Course Summary

Thank you. This course in human physiology has been an exciting journey. I still remember during the first class we spoke about the phenomena of homeostasis. Indeed we are grateful to the great philosopher and scientist called Claude Bernard. He first for the first time he came up with the concept. He said that for life to survive anywhere the constancy of the internal medium is a basic requirement and he called it as the milieu interior.

Essentially however in the year 1926 Sir Walter Cannon a professor at Harvard coined the term homeostasis which is prevalent till today. He essentially says that the physiological systems function to maintain or regulate the condition of internal environment within relatively narrow limits. Now what do you mean by that? We mean we can consider any parameter in the cell outside the cell and we try to look at within the we try to look at the limits within which the parameter must be regulated. For example you can think of sodium ion concentration in the extracellular medium which has to be around 140 milli-acquarants per liter.

Similarly you can think of potassium, calcium, magnesium. You can think of any any of these criteria and you have to be sure that within the extracellular medium they are within a range and within intracellular medium they are within a different range and that they have to be carefully regulated in the respective ranges. We have different organ systems. We can also look at those organ systems as contributing to the maintenance of homeostasis. What do you mean by that? Let's just think of lungs.

Lungs are very important and essential for making sure that the level of oxygen in the blood is always kept constant. Eventually they keep on removing the carbon dioxide and ensuring that the level of carbon dioxide in the blood is constant. You can take the example of another organ. For example gut. We take food and the food is eventually digested and the constituents are taken to the blood that make sure that the components like glucose and amino acids are always constant within the medium.

You can take another example of kidney. The kidney ensures that the ingredients in the blood like urea is always kept under very narrow limits. So all these organ systems on one hand they depend on the constancy of the medium that is provided by different mechanisms and also they contribute to some of those elements which they themselves regulate. So in this way you can think of temperature, blood pressure, osmolality, energy supply. They are all the different.

So how does the body know that a particular parameter has to be within a particular range? We call that mechanism as a set point. It is an abstract concept that tells us as to how if we

take the example of temperature, how the thermo receptor mechanisms in the brain, they consist of several circuits which ensure that if the temperature goes up, the circuits are excited so that the body initiates the mechanism that lower the temperature or the circuits note, the changes in the circuit note that the temperature has fallen, then the mechanisms are set in operation to raise the body temperature. Now this does not mean that there are neurons at a set temperature, set temperature, no. There are circuits which respond to different temperatures and from that the rest of the body calibrates its mechanisms for temperature control. I think then we moved on, if I remember we moved on to understanding as to what the muscles really are.

You know muscles are very interesting organ. They perform a range of mechanical functions. We have skeletal muscles that enable us to move from one place to another. We have cardiac muscles that continuously run the heart and we have smooth muscles which are lining our visceral organs like the elementary canal. The muscles essentially consist of actin myosin filaments and those actin myosin filaments are anchored, the actin myosin, I am sorry, actin filaments are anchored on what you call as Z membrane and you remember we talked about the sarcomere which are lined by the Z disc and anchored on the Z disc are the actin filaments and they alternate with the myosin filaments and they provide a certain geometry in which the actin and myosin filaments can slide into one another and facilitate the contraction of the entire muscle.

We also recorded that the muscles are divided into dark band and the light bands and they are essentially constituted of the actin and myosin filaments. And then there are of course the transverse tubules which take the action potential from the surface whenever the muscle cell is excited because of a neurotransmitter called acetylcholine it can take the action potential, release calcium ions and in the presence of calcium ions the actin myosin filaments they can slide in one another and bring about the contraction. The stimulus that is required for the skeletal muscle essentially comes from the nervous system. It is by way of a motor fiber that has a neuron which is there in the central nervous system either brain or spinal cord. It is a fiber that uses acetylcholine as a neurotransmitter and whenever acetylcholine is released on the muscle fiber the muscle fiber which is equipped with nicotinic fibers is, takes the, it opens the certain what you call as the sodium ion channels and the muscle cell depolarizes that facilitates the influx of calcium ions and that leads to the contraction of the muscles.

