Human Physiology
Prof. Nishikant Subedar
IISER-Pune

Lecture – 56
Hormones of adrenal cortex - Part : 1

So remember, we are currently focused on finding out something about endocrine glands and then we did spend some time on finding out about the thyroid and the hormones of the thyroid and we learned that the thyroid has one of the most important functions it performs is the metabolic function and without the involvement of the thyroid perhaps our the rate of metabolism will almost fall to 50% what it normally should be just so important. We will now move on to yet another equally interesting gland endocrine gland which we call as the adrenal cortex. What do you call it as? It is a very interesting gland just focus on this you will the it has such a profound impact on an on a large number of things the adrenal cortex. So let us let us try to find out about what this adrenal cortex is and it is located as the name indicates it is located just above the just above the I am sure you have seen this when you did the rat. So what are we looking at you can see the pair of kidneys there and just sitting on like a cap there are two kidneys sitting like a cap on the kidneys you have what you call as the adrenal glands it is covered with rich fat tissue is there and in that you have the two adrenal glands.

Each gland is about very small about 4 grams 4 grams what is 4 grams so it is very small but it has a very profound effect as we shall soon find out. So to find out what gland is like histologically just find out so I take a section as usual take a section through the adrenal gland and then I find that it is made up of so this is the section through that and at the center I immediately identify the medulla. What is it? It is large neurons and I know that it is source for hormone what hormones? Adrenal medulla is a source for what hormones? Apinephrine and norepinephrine. Okay and these are what hormones these are derived from the tyrosine derived hormones remember we had categories three categories you know there was one some of the hormones which belong to tyrosine derived others were peptides and still others were what? Very good very good what were they? Steroid hormones okay so what we are talking about is where as the adrenal medulla here right in the central is grayish patch it indicates neurons what are they? Neurons what are they? Neurons and they do they synthesize and release what hormone? Tyrosine derived hormone namely what and what? Apinephrine and norepinephrine and they go directly into the blood and then we have seen that they do the function of we have already seen that okay.

The adrenal cortex is very different the adrenal cortex is very different a different in a sense that it secretes the hormones which belong to the steroid category it is a very complex gland the inside is medulla which is apinephrine and norepinephrine and outside is what cortex which is consisting of which is consisting of cells which secret hormones more than one hormones and in terms of chemistry what are they? Steroids. They are they are they are they are a steroids hormones and structurally the animal the adrenal cortex is divided into three

layers one two three let us ignore the inner one medulla so outer one is called as zona glomerulosa what do you call it as zona glomerulosa let us talk more about it glomerulosa fasciculata and reticulata these are the three zones the outer zone the middle zone and inner zone I am not talking about the medulla I am just talking about the cortex is divided into three layers one layer second layer and third layer if you go deep into the core you will get medulla I am not going to talk about it okay so zona glomerulosa zona fasciculata and zona reticularis will by and by we will acquaint ourselves with these names and their respective functions and this is histological again just take the section put through the microscope and you find the outermost thin layer extremely thin layer of cells which is called as zona glomerulosa zona fasciculata the cells are arranged more or less more or less strands of cells series of cells one cell two cells two there is strands of cells and they are radially arranged means what from the like the spokes on the wheel of a bicycle there are arranged so and then the innermost part is zona reticularis and if I go down there somewhere I will get medulla but which I am not going to talk about and then this is a very interesting land because if you normalize it per gram you see the highest amount of blood that is flowing anywhere is in the adrenal cortex huge amount of blood okay very highly very highly vascularized adrenal cortex and also medulla is one of the most highly highly highly okay okay. Now listen to this the steroidal hormones by steroidal chemistry this is a steroid steroid chemistry steroidal hormones depending on the type of function they perform okay we classify classify them so like biology everywhere we first classify and then when we by the time we have understood the classification we go for the exceptions you will find that is what happens in biology all the time it is irritating sometimes but it is true okay we have to deal with it okay. So first I will tell you some of the rules okay which try to govern the functions of the adrenal cortex okay what are they what are they some of the steroids steroid hormones they perform the function of releasing glucose from the liver what did I say releasing glucose from the liver and this this function is called as glucocorticoid function and those hormones those steroid hormones which do it are called as glucocorticoids what did I say glucocorticoids what is the glucocorticoid it is one of the steroid hormones what does it do it has a profound function in the regulation of carbohydrate what does it do with reference to liver it brings about the release of glucose from the from the liver glucocorticoid okay got it one harm the second the second category of hormones which is released by the adrenal cortex are called as mineralocorticoids what do you call them as and as you guessed correctly I am sure you have guessed that it has a profound function profound role in the regulation of sodium and potassium in the blood and in the everywhere in the body sodium potassium okay so therefore mineralocorticoid are you okay so far the third category of hormones which is released by the adrenal cortex the third category is called as androgens amazing androgens male sex hormone male sex hormone now this is interesting do you mean to say that adrenal cortex in a woman or in a female is also releasing a male sex hormone the answer is yes answer is what yes yes in the males testis is a prominent hormone for male sex hormones which is testosterone which is very strong very powerful hormone these hormones which are released by the adrenal cortex male sex hormones they are not that strongly active the testosterone activity is minimal but it's there okay so you can just imagine and I in under normal conditions it doesn't matter much but in a case of female if there is a tumor in those cells which secrete male steroid hormones okay she could have excess of androgens okay which could have consequences so what is the does it mean that so please remember one basic fact do the males have testosterone yes do they have the female hormones of course

