

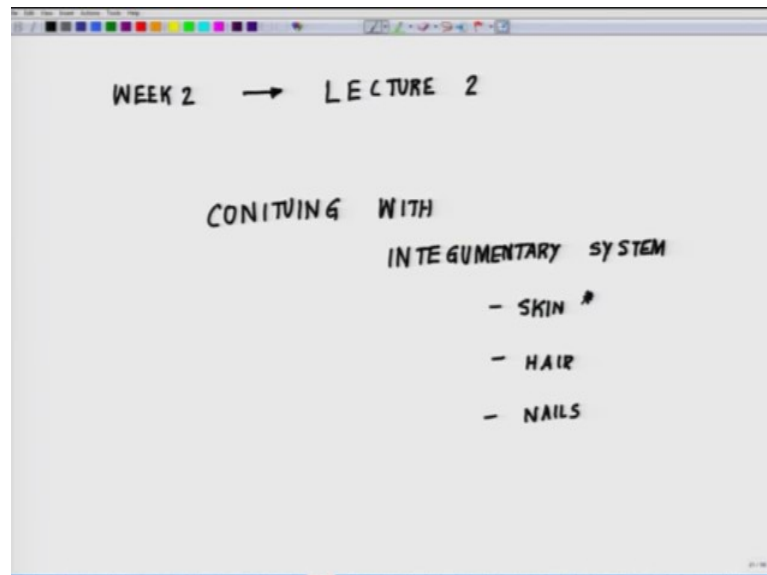
Animal Physiology
Prof. Mainak Das
Department of Biological Sciences & Bioengineering & Design Programme
Indian Institute of Technology, Kanpur

Lecture - 07
Integumentary System – II

Welcome back to the 2nd lecture of the 2nd week. So, in the last class, we started with integumentary system and I highlighted the fact that this is one system or one organ system which all of us irrespective of our general, irrespective of our regionalism, irrespective of which part of the world we all use it every day, we comb our hair, we ensure our nails are been cut properly, we do manicure, we do pedicure, we take care of our skin. So, yesterday when I finished the first class of the 2nd week, I gave you the cross section of the skin if you remember just to have a small recollection what we talked.

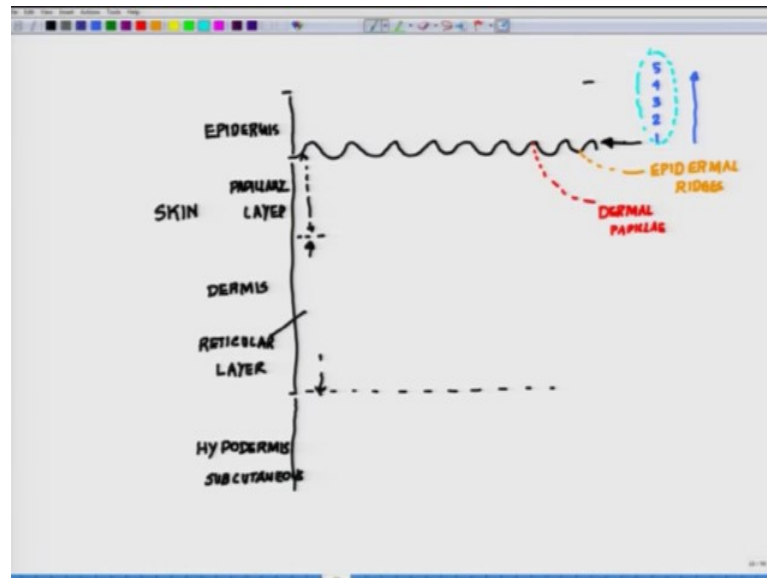
So, we talked about the two major layers, right. The epidermis and the dermis layer and underneath the dermis layer is something called a hyper dermis layer. So, let us put it instead of going back to, so let us put it here. So, this is lecture 2 of week 2.

(Refer Slide Time: 01:21)



So, we will be continuing with integumentary system that is where we are just to have a recap integumentary system and today we will be talking more or less about the skin. Of course, we will talk little bit about the hair later on and we will talk about the nails.

(Refer Slide Time: 02:20)



So, today our trust here the skin: so in the previous class about the skin cyclo architecture, we talked about two different layers. There is this epidermis layer, then underneath is you remember the structure there was convoluted, convolution and undulations out here and followed by the dermis layer and underneath the dermis layer, where you are having the lot of blood vessels and fat tissue and anything we call it the hypodermis layer if you remembered in the hypodermis or subcutaneous layer.