We also read something very interesting we recorded, we noted that the things do go wrong and that gives rise to certain diseases and the example was a very interesting autoimmune disease which we called as Myasthenia Gravis in which the antibodies are generated against the receptor for acetylcholine and as a result of that the neurotransmitter does not really go to the muscle and the muscles become extremely weak. Then we switched on to understanding the cardiac muscle. At the histology level we find that the cardiac muscle is very similar to that of the skeletal muscle. Here we have the Z membranes, the light bands and the dark bands but there are some differences, very clear differences. Here in the cardiac muscles show what you call as the gap junctions which permit the ions to travel from one cell to

another cell and thereby the cells can contract in a certain rhythm, in a certain synchrony and then we find that the excitation, the property of the heart muscle is to excite on its own and that happens because there is what you call as conduction system which initiates at the level of the AV node, SA node and that SA node when it initiates the signal that travels over the internodal discs to the AV node and then over the Purkinje fibers to the different parts of the ventricle and as it goes it opens the calcium ion channels in the plasma membrane, the calcium ion channels act on the release the calcium from the endoplasmic reticulum and sudden surge of calcium brings about the sliding of the actin and myosin filaments.

Whenever the heart goes into systole the blood is pumped from the ventricles into the aorta and from the aorta it goes into the rest of the organs, the rest of the organs the blood is returned via the venous system to the right auricle, from the right auricle to the right ventricle and then it is pumped to the lungs for oxygenation. We also had some numbers to quantify the amount of the functioning of the heart, for example we said that the end diastolic volume is about 110 to 120 ml and systolic volume means when the ventricle goes into systole the left ventricle may have still may pump out about 70 ml of blood and 40 to 50 ml of blood may still be there and if you just trace the activity of heart for a minute or so you will find that about 5 to 6 liters of blood is pumped out but that is under resting conditions, under conditions of hyperactivity the cardiac output may indeed go up by 3 or 4 folds. Then another interesting thing that we find is that whereas the blood that is being pumped out of the left ventricle is under very high pressure, the mean pressure may be about 95 to 100 mm hg whereas the blood that is pumped from the right ventricle into which goes towards the pulmonary circuit this blood is kept deliberately kept under much lower pressure that may be about 10 or 15 the mean pressure may be about 10 or 15 mm hg and the differences are obvious because the pulmonary circuit is relatively short, you need to keep the low pressure so as to make sure that there is no leakage of plasma from the capillaries in the lungs whereas in the case of the in the systemic circuit you have to maintain the high pressure because the blood has to go throughout the throughout the body into the distant organs. When it comes to pumping of heart there is something very, the particularly the the nodes are very interesting because they are self excitatory and that happens because the there is a thing called as as the there are some of the channels in the in the nodes which depolarize when the plasma is is is hyper polarized they suddenly discharge the current they the channels open and as a result of that the that the calcium ions go in and this is the in this way the rhythmic phenomena is sustained. The heart also shows a very interesting phenomena what you called as the Frank Starling mechanism it really means it is the ability of the heart to adopt to the changing volume of inflow blood which means that if the inflow of blood in the ventricle is more then the ventricles will contract to the same extent such that the whatever blood has been has has has entered into the left ventricle will be pumped out this is to ensure that there is no stagnation of blood into the heart and this phenomena is called as the Frank Starling mechanism.

Although the heart generates its own rhythm it is secondarily under the control of the autonomous nervous system there are parasympathetic fibers which control which which which can excite the heart increase the rate and force which which the heart can contract on

the other hand the heart is equipped with nerve supply from the parasympathetic nervous system which can reduce the rate of the rate at which the heart keeps on beating or the frequency of the heartbeat. It is very interesting to note that Sir James W. Black came up with the molecule which is called as propranolol which is commonly called as the Brita blocker and which acts which inhibits the with the the adrenergic receptor beta adrenergic receptors and they play a key role in the treatment of the of the angina pectoris and similar diseases. One of the easy ways to record the contractions of the heart is to apply the technique which we called as ECG or electrocardiogram and that electrocardiogram is non-invasive it is very useful every time the heart undertakes the the initiates a signal from the from the SA node the you can get the electrical signals recorded from the periphery and any disturbance in them can be recorded and visually analyzed. The presuming that a 70 kilogram healthy individual has a volume of about 5 liters of blood and total total quantity of blood is 5 liters and with every with every time the heart goes into systole about 5000 ml of blood is pumped out all of that returns some of it goes to the brain coronary circulation kidney gastrointestinal tracts, skeletal muscle and the skin but all these all these parameters are variable depending on the condition or depending on the organ that is under use.

