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NPTEL ONLINE CERTIFICATION COURSE

Course Name
Stress Management
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Lecture 07: Hypothalamic-Pituitary-Adrenal (HPA) Axis

Welcome back to the second week on the course on stress management and in the second module on stress psychophysiology today we shall discuss the stress and the HPA axis.

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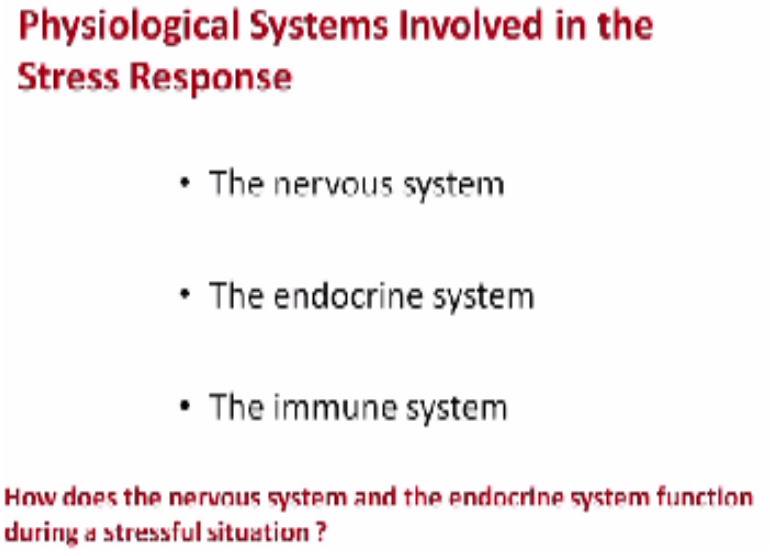

The HPA axis is primarily known as the hypothalamic pituitary and adrenal axis, so we shall understand what is the HPA axis? What are the organs that it involves? We shall understand the role of the endocrine system and the interaction with the nervous system and how these induce stress within the individual. So this brings back to our old slide of the various physiological

systems that are involved in the stress response, and we have seen that the nervous system the endocrine system, and the immune system they these are the three systems involved in stress.

Now in today's session we shall see how does the nervous system and the endocrine system function during a stressful situation.

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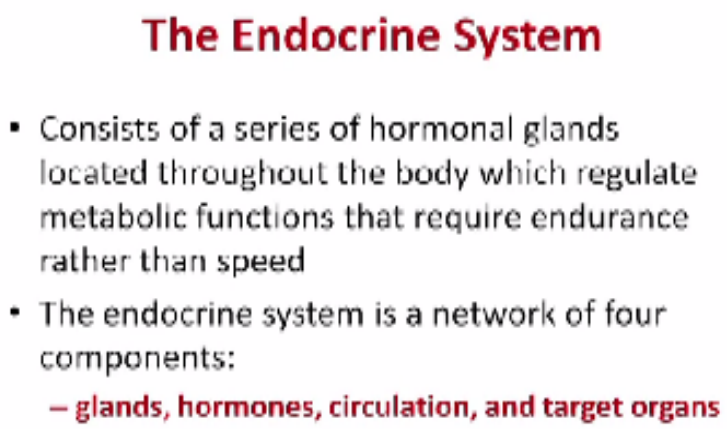

Now what is the Endocrine System? The Endocrine System consists of a series of hormonal glands located throughout the body which regulate the metabolic functions that require endurance rather than speed. So basically the endocrine system is due to long-term stress or chronic stress several long-term changes are brought about in the endocrine system but the endocrine system is also related to the immediate response during a stressful situation.

The endocrine system consists of four components primarily the glands, the hormones, the circulation of these hormones, and the target organs. That is how the hormones affect or reach the specific organs and how do they affect during a situation stressful situation.

