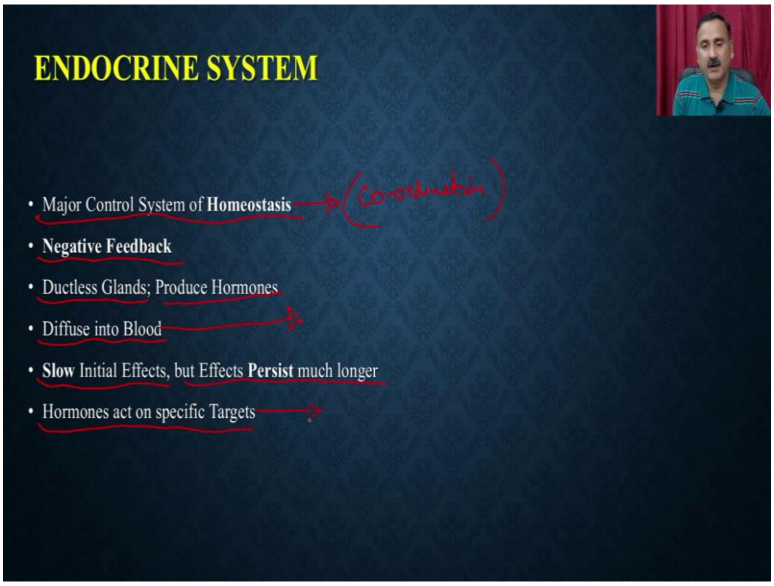

So, endocrine system is the major control system of the homeostasis because it is actually going to have the coordination role. It is actually going to tell the body that which part of the body is actually under the stress, which is under the disturbed homeostasis. It always works with the negative feedback mechanism. So, positive feedback mechanisms are also there within the endocrine system, I think we have taken an example of oxytocin, but that is very rare, mostly it is actually negative feedback mechanisms.

Then we also have the ductless glands, which are actually going to produce the hormones. The hormones are actually going to diffuse into the blood and that is how they will be actually going to travel to the distant location and that is how they are actually going to provide the signal or the informations. They are slow, but the effect persists for a very, very long time.

For example, you can have, you might have heard about many of the hormonal effects. So, they are slow, they will take time for maintaining or causing the final effects but they will be going to be continue like that. And hormones are very specific, they will go and hit to these specific targets only. For example, if there is a hormone which is secreting from the hypothalamus or adrenal glands, it will go and bind or hit the specific targets.

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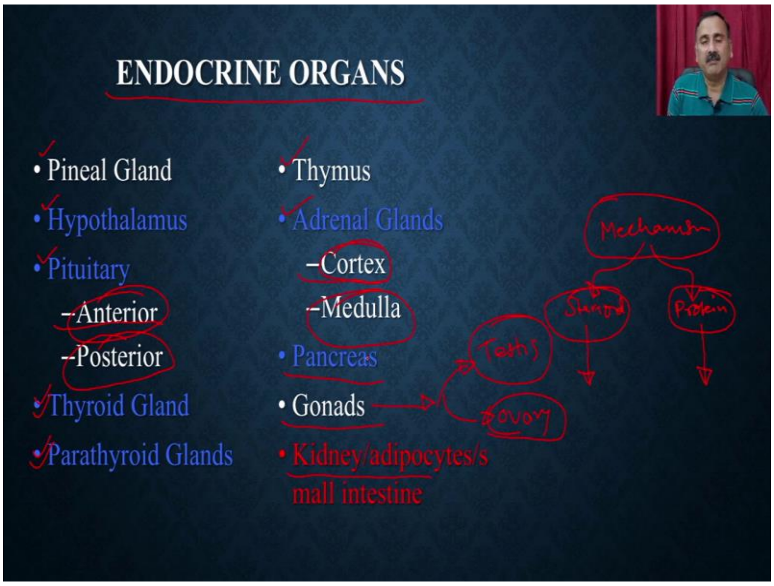

So, these are the some of the endocrine organs which are responding to the, or which are maintaining the endocrine functions. You have the pineal glands, we have the hypothalamus, then we have pituitary, within the pituitary you can have the anterior pituitary or the posterior pituitary, then we have the thyroid glands, then we have a parathyroid glands, thymus, adrenal glands.

So, within the adrenal, you have the adrenal cortex or adrenal medulla, both are involved into the secretion of the different types of hormones. Then we have the pancreas, we are also having the gonads. So, whether, within the gonads we can have the testes or the ovaries, and both are actually been, actively be involved in secreting the hormones. And then you also have the kidneys, and that also is part, secreting the some of the hormones.

So, let us discuss first about the mechanism. So, if you talk about the mechanism of their hormone actions, the mechanism could be fall under the two categories. One is the hormones which are steroid hormones and the other one is the protein hormone. So, you have the two different broader categories of the hormones, and their mechanism is very, very different.

So, steroid hormones follow the one type of mechanism, the protein hormones are following the different types of mechanisms. So, let us discuss about the mechanism and then we are actually going to discuss about the different types of hormones what are been secreted from these glands and how they are actually been participating into the maintenance of the homeostasis.

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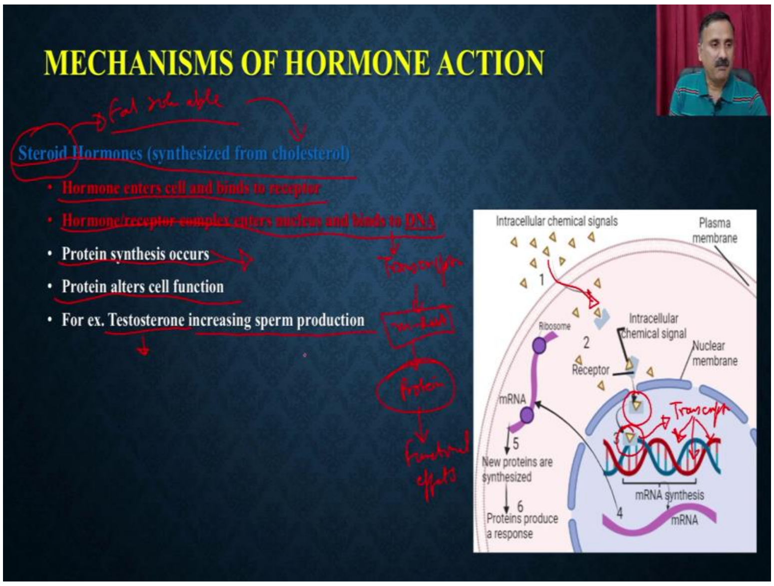

So, now let us talk about the steroid hormones. So, steroid hormones is synthesized from the cholesterol. So, most of the steroid hormones are the fat soluble, So, they are actually being synthesized from the fat, mostly the cholesterol. So, hormones enter the cell and it binds to the receptor.