The blood as it flows through the capillaries a small quantity of that also is perfused out that is generally plasma it does not contain large protein molecules and certainly no RBCs and these fluids give rise to the lymph which is drained by the lymphatic system back to the venous system close to the heart as the blood travels to the lymphatic vessels it encounters lymphatic nodes which play a very important role in the immune system. We note that whereas the arteries are relatively thick and they can put up with lot of pressure the veins are relatively far more compliant and they are equipped with valves so as to make sure that the blood does not flow backwards particularly under the influence of gravity. The blood that is in the aorta is pulsating within the range of 80 to 120 mmHg however the blood as it goes towards the capillaries it is the pressure has fallen to about 30 mmHg the blood under capillaries is under very low pressure and then it goes to the heart and from the heart as it goes to the pulmonary it is oscillating between 10 to 25 mmHg. August Krog one of the dions of physiology came up with a very interesting observation he observed that not all capillaries are active at the same time he showed that some of those organs which are particularly active organs and they need more blood during those circumstances there is increased flow of blood through the capillaries however the capillaries by virtue of the smooth muscles right at the origin they can constrict and they can reduce or retard the flow so depending on the organs depending on the activity undertaken by the organ the capillaries can open and close and regulate the blood supply. However it is to be noted that while most of the capillaries in most of the organs the endothelial cells show the opening through which the blood can flow out and the molecules can easily flow particularly the small molecules can easily flow out the capillaries in the case of brain are highly protected by way of astrocyte processes which do not allow the plasma to easily flow out and even the endothelial cells are show what you call as the tight junctions and this phenomena we call as the blood brain barrier this is very necessary to ensure to regulate the transport of material from the blood into the neurons or into the brain.

The regulation the flow of blood through different vessels is tightly regulated by a range of agents some of them are some of them are locally generated and some of them serve as hormones one such very powerful agent is the nitric oxide nitric oxide is a gaseous molecule that is released by the endothelial cells and it can just travel across from the endothelial cells into the smooth muscles of the blood vessel and there it can trigger the mechanisms by which the blood vessel can relax and facilitate the flow of blood. Then there are some hormonal systems about which we studied and one such hormonal system is which is very well studied and which is extremely powerful is angiotensin 2 which comes from the action of a hormone released by kidney called as renin, renin acts on a molecule called angiotensinogen which is released by liver which is eventually converted into angiotensin 2, angiotensin 2 is a small molecule made up of about 8 amino acids and that can act on the blood vessels that stimulates the secretion of aldosterone from the adrenaline gland and it stimulates the third mechanism and all put together it helps to increase the blood pressure it is very effective particularly when there is loss of blood or fall in the blood because of any other reason. The blood pressure is also continuously being monitored the brain continuously monitors the blood pressure by way of what you call as the baroreceptors which are located in the aorta and also in the carotids. If you remember then we moved on to the understanding of the function of the kidney we recorded that the kidney is made up of different of thousands and thousands of neurons and each nephron is made up of the Bowman's capsule that has glomeruli, a proximal convoluted tubule, a descending tubule, lupofenle, the thick ascending tubule, the distal convoluted tubule and eventually it goes into the collecting tubule and the collecting duct and as a result of ultra filtration at the level of Bowman's capsule the ultra filtrate travels down the nephron and it is processed a lot of material that is filtered but useful to the body is being reabsorbed molecules like sodium, molecules like glucose they are all being absorbed at the level of the proximal collecting tubule itself and then the ultra filtrate travels into the distal convoluted at every step it undergoes a change and as it travels the ultra filtrate is being processed and till you get the formation of the final urine. Particularly the distal part of the distal part of the tubule and the distal duct play a key role in making sure that the water content of the urine is very tightly regulated meaning there by that if there is too much excessive consumption of water then the dilute urine will be formed whereas if there is dehydration of the body then the concentrated urine will be formed and the urine can be the osmolarity of urine can be as high as that of 1200 to 1400 milliosmoles this is very high when we compare to that of the blood where the osmolarity of the blood is about 300 milliosmoles.