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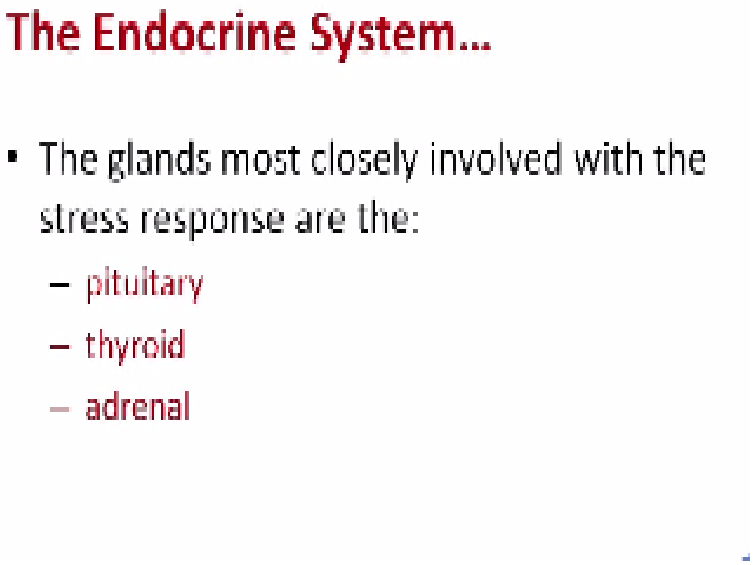

In this situation the major and glands that are involved with stress in the endocrine system are the pituitary gland or the master gland, the thyroid gland and the adrenal gland. The thyroid gland very frequently we come across people suffering from hyperthyroidism due to stress. Now hypothyroid whenever there is a long term say stressful situation chronic stress that is that this regulates the thyroid secretion within an individual, and in this way it may affect the thyroid gland look but today we shall not talk too much about the thyroid gland but focus ourselves more on the pituitary and adrenal gland because today's section.

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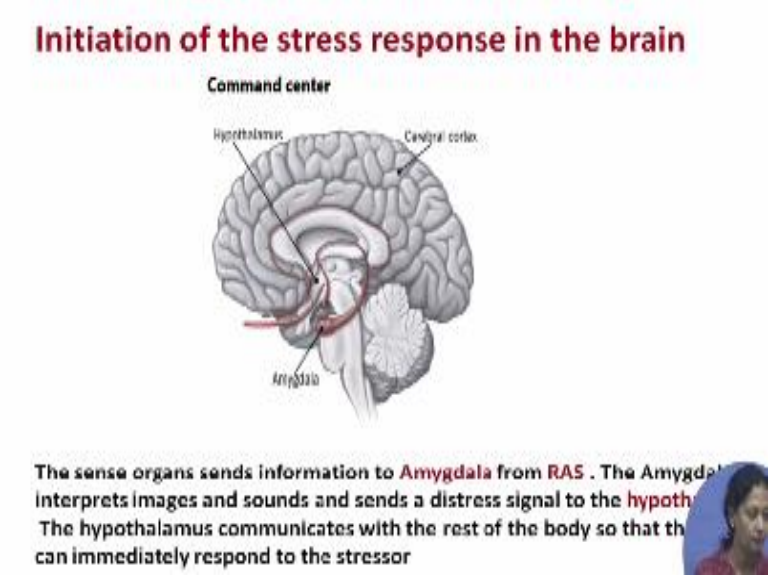

In today's section we are discussing about the HPA axis now when the stress response is initiated in the brain the sense organs sends information to the amygdala from the reticular activating system this part we have already covered in the previous section. The amygdala as we know interprets these images and sounds and see evokes the emotional response and sends a distress signal to the hypothalamus.

The hypothalamus communicates with the rest of the body so, here is the hypothalamus and it communicates with the rest of the body so that the individual can respond immediately to the stressor.