So, see, this is the hormone what is being secreted. So, it will, actually because they are hydrophobic in nature, they will easily been diffuse out, they will be get dissolved into the plasma membrane, they will enter, and then directly they will be getting into the nucleus or inside the nucleus, and that is how they will be binding to a specific region within the target site.

So, the hormone, receptor complex enter the nucleus and it binds to the specific site within the DNA. And once it binds to the specific site of the DNA, it is actually going to modulate the transcription of that particular region of the genome. And once it changes the transcription, there will be a change in the transcription, it is actually going to generate the messenger RNA, and once you have the messenger RNA, it will result into the synthesis of the protein.

And once there will be a change in the protein level within the cell, it is actually going to have the functional outcomes, So, functional effects. So, there will be a protein synthesis, this protein synthesis is going to be very specific. Sometimes what happens is that you are, these receptor hormone complexes probably will go and bind to a specific region within the protein, within the DNA and that is actually going to generate the transcription factor. And that transcription factor is subsequently will go and bind to many more sites.

And that is how you may not have the one single protein which is going to be synthesized but you may have the multiple proteins which are going to be synthesized. So, that is why there could be a complete change of the protein content within the cell and that is how the cell may actually going to give you the very diversified phenotype. So, protein will alter the cellular functions, and, for example the testosterone, testosterone is the steroid hormones and that will actually going to increase the sperm productions. Now, let us talk about the non-steroid hormones or the protein hormones.

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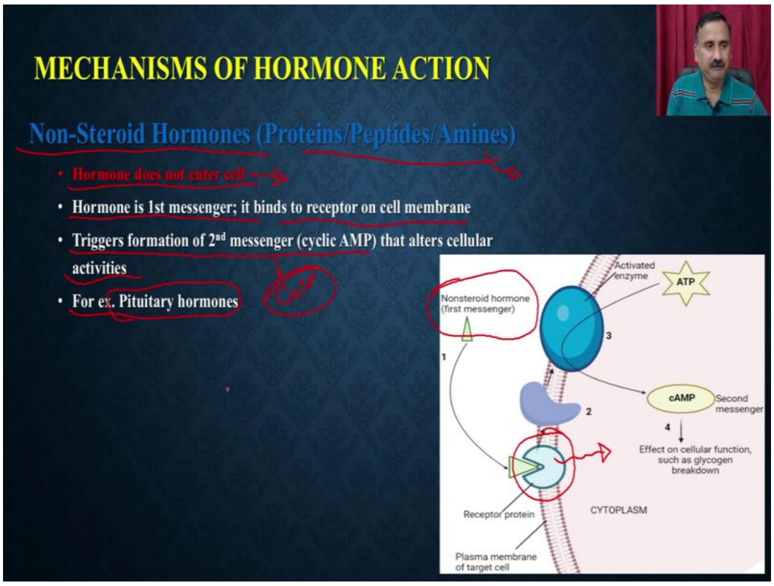

So, non-steroid or the protein hormones are actually going to be, because they are hydrophilic in nature, So, they will not going to enter into the cell. And that is the major difference between the steroid hormone as well as the non-steroid hormone. So, what they will do is they will come, So, non-steroid hormones will go and bind to the receptor which is present on to the cell membrane, and then this receptor is actually going to have the downstream signaling. And that is how it is actually going to affect the protein production within the cell.

So, hormone is the first messenger. It binds to the receptor on the cell membrane, then it triggers the formation of the second messengers, for example the cyclic AMP or other kind of secondary messengers like calcium and so on, and that is how it is actually going to alter the cellular activity. So, the non-steroid hormones are not directly altering the gene expression profiling or the protein productions, but they will be indirectly doing that. What, how they were doing it?

They will be binding to the receptor which is present on to the plasma membrane, and then it is actually going to produce the secondary messengers, whether it is the calcium or isotonic phosphate or the cyclic AMP, and that is actually going to change the, or sometimes the cyclic AMP is actually going to alter the gene expression profiling and that is how it is actually going to alter the cellular activities. Classical example is the pituitary hormone, thyroid hormones and all that.

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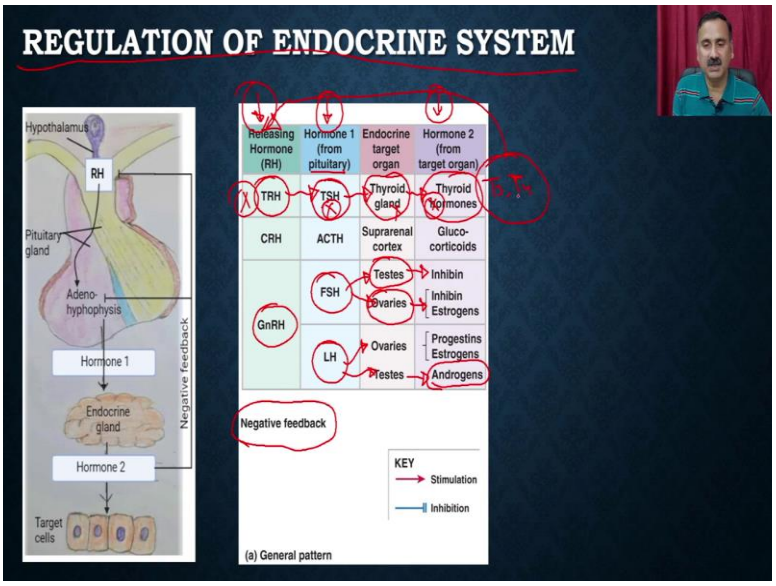

Now, because we have the So, much complication in terms of the, because we have the primary messengers and as well as secondary messengers, every hormone is being regulated by one or other hormones. So, that, and that is how the they would be under the tight control. So, then what is the regulation, how the regulation of endocrine system works?

For example, you can have the TRH hormone that is going to be released and once it binds, it is released, it is actually going to stimulate the production of the TSH from the pituitary, and that is going to be, a TSH releasing hormone, So, that is actually going to activate the production of the TSH from the pituitary, which is present in the brain, and it is actually go and bind to the thyroid glands.

So, once it binds to the thyroid glands, it is actually going to have the production of the thyroid hormones, T3 and T4. And So, that is how what you see here is there is a complete loop. So, if there will be no production of TRH, there will be no production of TSH, there will be no production of thyroid hormones and So, on. And same way we have the another other hormones also.

Like for example, we can have the production of follicular stimulating hormones from the gonadotropin releasing hormones. And that is actually going to act on the two different organs. It could be acted on the testes in the case of male or it may be acted on the ovaries in the case of the female. And from the testes it is actually going to secrete the secondary hormones, and that is how it is actually going to have the role in the reproductive product system.

Then we can have the luteinizing hormones, that is actually going to have the effect on the testes and ovaries, and that is how you are actually going to have the production of estrogen as well as the progesterone or in the case of male, it is actually going to have the production of androgen. So, what you see here is that the one or the other hormone is actually having the, So, it is not like you got the signal and it they got secreted. No. It is a double layer protection.