We also studied about the structure, we studied about the podocytes at the level of the Baumann's capsule, we also learnt about the importance of creatinine if you remember creatinine is a molecule is a that is a breakdown of creatinine phosphate and that creatinine molecule is to be thrown out any accumulation of creatinine in the blood is an indication of malfunctioning of the kidney. One of the very interesting since kidney the functioning of the kidney is essentially based on the blood pressure and it is about 60 mm Hg that the blood is being filtered at the level of Baumann's capsule it is very necessary that the changes in the blood pressure elsewhere in the body do not impact the pressure at which the blood is being filtered at the level of Baumann's capsule therefore the kidney has mechanisms by which the blood pressure is kept constant and we call it as the auto regulatory mechanisms by which

the glomerular filtration rate and the renal flood flow are fairly kept constant although the changes may be effective elsewhere in the body. Another interesting point that we learnt about the kidney is its capability to secrete a very interesting molecule called erythropoietin and in case of in case there is a fall in the oxygen level of the blood then the kidney is capable of generating this hormone which we call as erythropoietin and that erythropoietin can stimulate the formation of blood at the level of the bone marrow and thereby try to increase the capacity of the blood to carry the oxygen to the different tissues. We notice that the osmolarity of the fluids in the kidney although in the kidney it is about 300 milliosmoles we find that as we go deeper into the medulla the osmolarity of the biological fluid goes on increasing this is necessary to make this is essential to ensure that the kidney can generate highly concentrated urine particularly into the circumstances when the body is being dehydrated. And in that respect the hormone that plays a key role is the antidermatic hormone so if you are being dehydrated then the hypothalamus releases this hormone which is released via the posterior pituitary gland and as that hormone comes into the blood it will act on the collecting duct of the pituitary gland of the I am sorry of the kidney and there it will ensure the reabsorption of water so that the kidney can form relatively concentrated low volume urine thereby reducing the loss of water through the urine.

If you remember then we moved on to the anatomy and physiology of the respiratory system we learnt about the lungs we learnt about how the lungs are organized in the thoracic cavity guarded by the diaphragm and how the movement of the diaphragm plays a key role in the inspiration and experience process of inspiration and expiration we saw how the we have the trachea and the bronchi and the bronchi prance and then finally they end up into the alveoli and every time every time the there is negative pressure generated into the thoracic cavity the air flows in via the nose and the trachea and the air flows into the alveoli and in the wall of the alveoli the gaseous exchange happens where the oxygen from the air transfers into the blood and the carbon dioxide from the blood goes into the goes into the alveoli and then we learnt something about the partial pressures we learnt that the partial pressure of oxygen by that partial pressure of oxygen by the time the air reaches into the alveoli is about 100 mm hg then it goes into the oxygen so the partial pressure of oxygen in the blood is also about so much and then we also learnt the importance of the cell type 1 alveoli cell type 1 which lines the alveoli and then we also studied something about the cell type 2 which play an important role in secretion of the surfactants which form a thin lining across the across the across the layer of the watery fluid that lines the alveoli cells this is necessary to reduce the surface tension if you remember if this if the if the if this layer of phospholipids is not there and if the surface tension is not reduced then the alveoli just collapse and then no no gaseous exchange is possible so we need to make sure that the alveoli will remain open and then they facilitate the facilitate the gaseous exchange. We also learnt something about the movement of the diaphragm the diaphragm are being supplied by the phrenic nerve every time the impulse comes from the phrenic nerve which brings impulse from the medulla via the spinal cord to the to the diaphragm the diaphragm expands generates negative pressure in the thoracic cavity that sucks in the air via the nostrils into the lungs and then and and then eventually the expiration starts where the diaphragm again moves upwards it assumes a dome shape that is because of the elasticity of the diaphragm and the air is pumped out of the thoracic cavity the lungs there is a positive pressure on the lungs and the the air is expelled.