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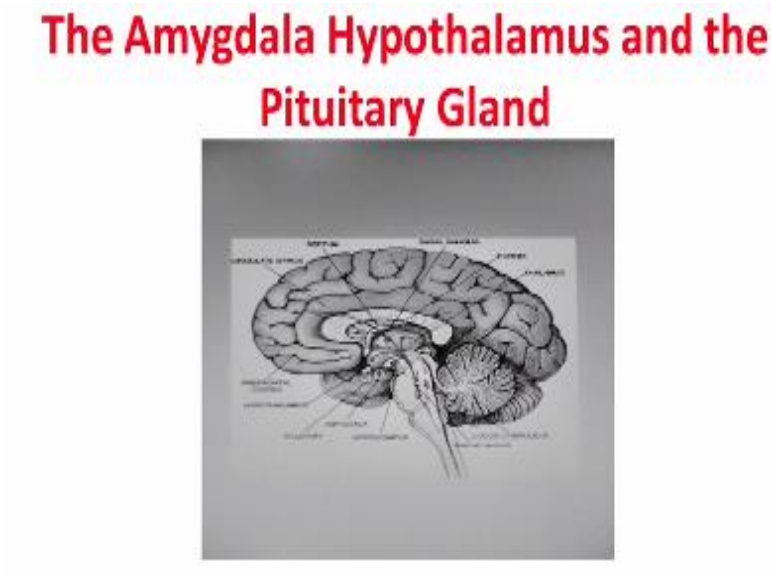

So a little more in details we can actually see the amygdala here the pituitary gland which is located below and the hypothalamus and here we can also see the several limbic structures of the hippocampus the raphe nuclei. These we have the basal ganglia these are primarily of the limbic structures that are also seeing here. Now coming to the hypothalamus.

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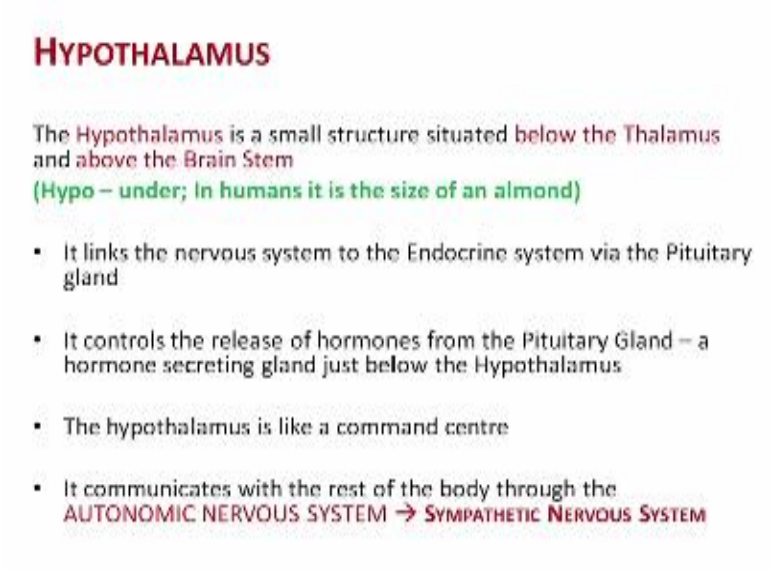

The hypothalamus is a small structure below the thermal thalamus and above the brain stem. We have talked about the brain stem and its structures in the previous section. The brain stem structures are basically related to the physiological arousal of the system and is more involved with the survival of the system hypo stands for under and in the human brain the size of the hypothalamus that lies under or below the thalamus is almost the size of an almond.

The hypothalamus links the nervous system to the endocrine system via the pituitary gland and it controls the release of hormones from the pituitary gland that is the pituitary gland is the hormone secreting glands just below the hypothalamus.

So you can see here that the pituitary gland lies just below this is a hypothalamus and it just lies below the hypothalamus it is such a small structure but it regulates almost most of the hormone secretions within the body and thus it's known as the master gland. The hypothalamus is like a command center it communicates with the rest of the body through the autonomic nervous system and in this case the sympathetic nervous system.