So, until you do not have the secretion of the releasing hormone, you will not going to get the hormone 1 and then you also not going to get the hormone 2. So, that is how you have the double layer protection or double layer regulations of the secretion of these hormones. And mostly these are the feedback mechanisms, which means once you have the enough quantity of T3 and T4 productions, you are actually going to have the effect on the TRH, and that is how it is actually going to stop the secretion of the TRH and that is how it will be eventually going to stop the production of T3 and T4.

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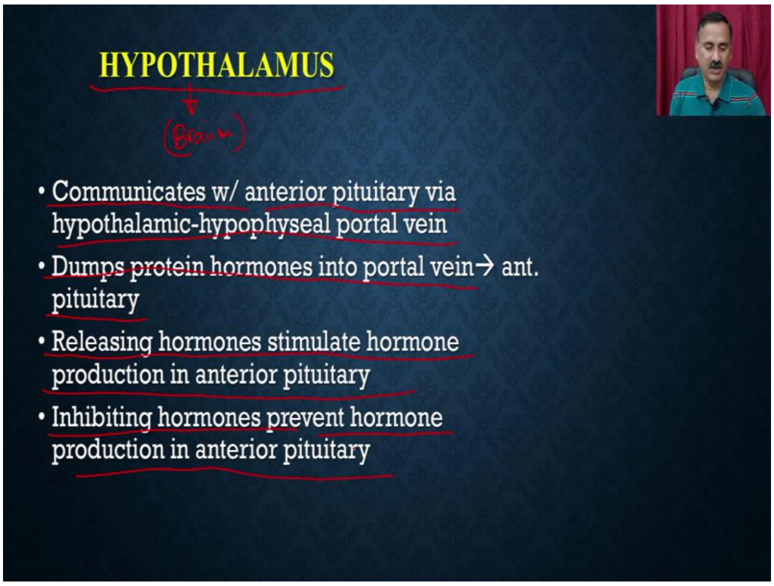

Now, let us talk about the different types of organs and the release the hormones what is being released and how they are actually contributing into the homeostasis. So, first hormone is the hypothalamus. So, hypothalamus is present in brain. Remember, when we were talking about the brain. It actually has a role in the communication with the interior hypothalamus or hypophyseal portal vein.

It dumps the protein hormones into the portal vein and that is actually going to be reached to the anterior pituitary. The hormones which are released from this is actually going to stimulate the production of, from the anterior pituitary, and the inhibiting hormones are going to prevent the hormone production in the anterior pituitary.

So, it actually can have the secretion of the two different types of hormones, the hormones which are actually going to stimulate the production of the hormones from the anterior pituitary or the hormones which are actually going to prevent the production of the hormone from the anterior pituitary.

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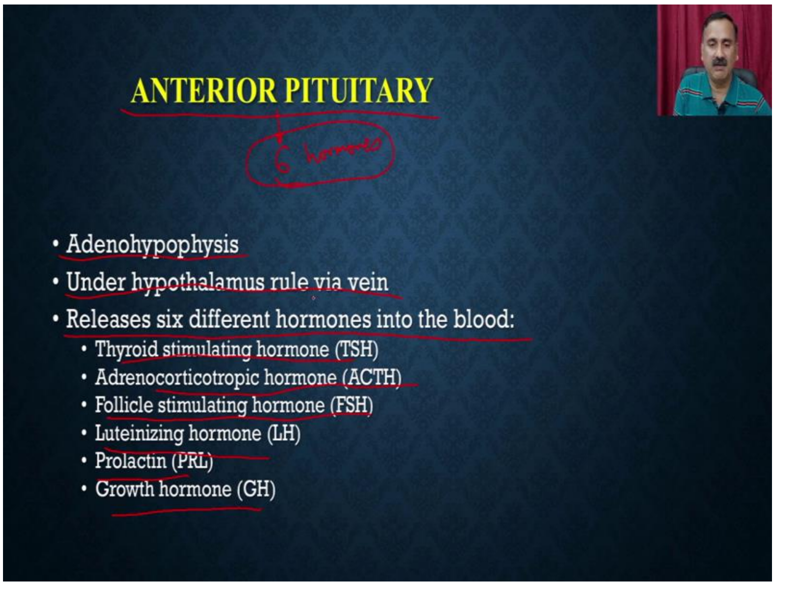

So, in the anterior pituitary, you have the Adenohypophysis, and then under hypothalamus rule via the vein, and it releases the six different hormones into the blood. It can release the thyroid stimulating hormones, it can have the adrenocorticotropic hormones ACTH, then it can also have the FSH, or the follicle stimulating hormones, luteinizing hormones, prolactins and the growth hormones.

So, anterior pituitary hormones, anterior pituitary is going to secrete the six different types of hormones, and that is going to be have the very significant effect in terms of the many of the pathways or the many of the essential roles.

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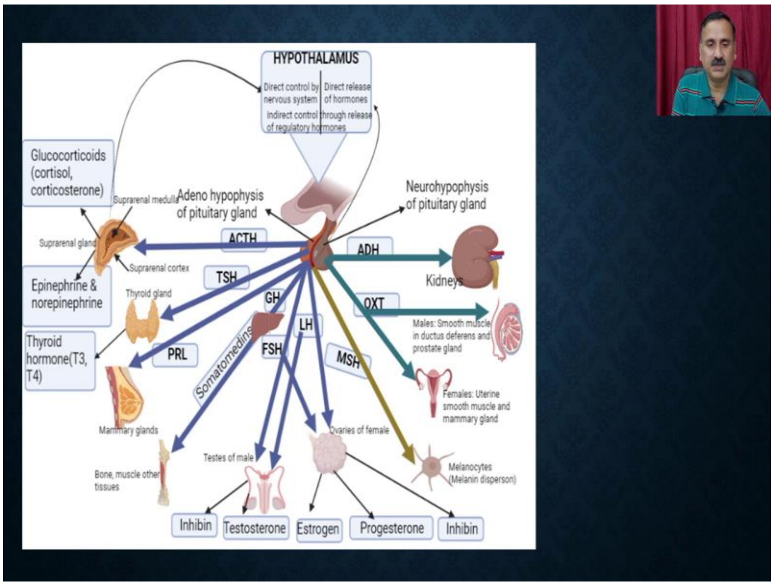

Then, we will talk about the, So, this is just shows how the network of the things. From the hypothalamus you have the secretion of the some of the hormones which are going to be either releasing hormones or the inhibitory hormones, and that is how it is actually going to cause the releasing or the inhibition of the different types of hormones from the different organs. For example, you can have the hormones like thyroid hormones, mammary glands and So, on.