The partial pressures the study of partial pressures is very important in understanding how the gaseous of the and try to understand how the gaseous travel we we noted that the at sea level the partial pressure of oxygen is about 160 mmHg by the time the air enters into the alveoli it is 100 mmHg by the time the blood passes from the lungs into the heart there is a there is shunt blood as a result of that the partial pressure is reduced to about 95 or 96 mmHg and then that is the partial pressure with which the with which the blood travels to all the organs and in the muscles as it travels to the muscle as it travels to the muscles through the capillaries the partial pressure in the in the tissue outside is very low it is about may be about about 40 mmHg so the oxygen readily travels from the capillaries into the tissues the tissues take up that oxygen the tissues at the same time have higher concentration of carbon dioxide which may be about 46 or 45 mmHg and then it travels back from the cells into the capillaries which take up the oxygen and then it goes by travels back to the lungs for gaseous exchange then we read something about hemoglobin the wonderful molecule which is made up of four subunits two alpha units and two beta units and it shows the capability of readily combining with oxygen converting into oxyhemoglobin we also noted that hemoglobin molecule is made up of a porphyrin ring at the center lies the iron atom and that iron atom can combine with can can reversibly come combine with the oxygen molecule and whereas 100 grams of blood contains has the capacity of carrying about 20 ml of oxygen if it carries 20 ml of oxygen we can say that it is about 20 ml and it is fully saturated fully oxygenated and as the fully saturated blood from which has picked up maximum oxygen as it travels through the lungs it goes to the different organs and there it gives up about 5 ml of blood so its partial pressure which was about 100 at the level of lungs falls to about 75 and the blood as it goes away from the tissues say muscle or any other tissue that has used oxygen it still has about 75 ml of oxygen and it still has partial pressure it can still exert partial pressure about 40 mm hg so the point here to remember is that even the deoxygenated blood has still a lot of oxygen which is about which can almost say 100 ml of blood is still carrying about 50 ml of oxygen that is very necessary that in case of there is exercise or any vigorous muscular activity then you still have a buffer amount of oxygen which can be which can be used under emergency cases. An interesting property of hemoglobin is that if the if the pH of the blood becomes slightly more alkaline it can bind with more oxygen if it becomes slightly acidic it can its affinity for oxygen is reduced this phenomena was described by Bohr and the phenomena is called as Bohr effect and this plays a key role so this is very interesting because as the blood is travelling through a tissue suddenly there is it encounters lot of carbon dioxide as a result of that carbon dioxide interacts with water in the process of carbonic anhydrase you generate H ions and as the H ions combine with hemoglobin the hemoglobin affinity for oxygen is reduced it readily gives away oxygen which is now available to the tissues and exactly opposite happens by the time the blood travels through the through the lungs where its affinity for carbon dioxide goes down and its affinity for oxygen goes up so that in the lungs hemoglobin can now absorb lot more oxygen so this elasticity which the hemoglobin molecules shows it really it greatly increases the efficiency of oxygen to of hemoglobin to carry oxygen from the lungs to the tissues and back from the tissues to the lungs. But another interesting property of the of hemoglobin is that its affinity for oxygen is reduced when the if the temperature goes up so supposing you do exercise and as a result of that the body temperature literally goes up by 1, 2 or 2.