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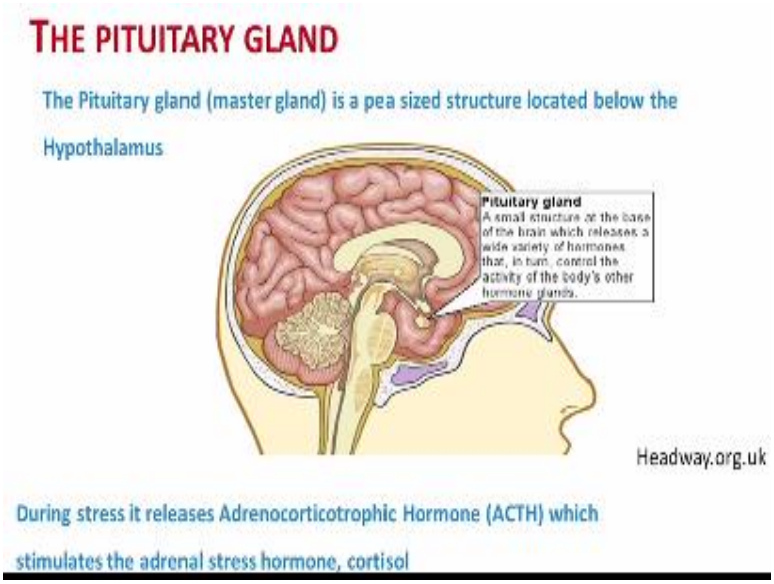

So now coming to the pituitary gland so, the pituitary gland here it is just below the hypothalamus is a SAT pea size structure. It is very small and is located below the hypothalamus. During stress and it actually controls the activity of the body's other hormone clans. We have discussed this and during stress it releases a hormone known as the Adrenocorticotropic Hormone which stimulates the adrenal stress hormone called cortical now coming to the adrenal gland.

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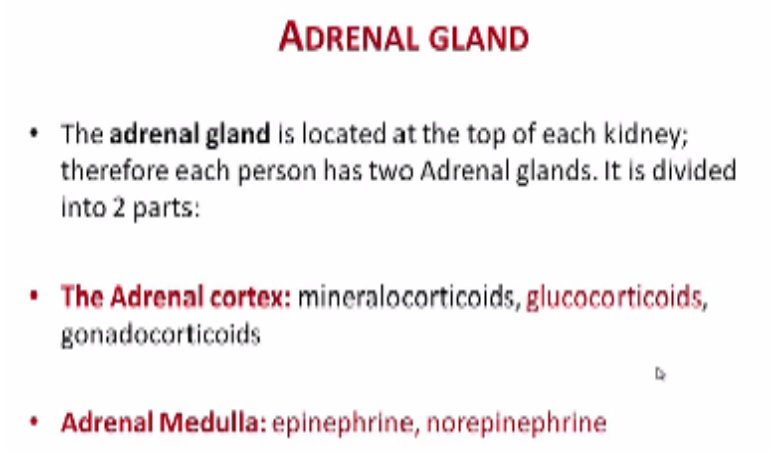

The Adrenal Gland is located far away from the brain so that is its position it is structured on the top of teach kidney so each individual has to adrenal glands and it is divided into two parts that is the adrenal cortex, and the adrenal medulla. The both these parts of the adrenal gland secretes different kinds of hormones the adrenal cortex and secrets mineralocorticoids, glucocorticoids, and ganadocorticoids.

Ganadocorticoids are related to the growth and in this case are more important hormone that is related to stress is the glucocorticoids. The adrenal medulla secrets to primary hormones known as the epinephrine, and the nor epinephrine which we discussed earlier is also known as adrenaline and nor adrenaline as it is secreted from the adrenal gland.

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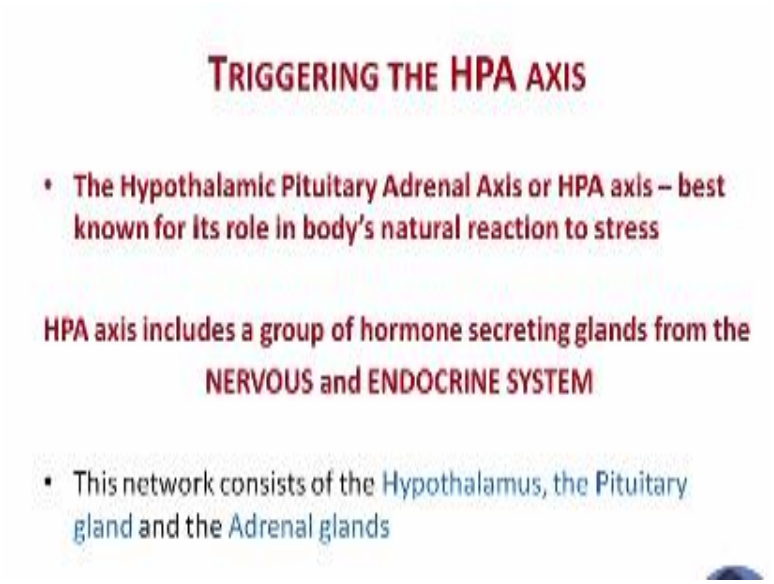