yes okay do the females have female hormones like estrogen and progesterone yes do they have testosterone of course yes okay so all all the genders have all the hormones it's only just a question of proportion it's just a question of what proportion it's just the question okay now that having been said now I'll drop your attention to the zona glomerulosa so again we are looking at the adrenal cortex here author has drawn for us the medulla cells the large cells and here the three layers zona glomerulosa fasciculata reticularis the outermost layer is known to secrete a mineralocorticoid hormone fortunately very familiar with it and the name of the hormone is what is it aldosterone so fill in the blank aldosterone is secreted by da da da da cells which gland cortex in the adult context which layer zona glomerulosa is very clear zona glomerulosa okay the second layer which we call as zona fasciculata the second layer which has all those strand like cells okay it secretes a large number of glucocorticoids again I'll step back this secretes aldosterone and aldosterone happens to be okay aldosterone step back again aldosterone is secreted by what zona glomerulosa aldosterone is the the the most important mineralocorticoid in our body why did I say the three times very important why because so tell me the name of the most important mineralocorticoid in your body and where is it secreted from zona excellent so far clear remember you can't you can't this is to be remembered okay the most important glucocorticoid in a human I am using word human okay because there are variations occurrence across mammals focus on humans the most important glucocorticoid in humans is called as again cortisol and it comes from which layer of the adrenal cortex zona fasciculata now zona fasciculata secretes many hormones okay different glucocorticoids but I am going to talk about the most important that is cortisol okay and then the inner layer which is called zona glute or zona reticularis okay is the layer which secretes a lot of androgen like hormones okay the male male sex steroids whether you are a male or female okay the zona zona reticularis will secrete several male steroid hormones one of them is DHEA dehydroepi androsteron okay now you know something if you take simply adrenal cortex of rat okay and make an extract and then do whatever chromatography is available there okay you'll find that it contains about 30 40 different kinds of steroids how many I don't know maybe 30 40 50 whatever different are those all those steroids hormones no no no no no they are not hormones there are several of them are intermediary metabolites or intermediary steroids means what means what is a steroid is it being released by the adrenal gland no does it go into circulation no does it have any receptor no then what does it do well it is there it is then soon converted to another steroid into another steroid and into another steroid and that steroid is a hormone so the number of actual hormones that are being released by the adrenal cortex is not more than 5 6 and out of those 5 6 we are only going to focus on to make your life very simple we are going to focus on what to and what are the two hormones I am going to focus on I told you just now one is what aldosterone which we have already done and the second I am going to talk about is what but that should not give you it should not you should not go home with a wrong impression that that's the end of it no no no no there are other steroid hormones for example for example there is another steroid hormone called as corticosteron what did I say say that again corticosteron corticosteron whereas in humans and in mice cortisol is very important glucocorticoid cortisol but even rat it is a corticosteron and not cortisol well both the hormones are there whether you are a human or a rat or a mouse both the hormones are there okay but for we humans and mice which is the most important glucocorticoid cortisol but if you are rat then which is the most important glucocorticoid for you corticosteron okay have I given you a broad idea as to the world in which we have to navigate now all right all right all right now the story begins with