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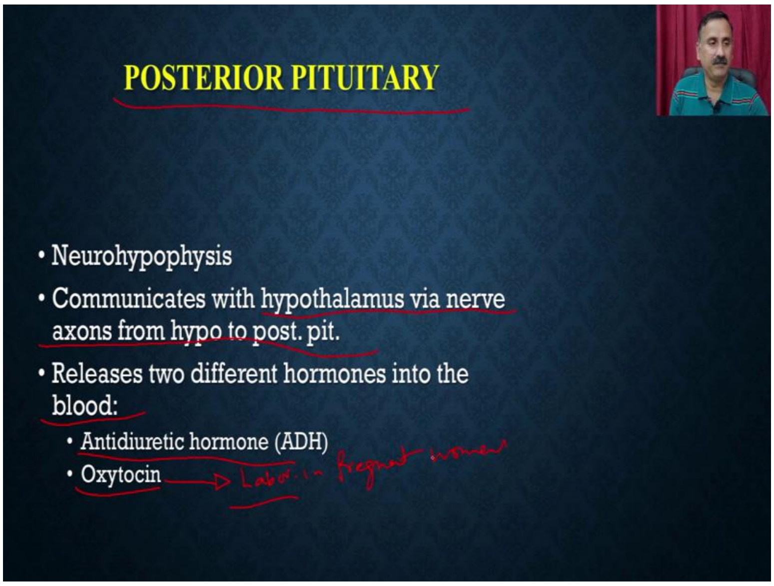

Then we have the posterior pituitary. The posterior pituitary is actually communicating with the hypothalamus where the nerves axons from the hypothalamus to the posterior pituitary, and it releases the two hormones into the blood. Its hormones is ADH or the antidiuretic hormones, and the oxytocin. So, oxytocin is a hormone which is responsible for the labor in the pregnant woman.

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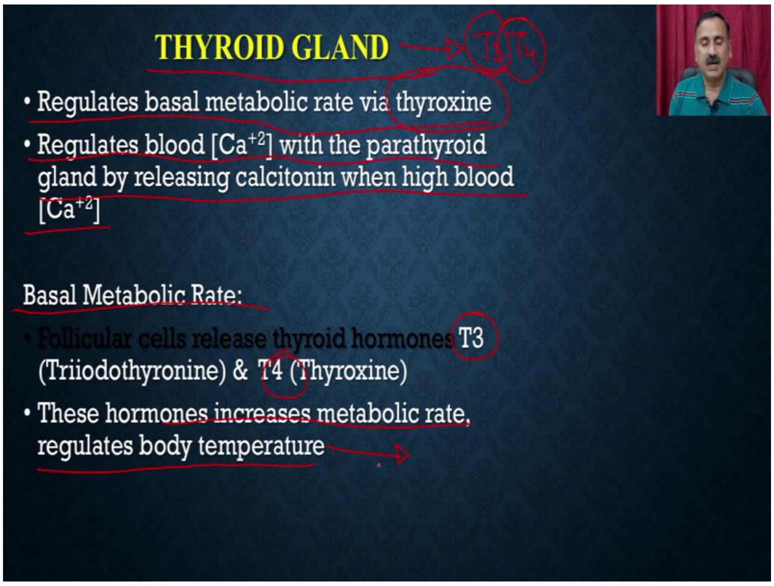

Then, we have the thyroid hormones or the thyroid glands. Thyroid gland is secreting the two hormones, one is called T3 and other one is called as T4, So, thyroxine. It regulates the basic metabolic rate via the secretion of the thyroxine. It regulates the blood calcium within the parathyroid glands by releasing the calcitonin when the high blood glucose.

And the basal metabolic rates, it is actually secreted the T3 and T4 hormones, and these hormones increases the metabolic rate and it regulates the body temperature. So, it actually is going to have the active role in terms of the maintenance of the glucose metabolism, and as well as it also has a role in maintaining the thermal balance. Thyroid hormones are always been under the continuous regulatory mechanisms.

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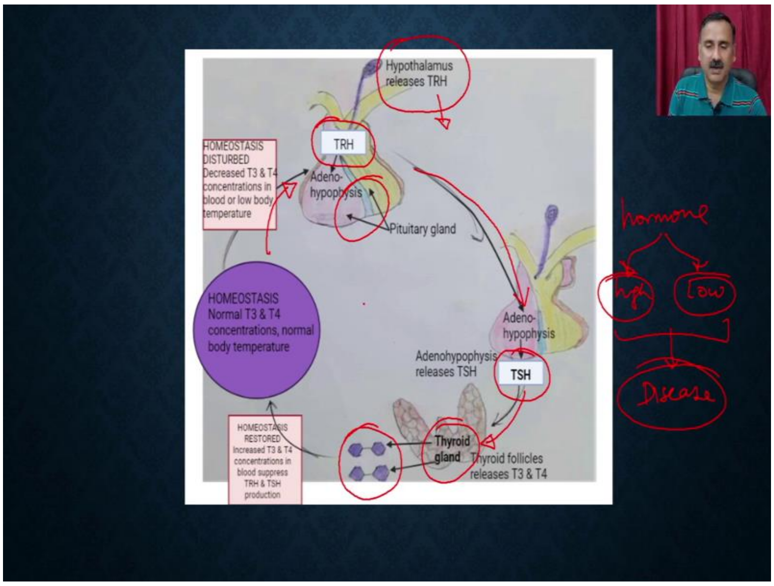

So, what we have is we have the hypothalamus which is actually going to release the thyroid releasing hormones and that thyroid releasing hormones are actually going to be act onto the pituitary glands and that pituitary glands are then going to release the TSH. So, pituitary glands are then going to release the TSH which is called as the thyroid stimulating hormones, and the TSS is actually going to have the receptors into the thyroid glands, and these thyroid glands are then going to release the T3 and T4.

And these T3 and T4 are actually going to have the function in terms of regulating the metabolic pathways and as well as it is having a role in terms of maintaining the calcium metabolisms. And once the, that their role is over, once you have maintained the normal homeostasis, it is actually going to go and bind to the TRH binds, it goes and bind to the adeno hypophysis, and that is, into the pituitary gland, and that is how it is actually going to inhibit the production of the TSH from the pituitary glands.

Since we are talking about the hormones, hormones could be of in two conditions. Hormones, there could be high hormone productions or there could be low hormone production. And both of these conditions are actually going to cause the production of the different types of diseases because if there will be high hormone production, it is actually going to disturb the homeostasis, if there will be a low hormone production that also is going to contribute into the disturbance of the metabolism.

And both of the way it is actually going to, it is going to affect the overall physiology of the, that particular individual. So, let us see how the thyroid hormones are actually going to cause the disease.