Now coming to the Hypothalamic Pituitary Adrenal axis. This axis is the best known for its role in the mediation of stress within the body. The HPA axis or the Hypothalamic Pituitary Adrenal axis includes a group of hormones, secreting glands, hormone secreting glands from the nervous and endocrine system this we have just seen and this consists of the as the name suggests the Hypothalamus the pituitary gland and the adrenal glands.

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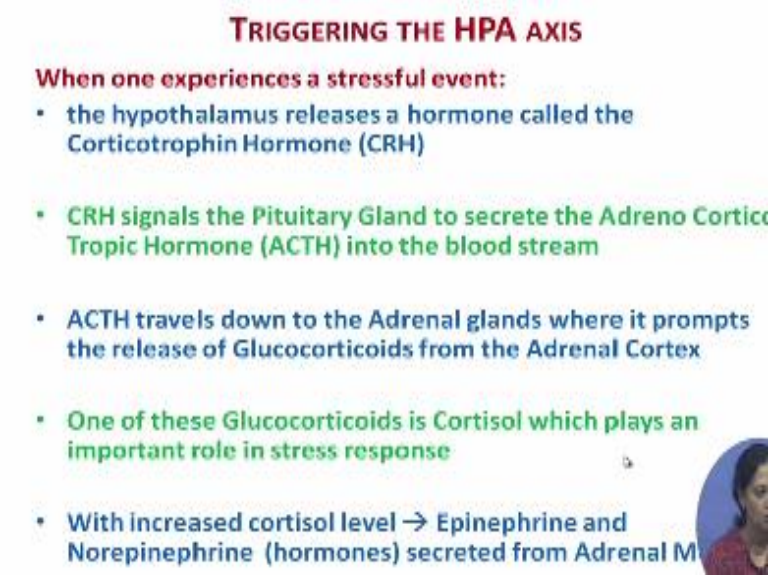

So what happens during a stressful situation? When a stressful event is experienced the hypothalamus releases a hormone called the Corticotrophin Hormone or the CRH. The CRH signals the pituitary gland to secrete the ACTH or the Adreno Cortical of the hormone into the bloodstream. Now when ACTH travels down to the adrenal glands where it prompts the release of glucocorticoids from the adrenal cortex.

So this is one of the three hormones that is secreted by the adrenal cortex and one of these glucocorticoids is Cortisol which plays a very important role in stress response so what happens how is Cortisol related to stress? When the Cortisol level is increased Epinephrine and nor Epinephrine these two hormones are secreted from the Adrenal Medulla. So if we just revised this once more so it starts with the hypothalamus getting at reloading response to releasethe corticotrophin hormone.

The corticotrophin hormone goes to the pituitary gland and releases the ACTH or the Adrenocorticotropic hormone into the bloodstream and the ACTH travels from the pituitary gland is released into the bloodstream and travels to the adrenal glands and triggers the

glucocorticoids and one of the glucocorticoids is cortical which again stirs up the adrenal medulla to release the epinephrine and the nor epinephrine.

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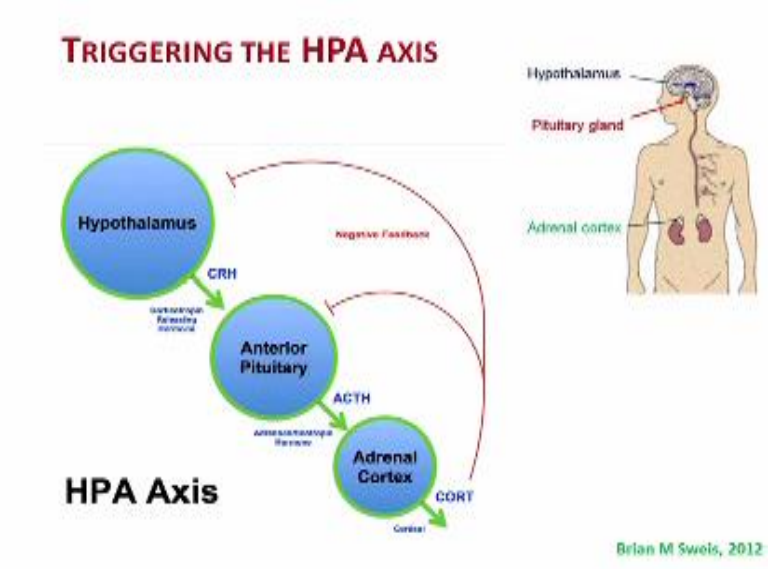