well the well our adrenal cortis can steroid can synthesize right from very small molecules we can steroid we can synthesize cholesterol but it's a very minor part most important part is we eat a lot of cholesterol eat a lot of cholesterol that cholesterol is taken along with the lymphatic system lymphatic system okay absorb lymphatic system finally those molecules they find their way into the liver okay and the liver keeps on secreting what you call as as low density lipoproteins what is it it's a huge mixture of several proteins and several facts huge complex several molecules put together into compartments where is it is there in the blood now please remember the it is abbreviated as LDL what does LDL stand for yeah and homostatically it is it is it is important as to how much LDL you have and what kind of facts are there okay if they mess around then it is an indication that you have problem with the deposition of certain facts in your coronaries okay but I am not going to talk about it so these are coming from the liver and these are taken by the they are in the blood they are in the blood and as they flow along you keep in the cells of the adrenal cortex there are receptors there are protein molecules which can selectively absorb the LDL means what in these cells of the adrenal cortex in the plasma membrane there are protein systems which we call as receptors which will selectively pick up LDL from the blood take it inside and from there you take they'll take cholesterol and that no cholesterol is the source for all the steroid hormones so what have we done we have tried to understand as to what is the molecule the parent molecule okay which is which has to be there in all steroids since the steroid hormone synthesizing cells what is the parent molecule cholesterol say that again cholesterol so whether actually we are talking about the adrenal cortex or other steroid hormone secreting glands like testis in the case of male and ovaries in the case of female what is the parent molecule start with cholesterol and where does it come from liver in the form of what LDL okay and this is taken in by okay and now so this is a so there are four rings six membered six membered six membered how many membered five membered and this is called as a steroid nucleus what do you call it as seroid nucleus and a steroid nucleus to identify as to the position of every carbon we label it as number one number two number three number four five six seven eight nine and the cholesterol has about how one how many so in a cholesterol molecule how many carbon atoms are there say that loudly 27 27 now please remember for as a student of at least nodding acquaintance in the chemistry some of the positions are very important I'll particularly ask you to remember number three position okay a little change here and there you remove H and put double bond O and some other steroid happens and then you do and then some other and then it's properly change okay and then it becomes other steroids etc so please remember remember a position three remember position 18 remember position 20 just three four positions it will be it will be it will it will make your life simple okay now we begin with the at the level of cholesterol is cholesterol a hormone no cholesterol is not a harm no out of question cholesterol is not harm so we start begin with the level of cholesterol it is taken in the in the in the in the cell and in the cell we have in the in the cells of the cortex in the cortex each layer will have different sets of its own enzymes and what the cells will do is first thing that it does is it cleaves the okay so there are there are there are four things there are you okay and then then it is I'll call them as the side chain okay that side side chain is cut and it is it is cut away by an enzyme which is called as site the phenomena is called as side chain cleavage cleavage is cutting away side chain cleavage and if you cut away the slightly and you how many how many carbon atoms were there originally there say that again when you cut away about 21 carbon atoms remain there and then you play with that steroid molecule and one of the so you have the cholesterol and it

gives rise to this molecule in which you have the OH group here and C double bond here CH3 there and this about C21 and this molecule will call as what? Pregnanolone what do you call it as say that again you have to remember this Pregnanolone what do you call it as Pregnanolone now in all steroid hormone secreting cells by that again I by that again what do I mean cortex and then ovaries and testes this is going to happen here you begin with cholesterol okay you you remove the side chain side chain cleavage and then you will have you have Pregnanolone and then Pregnanolone molecule is then processed into the adrenal cortex by into into this adrenal cortex to give rise to one steroid hormone which we call as what? Aldosterone why Aldosterone let us look into the logic it's very simple at the 18th position I will draw your attention to to to to to to what is there? CHO hello do you find do you see CHO there at the 18th position therefore it makes sense to call it as what aldehyde aldosterone therefore aldosterone okay are you okay there I tell you why it is aldosterone this is this is aldo aldehyde and this double bond O here aldosterone ketone are you with me the the basic logic which is there is always there in the chemistry okay labeling of a molecule that logic that logic is very much applied here and there you have aldosterone and then here you have the cortisol that cortisol indicates OH group here OL cortisol here and then of course there are there are testosterone and study and we will talk about about when we talk about D. Go next.