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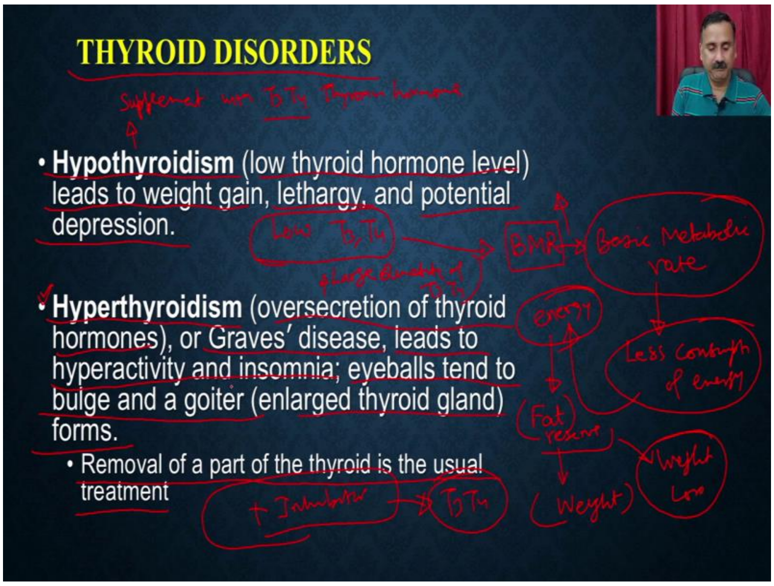

So, in the case of thyroid, you can have the two different diseases. One is called as the hypothyroidism, the other one is called as the hyperthyroidism. So, hypothyroidism means the low amount of T3 and T4. And it could be because of the many reason. It could be a product less production of TSH or it could be the less production of the TRH.

So, the hypothyroidism is characterized by the low thyroid hormone level, which means the low level of T3 and T4. And that is actually going to do, what it is going to do it is actually going to reduce your basic metabolic rate or BMR. So, basic metabolic rate, So, it is actually going to reduce the basic metabolic rate.

And when you reduce the basic metabolic rate, it is actually going to allow the less consumption of the energy, which means it is actually going to conserve the energy for the body. And when you have the conservation of energy, that will be responsible for the accumulation of the fat reserves because when you do not spend the energy what you are actually acquiring through the nutrition, it will result into the storage of that energy. And the storage of that energy would be in the form of fat.

So, once there will be a low thyroid hormone level, it is actually going to lead to the lower BMR or lower basic metabolic rates. And that eventually will results into the accumulation of the fat, which means once there will be an accumulation of fat that will result into the increase of the person's weight, which means it will indirectly going to induce the obesity. So, it leads to the body weight, lethargy and the potential depressions.

In another way, you can also have the hyperthyroidism. Hyperthyroidism means you are actually secreting the large quantity of T3 and T4. So, over-secretion of the thyroid hormones. Now you can imagine that if there will be an increase in BMR it is actually going to start activating the basic metabolic rate, which means there will be a more consumption of energy than what you are acquiring, which means it is actually going to induce the reversal.

It is not going to, it is going to be a weight loss. So, there will be a weight loss, and it also causes the disease which is called as the Graves' disease because when you could keep losing the weight, you will be losing your body fat and it leads to the hyperactivity and the insomnia. Eyeballs tend to the bulge and goiter, enlarged thyroid gland forms. The removal of the part of the thyroid is the usual treatment.

So, how you are going to treat? You can actually be able to treat the hyperthyroidism or the hypothyroidism very optimally. So, in the case of hypothyroidism what you can do is you can do the, you can supplement with the enough quantity of T3 and T4 or thyroxine hormone. So, that is requiring, going to the consultation with the doctor and the doctor is actually going to optimize the level of thyroid hormone which you can actually be able to consume.

In the case of hyperthyroidism, because you are producing the large quantity of thyroid hormones, the only way you can actually medically be treated is that you can remove some part of the thyroid gland. So, if you reduce the amount of thyroid gland it is actually eventually going to reduce the production of the hormones. The other option could be that you are putting the inhibitor. So, if you treat the body with the inhibitor of the T3 and T4 hormones, then also you can be able to overcome the hyperthyroidisms.

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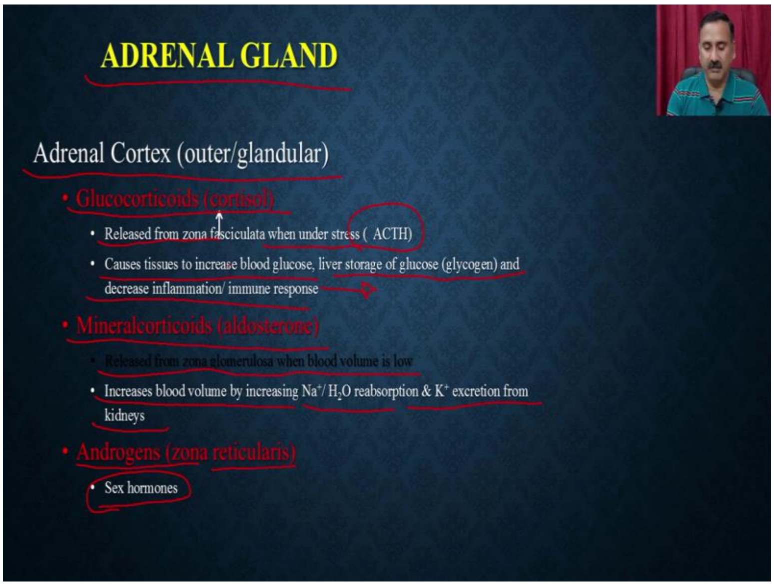

Then, we talk about the adrenal glands. So, adrenal glands could be of two parts. You can have the adrenal cortex or adrenal medulla. So, adrenal cortex is also going to secrete the three hormones. One is called as the glucocorticoid or the cortisol, the other one is called as the mineralocorticoid or the aldosterone and the other one is called as the androgen which is also called the, and the glucocorticoid, So, the glucocorticoid is released from the zona fasciculate and it is also under the stress.

And it causes the tissue to increase the blood glucose level, shortage of the glucose, storage of glucose, and the decrease inflammation or the immune responses, whereas in the case of mineralocorticoid, it is released from the zona glomerusa. When the blood flow level is low, it increases the blood flow by increasing the sodium and the reabsorption of the sodium, potassium excretion from the kidney.

Whereas the androgens, androgen is a sex hormone which is going to be secreted. Majority of these adrenal gland hormones are being secreted under the stress conditions. A stress could be of any type. It could be of the stress from the because you are expecting an exam or you could be expecting some kind of family tension or something. So, stress could be of many types. Stress could be that you are you are participating into a race and that also could be a stress.