5 degrees then as because that is because you are doing exercise and your body needs more oxygen in this circumstances you find that as the temperature goes up the affinity for hemoglobin in the tissues in the tissues goes down and therefore the oxygen can more readily release the release the oxygen. Hemoglobin also shows yet another interesting property what you call as cooperativity we have just now seen that hemoglobin has 4 subunits and oxygen combines with the first subunit its affinity increases in the case of second more in the third and more in the fourth and this cooperativity is also plays a great role in inefficiency of oxygen inefficiency that hemoglobin shows in carrying the oxygen. Then we learned something about the smooth muscles we found how the smooth muscles are quite different from the skeletal muscles they are they some of they are again they are several of them show connectivity by way of gap junctions through which the ions can travel and the cells can show a rhythmic activity we found that the cells they do not have Z-memorane as in the case of skeletal muscles but they have what they call as the dense bodies on the dense bodies the actin molecules are anchored and then there are myosin filaments but the sliding of the actin myosin filaments is very much similar and they can they can and we find that they they can they can show a great deal of contraction which is even much more efficient than that of the skeletal muscles. However we found that the cellular mechanisms are somewhat different in the case of skeletal muscle we had troponin here we have calmodulin and we have different steps by which the skeletal muscle can show. Then we moved on to the digestion we studied about disophagus we studied about the stomach we decided we studied about the different cell types in the stomach if you remember we talked about the auxintic cells or the parietal cells which secrete the hydrochloric acid and then we learned something about the parietal cells their capability to secrete the hydrochloric acid as well as intrinsic factors which play key role in the absorption of vitamin B then we also studied about the G cells which secrete about the gastrin and then we elaborated about how the parietal cells secrete the hydrochloric acid into the lumen we studied that and then we studied about the pepsinogen we studied about the how the stomach is coated with a layer of mucus which plays a great role in protecting the stomach from the high acidity in the stomach and then we read about the importance of the gastrin and then we talked about how the duodenum plays a key role in the in by way of bicarbonate ions it neutralizes the acidic chime that is arriving from the stomach and then how the pancreatic juices play a key role in further digesting the food and making it available for the absorption and then we also talked about the hepatic portal system and its role in carrying the digestive food from the from the intestine to the liver and then we had we gave a considerable focus on the liver and its role in sensitizing bile the anatomy of the liver how their plates of the cells which on one hand secrete bile and on another hand it is a conduit for the blood from the portal system and from the arteries and how the blood flows then into the central vein and from the central vein the blood is carried to the heart we talked about the function of bile in the digestion of the food particularly the emulsification of the fat and the absorption of the and in the absorption of the fat and then how the glucose how carbohydrates finally convert into glucose are absorbed galactose is absorbed and how the fatty acids by way of because of the action of the bile we have the formation of the missiles and how the missiles generally help in the absorption of fatty acids across the wall of the intestine.

Then we moved on to study of some very interesting aspect we studied about the hormones we read about how the some of the important interesting endocrine glands we studied about the role of the hypothalamus in controlling the pituitary gland how the pituitary gland is organized into the anterior and the posterior how the anterior endocrine gland is a source for such important hormones like if you remember LH and FSH are the two known as gonadotropins and the third was the TSH which plays a very important role in stimulating the thyroid gland and then yet another very important hormone was ACTH adrenocorticotropic hormone that adrenocorticotropic hormone plays a role in stimulating the adrenal cortex and then we also talked at length about the growth hormone we said that growth hormone comes from the pituitary gland and it has a profound effect on the growth of a large number of tissues and also it is a great anabolic hormone it promotes the growth of bones growth of muscles and growth of a large number of and then we also studied as to the that there are some instances where growth hormone has a direct effect but growth hormone also has an effect indirectly via the why the insulin like growth factor then we also read about the different hormones how they have a different half lives whereas amines have a half life of few seconds thyroid hormone has a we talked about T3 and T4 and we also talked about polypeptides also talked about polypeptides and then protein hormones and how the steroid hormones have a relatively a very long then we talked about how some of the hormones whereas most of the peptide hormones do not need a carrier in them but some of the hormones like thyroid hormones has a carrier which is a huge protein molecule which is called as thyroxine binding globulin and how the half life of the hormone is being influenced by this binding affinity we saw how the T4 how the T3 and T4 are being synthesized at the level of thyroid we saw how the thyroid is made up of the thyroid follicles thyroid follicles is made up of single layer of cells it secretes what you call as a colloid and colloid is a store which is actually essentially made up of amino acids which is a polymer of tyrosine amino acids but then tyrosine is is iodinated and if if a molecule of tyrosine receives and tyrosine is eventually convert what you call as monoiodo tyrosine, diido tyrosine and then eventually into thyronine which is which we call as a three iodide items we have called is at T3 or triiodo thyronine or tetriiodo thyrothene which is same as thyroxine and these hormones when excited by the by the TSH which is coming from the pitory thyroid will release T4 and T3 and T4 can can circulate bound to thyroxine binding globulin mostly T3 is on its own it does not it does not bind but eventually T3 will find its way into the tissues and it will act T4 will also be released eventually in small proportions it will also go but before T4 acts it is invariably found to convert lose one of the iodine convert the T4 is converted into T3 and then it will act on its receptor and we also we also understood the profound importance of T3 and T4 in in what they call as the metabolic it is a main metabolic hormone if they in the in the absence of T3 and T4 the rate at which the metabolism is being undertaken almost falls to falls to more than more than more than half so it is it is a very important metabolic hormone. We also saw that the thyroid is a source for yet another hormone which we call if you remember there is another another hormone which we call as calcitonin which is secreted by the parapollucular cells of the thyroid and plays a key role in reducing the calcium in the blood level. What are the factors that control the release of thyroid hormone? Thyroid hormone is controlled by the itself is under the control of the pitory hormone TSH, TSH itself is under the control of what you call as TRH, TRH is a small tripeptide hormone that is synthesized by certain neurons of the hypothalamus this tripeptide is delivered from the hypothalamus via the median eminence to the pituitary gland and in the anterior pituitary