Now the epinephrine and the nor epinephrine are primarily related to the sympathetic activation system and these are released during a stressful situation. So you can see the adrenal cortex and this these are the two adrenal glands situated just on top of the kidneys and so here the HPA hypothalamus secrets the CRH then the ACTH is secreted which travels over here and here adrenal cortex secrets the cortical and here from here epinephrine and nor epinephrine is secreted.

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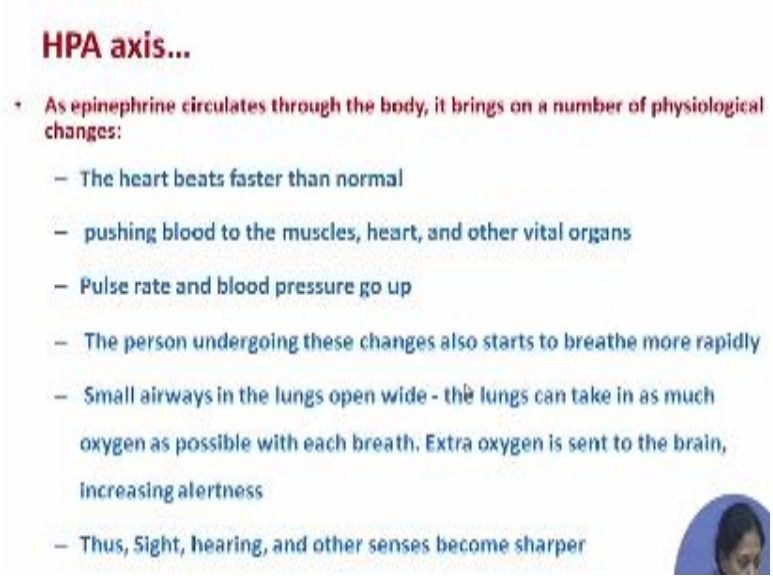

Thereafter this epinephrine circulates throughout the body and brings on a number of physiological changes. So, what are the physiological changes if you just go through them you will realize that we have been talking about these changes in the fight-or-flight response since, the first week so the heart beats faster than normal so there is a pounding of the heart pushing blood to the muscles hearts and other vital organs the pulse rate and the blood pressure goes up the person undergoing these changes also starts to breathe more rapidly and small airways in the lungs open wide.

So these aerials in the lungs they open wide to let more oxygenated oxygen come into with each breath and with extra oxygen in the blood this is oxygenated blood is sent to the brain and it that increases alertness so does the seeing the hearing and other sense organs become more sharper.

So this if you remember when we were talking about the when we were seeing that video about Luke Icans jumping during from the from25,000 feet high above we saw that we were talking about how the sympathetic activation system or during a stress situation the alertness increases. Now you can understand why the alertness increases but again as we studied then that if this

continues for a long time then gradually the muscles will get exhausted and so the sympathetic system has to give way to the parasympathetic nervous system.