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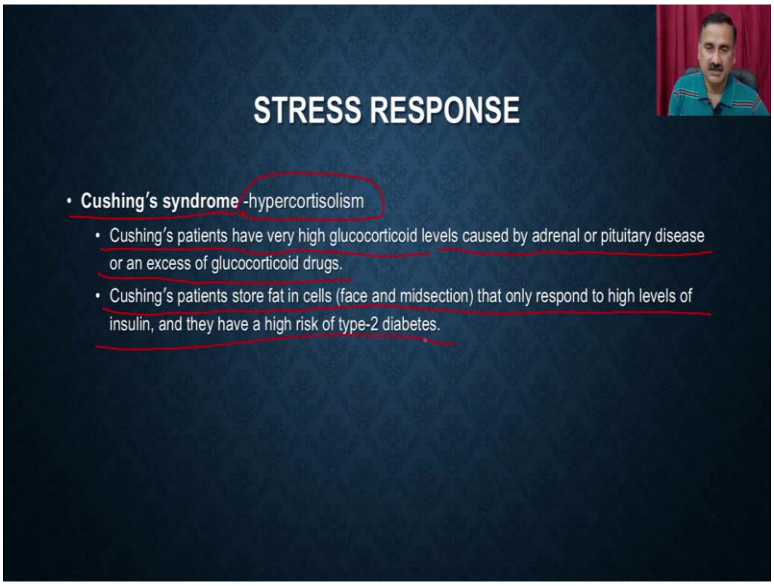

So, stress responses which is, So, hypercotisolism or the Cushing's syndrome. So, Cushing's patients have very high level of glucocorticoid level caused by the adrenal or the pituitary gland or excess of glucocorticoid drugs. Cushing's patients store fat in the cells and only respond to the high level of insulin, and they have a high risk of type-2 diabetes.

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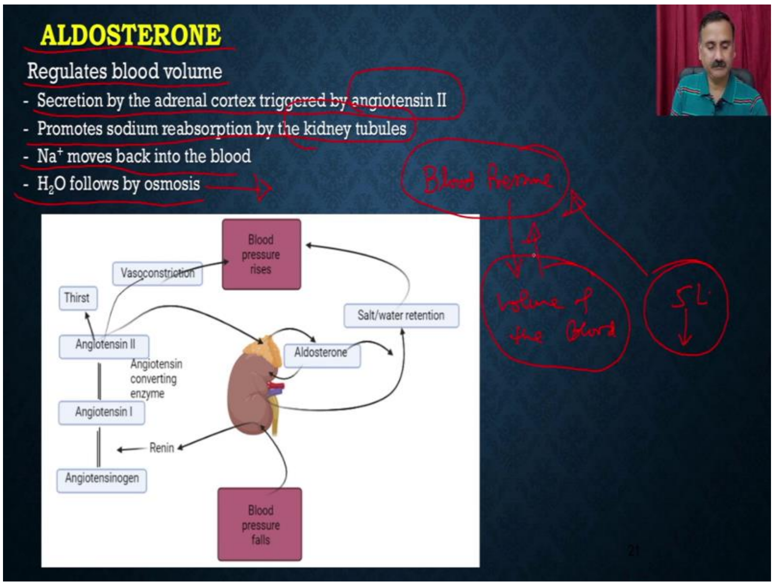

Then we have the aldosterones. So, aldosterones are the hormones which are going to be secreted from the gluco, from the adrenals, and it regulates the blood volume. So, secretion by the adrenal cortex triggered by the angiotensin. It promotes the sodium reabsorption by the kidney, and sodium makes the, moves back into the blood. And that is how the water follows by the osmosis.

So, its main function is that it is actually going to regulate the blood volume actually and that is how it indirectly actually going to contribute into the blood pressure of a particular individual because the blood pressure is indirectly been related to the volume of the blood.

For example, if you have 5 liter blood it is going to give you some kind of blood pressure, blood pressure is a is a pressure what the heart is going to experience when it is actually been actively been involved into the pumping of the blood. So, if you could somehow be able to change the volume of the blood, you could be able to modulate the blood pressure to some extent.

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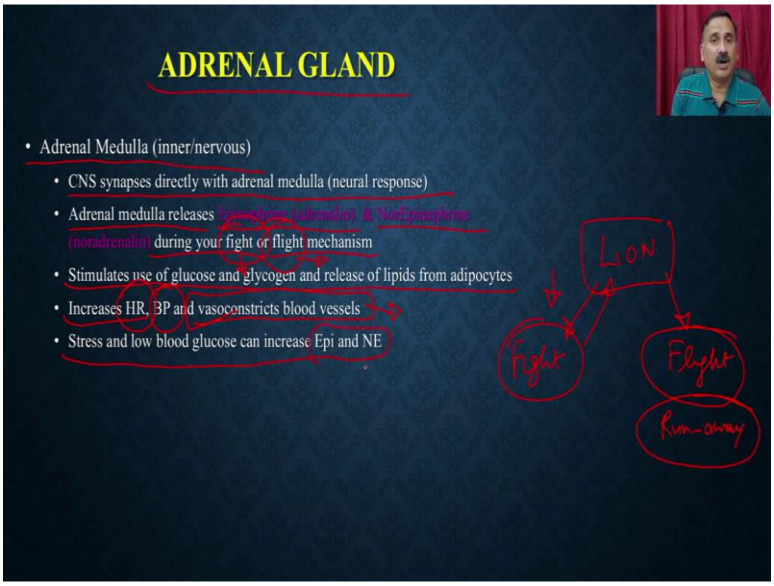

Then we will talk about the adrenal glands. So, adrenal glands could be of adrenal medulla. So, it could be a CNS synapses directly with adrenal medulla. So, adrenal medulla releases the Epinephrine, NorEpinephrines during the fight or the flight mechanisms.

So, what is mean by the fight and the flight mechanism is that it is actually going to allow a person to respond to multiple types of different types of conditions. The conditions where there will be a danger to the life. So, in those cases either you will fight or you will fight.

Which means, suppose you are encountering a lion for example. So, if you are encountering a lion, you have two options. Either you fight with the lion and you kill that guy, otherwise there will be no way that you can be able to survive, or the other option is that you actually going to be flight, which means you just run away from the situation or you run away from the conditions.

This decision whether you are actually going to make a fight with the lion or whether you are going to be run away from that particular position is going to be decided by the Epinephrine and NorEpinephrine secretions. So, if there will be a lower level of secretion of Epinephrine and NorEpinephrine, you will actually going to in indulge into the fight.

But if there will be huge quantity of the Epinephrine and NorEpinephrine which is going to be secreted, then you will say okay, I cannot win, I cannot win with lion, So, what is better is, I should flight, I should run away. So, it stimulates use of the glucose and glycogen and release of the lipids from the adipocytes.

Because this hormone is responsible for contributing into the fight or the flight response, it is actually modulating the metabolic pathways. So, it actually going to change the glucose and the glycogen and it is actually going to release the lipids from the storage materials. And that is how all these materials are actually going to be used either for the fight or the flight response.