gland it acts on the in the TSH cells they excite the TSH cells the TSH cells release the TSH hormone and the TSH hormone then acts on the thyroid gland and in return the thyroid gland releases the hormone T3 and T4 and it is these it is these hormones which have negative feedback effect at the level of the pituitary and also at the level of hypothalamus. So in this way the T3 and T4 regulate their own secretion by way of negative feedback effect at the level of pituitary as well as the hypothalamus. In the case of thyroid if you remember we also learnt about this interesting disease in which is called as a goiter thyroid goiter which is again an autoimmune which is again an autoimmune disease.

Then we spent quite some time on this very interesting gland which we call as the adrenal gland which is a source for the steroid hormones it has some very interesting steroid hormones like the aldosterone we said that the thyroid gland is divided into the three components the the zona glomerulosa the zona fasciculata and the reticularis the outermost zone zona glomerulosa is particularly plays a key role in the in the in the in the synthesis and release of a hormone called as aldosterone. If you remember we talked about aldosterone being under the control of angiotensin 2 so so whenever there is fall either in the volume of the blood or in the there is reduction in the sodium ion concentration in the blood then there is angiotensin 2 comes into the play and then angiotensin 2 has a profound effect in stimulating the cells of the zona glomerulosa the outermost layer of the adrenal cortex and those cells of the adrenal cortex release a hormone which we which we said just now the aldosterone and then aldosterone goes back to the kidney and it acts on the principle cells of the kidney and then it plays a key role in the reabsorption of the sodium ions. So so for the for the homeostasis of sodium ions and sodium ions are so important for the functioning of the brain and the neurons they play a very very sodium ion concentration very important and therefore they need to be the the amount of sodium ion sodium ion concentration has to be very tightly regulated and aldosterone plays a plays a plays a key role. If you remember if you if the if the concentration of sodium ions in the blood goes up then we have we have another hormone that comes into play we talked about that also and that hormone was called as ANP or atrial nitriuretic nitriuretic peptide. Then we spoke about the the inner two layers of the adrenal cortex the cortisol the you know the the zona fasciculata and the zona reticularis these are known to secrete mainly the hormones which fall into categories what you call as glucocorticoids and other was androgen like hormones.

The glucocorticoids one of the most important glucocorticoids that you get in the humans is the cortisol it plays a key role in the carbohydrate metabolism it acts on the liver it plays a key role in the gluconeogenesis that is generation of glucose from the non-carbohydrate source. Yet another very key function of cortisol is in stress whenever there is stress cortisol is released and it it suppresses the immune system it suppresses the it suppresses the immune response and thereby it plays a role in what you call as a it it accomplishes its function as an anti-inflammatory agent. Interesting to note here is that there are lot of synthetic steroids which are which are commercially used or which are clinically used to treat inflammation. Yet another interesting aspect of this hormone was that it it it suppresses it suppresses the immune system and particularly in the cases where they where you need to where you need to undertake organ transplant and where you need to ensure that there is no organ rejection

the agent similar to cortisol or glucocorticoids they are they are used as as immuno immuno immunosuppressants. I think then we also spoke about the importance of testosterone which is a hormone which is produced by the leading cells of the testes it is responsible for the generation of the male maleness or the male character it is a great anabolic hormone and it is circulated in very high concentrations particularly at at on the arrival of the pitari however its concentration falls with the with the advance of the advance of the age.

I think these are these were some of the topics that we covered in our course on human physiology and there were there are some additional topics I hope you have enjoyed the course we have attempted to touch upon the molecular mechanisms on one hand and also try to correlate them with the way the different processes coordinate with one another and finally the how they can give rise to or express certain behaviors depending on the challenges that are being expressed that are being experienced by by by by our systems or by our physiology. Thank you very much.