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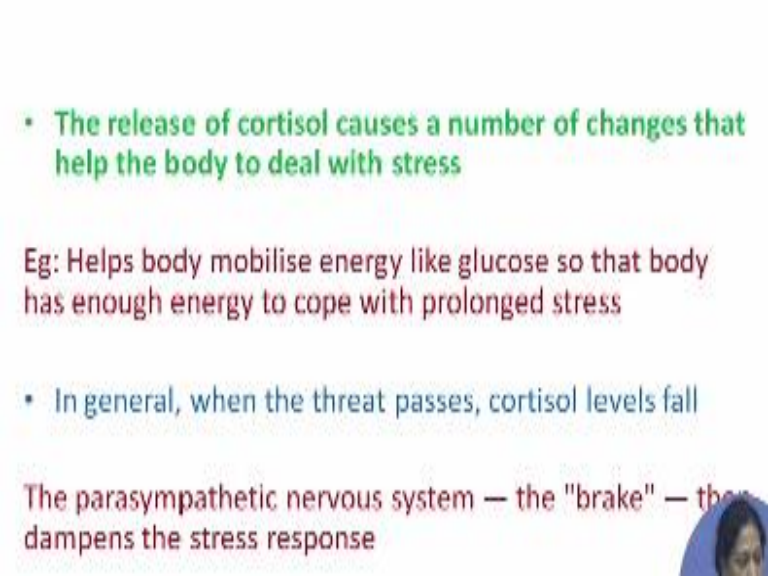

Now coming back to the HPA axis the release of we saw that the adrenal, the glucocorticoids one of the glucocorticoids is cortisol that is released and the release of cortical causes the number of changes at the body to deal with stress so what happens what is all also helps mobilize energy like glucose so that the body has more energy to cope with prolonged stress so in fact it also helps to breakdown the fat metabolism within the body in general when the thread passes the cortisol level falls so expected that when I see a train coming my way while I am standing on the railway track then this immediate threat response triggers the HPA axis into action but as soon as I step away from the railway track the thread passes and the cortical level falls.

So when the cortisol level falls the parasympathetic nervous system or the break in this case dampens the stress response.

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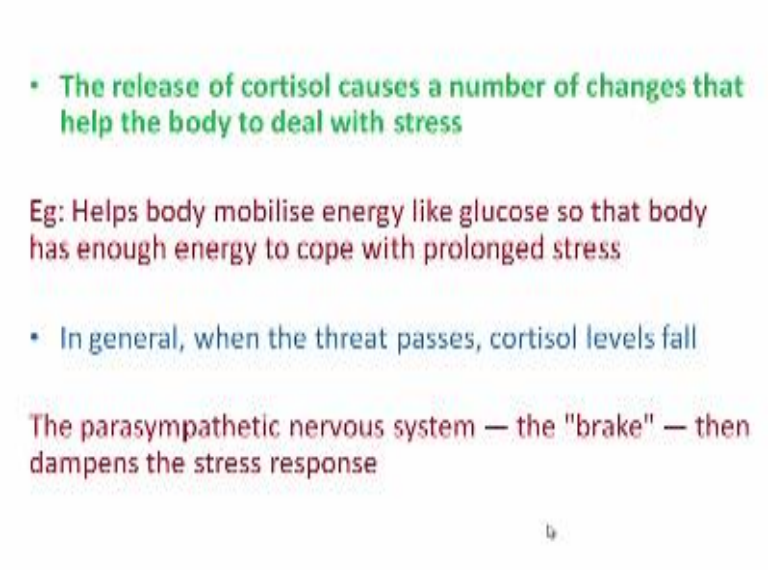

So the parasympathetic nervous system is activated and we know that some of the hormones secreted by the parasympathetic nervous system help maintain the body's homeostasis and the relaxation response.

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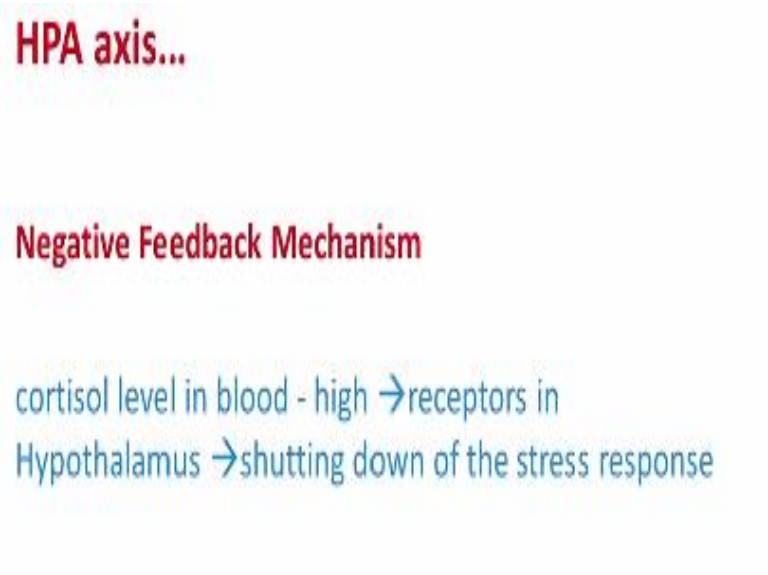