It increases the heart rate; it increases the blood pressure and it also vasoconstricts the blood vessels. So, all these is because it wants to prepare you for the flight or the fight response. Stress and the low blood glucose can induce the Epinephrine and Nor Epinephrine responses.

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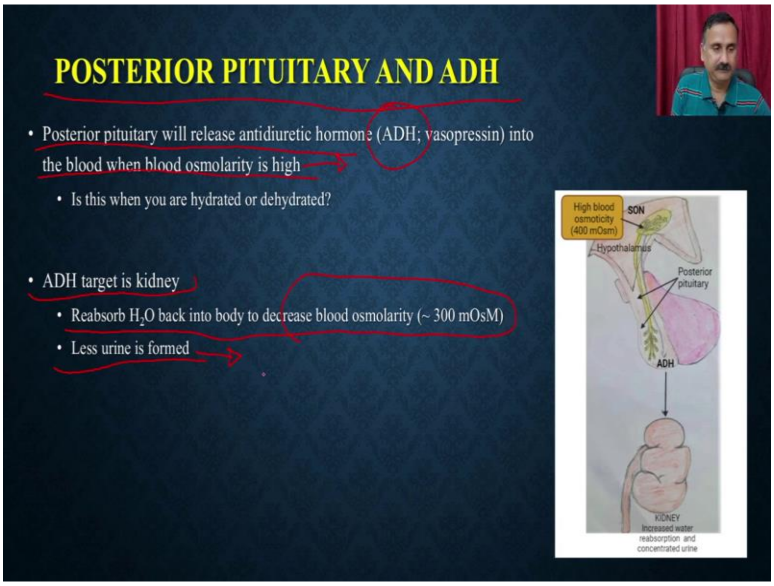

Then, we have the posterior pituitary and the ADH. So, posterior pituitary will release the antidiuretic hormone or the ADH into the blood, and the blood, when the blood osmolarity is high, which means it is actually going to dilute the blood. So, ADH targets the kidneys, it reabsorbs the water back into the body to decrease the water osmolarity or blood osmolarity. And this means if there will be a more production of ADH, it is actually going to induce the lower production of the urine.

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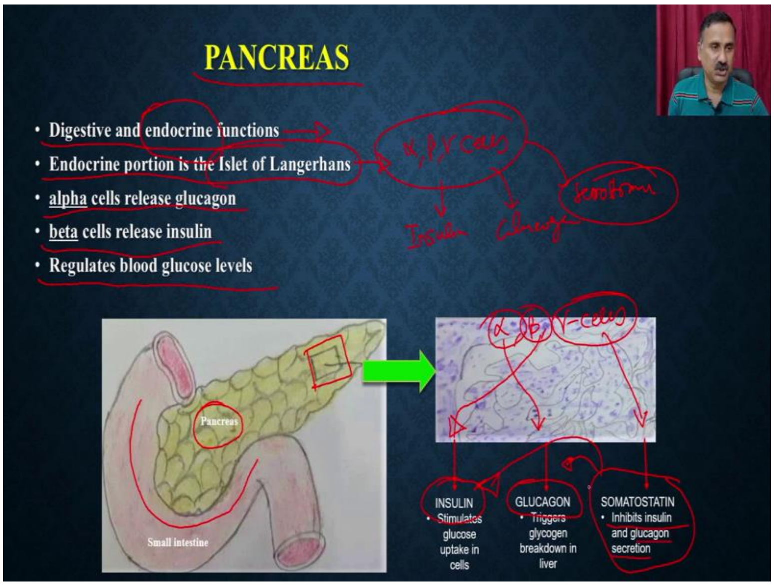

Then, we have the pancreas. So, pancreas is a digestive and endocrin functions. You remember that when we were talking about the digestion, we said that the endocrine, pancreas is actually going to release many types of the digestive enzymes like the pancreatic lipase, pancreatic amylase and So, on, and that is going to participate into the digestion. Apart from that it also going to release the different types of hormones.

So, endocrine portion is the Islets of Langerhans from where you can actually have the alpha, beta and gamma cells, and these alpha, beta and gamma cells are actually going to secrete the three hormones. One is the insulin, the other one is called as the glucagon, and the third is called as somatostatin. So, alpha cells releases the glucagon, beta cells releases the insulin, and they are actually going to participate very extensively into the blood glucose level.

So, this is what you see here, is the pancreas, this is the small intestine where the pancreas is being present, and when you see a very small portion and you will see the amplified region, what you will see here is that you have the alpha cells, you have the beta cells and you also have the gamma cells. And these alpha beta and gamma cells, what the alpha cells are doing, the alpha cells are actually secreting the glucagon, the beta cells are secreting the insulin, and the gamma cells are secreting the somatostatin.

And somatostatin is a hormone which is actually going to make a balance between these two hormones. So, see, beta cells are actually secreting the insulate that stimulates the glucose uptake, which means it is actually going to stimulate the conversion of the glucose into the glycogen, whereas the glucagon is actually going to do the reverse. It is actually going to be participate into the breakdown of the glycogen, and the somatostatin, somatostatin is actually going to participate into the regulation of these two hormones.

So, it is actually going to inhibit the insulin and it is actually going to support the glucagon secretions.

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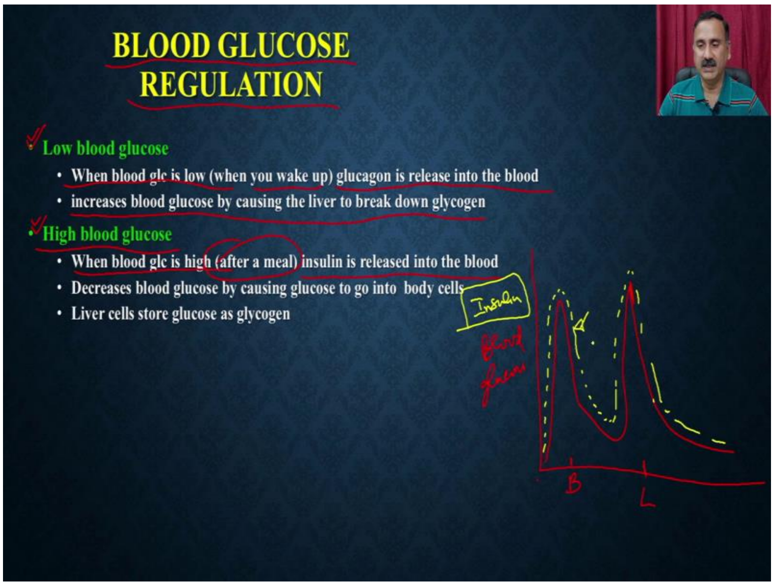

Blood glucose regulations. So, the pancreas is reactively involved into the blood glucose level. So, you can have the blood glucose, either the low blood glucose, or the high blood glucose. When the blood glucose is low, when you wake up in the morning, the blood glucose is going to be low, the glucagon is released into the blood, and it increases the blood glucose by causing the liver to break down the glycogen.

Similarly, we can have the high glucose levels. So, when the blood glucose is high, for example after the meal, the insulin is secreted into the blood. Now if you see a pattern, how it happens, suppose you have taken the breakfast, lunch, So, what will happen is that the blood glucose level will go down, go up like this, and it goes up like this. So, this is the blood glucose level. So, this is the blood glucose. Now if you see how the insulin level goes, insulin level goes like this.

As soon as there is a blood glucose level goes up, the insulin level or also going up like this. And then there is a decrease in the insulin level, then it goes up like this, and then there is a decrease in insulin level. This decrease in the insulin level is because of the, some of the enzymes which are degrading the insulin because once your high level of glucose is over, then there will be a lower level of insulin which is actually going to happen.

So, this is actually going to be the insulin what is going to be secreted, and this is the blood glucose. So, as soon as the blood level goes down, there will be a production of the glucagon as well.

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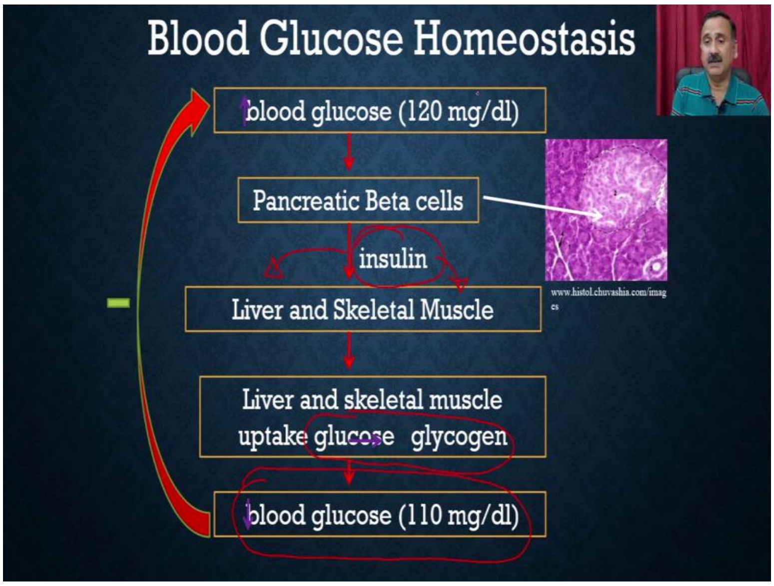

So, this is what exactly, I think we have already discussed about this. Blood glucose level, when it goes up, it is actually going to stimulate the pancreatic beta cells to produce the insulin, and that insulin is actually going to act onto the liver and as well as the muscle cells mainly, and that is how the muscle cell and lower cell are actually going to take up the glucose and as well as the glucose is being converted into the glycogen, and that is how the blood glucose level will go down to its normal level.

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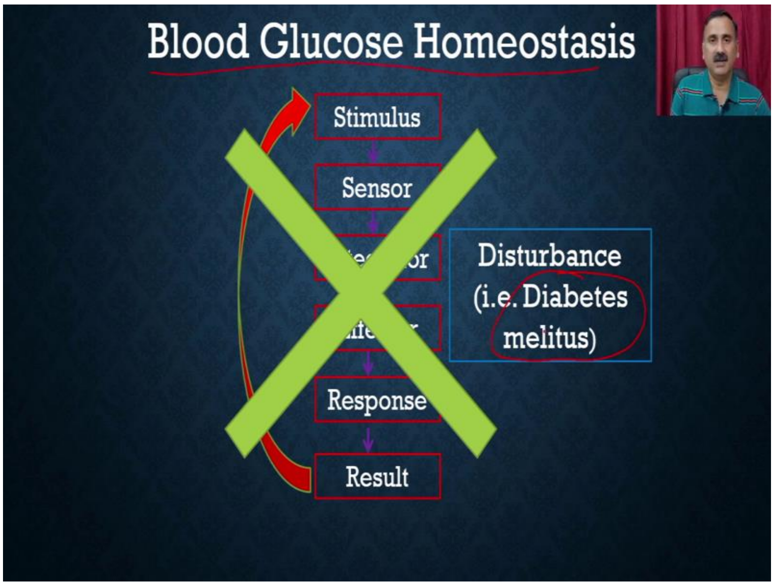

Now what will happen when this situation is not going to happen? It is actually going to cause the disease which is called as the Diabetes Mellitus. So, if this does not work out or there will be a disturbance in the blood glucose homeostasis, it is actually going to induce a disease condition which is called as the blood glucose homeostasis.

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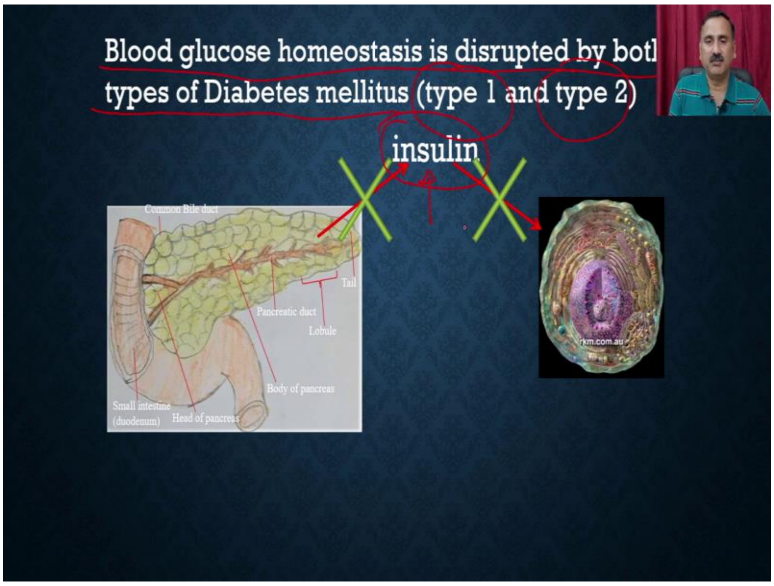

So, blood glucose homeostasis is disrupted by the both type of diabetes mellitus, whether it is a type-1 diabetes or the type-2 diabetes. In both the cases, the insulin is actually going to have a very active role. So, pancreas is secreting the insulin but the cells are not responding or there is a not adequate amount of insulin production. In both of these conditions, there will be a disruption of the blood glucose homeostasis.

So, what we have discussed, we have discussed about the homeostasis, we have discussed about the contribution or the participation of the endocrine system into the maintenance of the homeostasis. And in this particular discussion, in this particular lecture, what we have discussed So, far, we have discussed about the different types of the glands and their secretory products.

So, with this, I would like to conclude my lecture here. In a subsequent lecture, we are going to discuss more about the excretory system. Thank you.