Now what happens when the cortisol level in the blood gets high then it is sensed by the receptors in the brain like hypothalamus, which leads to the shutting down of the stress response and through the negative feedback mechanism. Earlier, I was talking about the human body not being able to be in stress for a long time say if the individual remains if the heart keeps pounding for a long time and if the epinephrine is released. So much that the brain is that the body is activated the all the sense of stress organs that are related activated for a long time then the exhaustion will set in so, to maintain the body homie state says the hypothalamus again shuts down the stress response through a feedback mechanism that works like a loop and the cortisol level is stopped.

So the cortisol secretion is stopped so here is the increase in cortisol level will send a negative feedback to the hypothalamus and also to the anterior to stop the ACTH and the cortisol secretion. Don't you find this interesting that so many things are happening we spoke about the HPA axis and how CRH leads to ACTH and then to the glucocorticoids and the neurotransmitters of epinephrine and nor epinephrine then how do we respond so quickly?

So this brings us to the efficiency of the sympathetic activation system all these changes happen so quickly that most of the times we are not aware of it.

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The amygdala and the hypothalamus work in conjunction that even before the visual centers have had a chance to understand what is happening the body has responded. So that is why before we actually realize how we are responding to a stressful situation the body has responded say like jumping off the road back to the curb when a speeding car crosses by.

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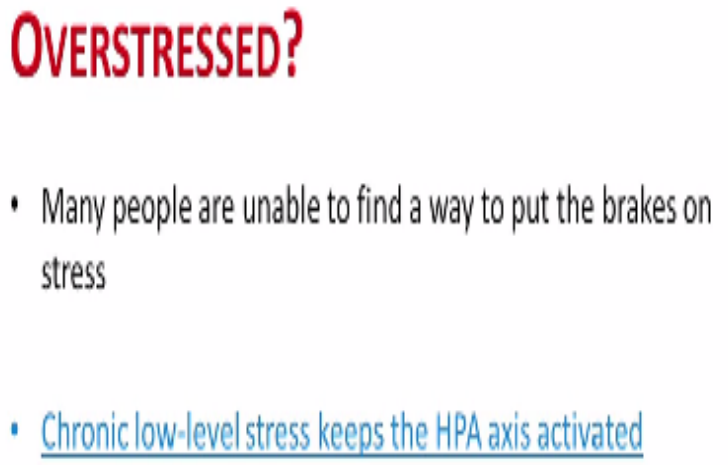

Now what happens when we are overstressed now many people are unable to find a way to put the brakes on stress. So chronic low level stress keeps the HPA axis activated so if there is we spoke earlier about chronic stress being very unhealthy for an individual so what actually happens is that after a while with the presence of chronic stress the body is affected by the stress and it contributes to help problems associated with chronic stress.

So it is like a motor that is idling away for too long so it is on the start and it's idling away for too long now this what we've studied so far is the different structures are the different structures that are related to the hypothalamic-pituitary-adrenal axis and we have seen how the HPA axis works during stress. We know that when there is a disregulation of this whole system we often have stress-related disorders. One of them being the panic disorder or several other disorders like PTSD.

So if we understand this is very important that why we study the stress physiology because when we understand how the HPA axis works and how the brain is related to the stress formation then we will also be able to use the stress management techniques effectively and also ourselves implement new techniques.

So maybe we can try some do-it-yourself DIY techniques ourselves to implement to reduce stress in our daily lives. In the next session we shall talk about stress and illness and the effect of stress on the immune system. Thank you.