So, I give you an example that if you have to give subcutaneous injection than the syringe has to come all the way down and within the dermis layer, there were two parts. One is called the papillary layer and the lower half is called the reticular layer. I think in yesterday or the previous class, I forgot to mention the name reticular layer. Just cross check it in case I missed out, and then add this reticular layer.

So, this is the overall architecture how you can remember it. Now, within the epidermis we have seen one is the top part, this is the exposed part of the epidermis and the other part which is underneath as you could see the undulation which you see is the underneath part; so this whole epidermis what you see out here. So, there are parts of the body. Now, think of it. What is the difference from this side and this side? The first difference what we talked in the last class is the color. This side is much more brighter, this side is much more darker. Apart from it there is something more. This side has no hair and this side has hair, right. Did it strike you? They are all skin, right. So, it is basically skin which is

containing how come certain parts does not have any hair and the other part as hair, why some of us are dark skins, why does other ones are as fair as this or even more fairer than that. What it means?

Now, today we will talk about this layer called epidermis. So, epidermis is more or less of five layer structure, five cellular layer and they have different names, but before I come to this layer of this five different layers, let me give you some basic understanding, our framework on which you can develop your knowledge. So, if there are five layers, so layer 1, layer 2, layer 3, layer 4 and layer 5 and if you noticed the 5th layer as is we will draw if you see here it is the layer which is the lowermost layer where I put the arrow, right. You see this one this is the lowermost layer.

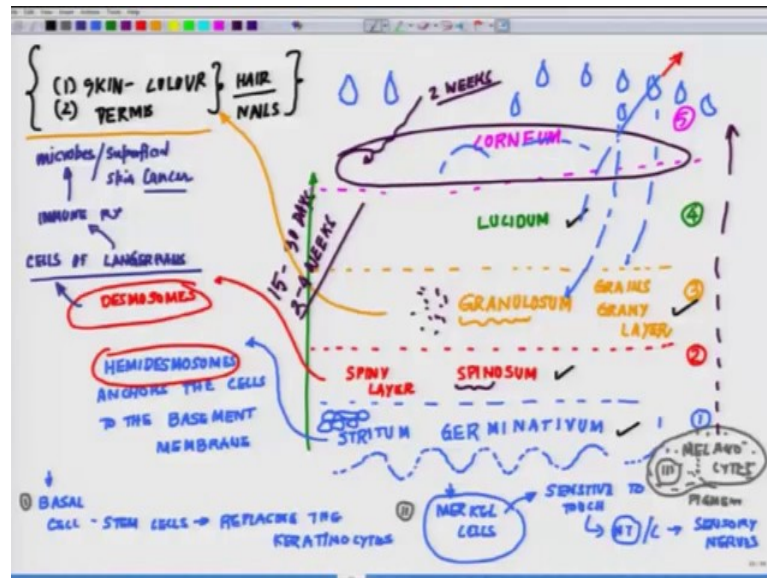
Now, let us add up bit of our knowledge. This is layer one from the bottom. So, I am going up like this, layer 2, layer 3, layer 4 and the uppermost and expose layer is called the layer 5 and the way we will be studying at is from the lowermost layer, the layer which is bordering the dermis where you have epidermal ridges. You remember we talked about the epidermal ridges and dermal papillae yesterday, previous class. So, those epidermal ridges and here you see the dermal papillae. The reason why we will be starting from the bottom up approach, the reason is, there is the moment of cell which takes place from the lowermost layer all the way to up and all the replacement what you see on the top, whatever over a period of time you know these cells you know skin spills out and it gets replaced by or that is a injury everything gets replaces.

So, it happens because in the lowermost layer of the epidermis, you have a set of something what we call has skin stem cells, epidermal stem cells which are present there. These stem cells continuously divide and ensure that the uppermost layer is does its function and it is removed from the body and the lower layer takes up because of this from lower to upper movement of the cells.

So, we will discuss this topic from bottom to up. There is one more thing. Whenever we talk about that something is moving from say bottom to up and likewise and this brings us of an interesting thing what is the rate of movement. It means this whole process is a time dependent phenomena, right because there has to be this much, it will move this much, it will move likewise.

So, we will talk about that time it is generally you know 3-4 weeks time. It takes in the go up and the uppermost layer what you see the expose layer. It remains therefore around 2 weeks before it gets replaced by the lowermost layer. So, with this background I will now name those 1 2 3 4 5 what you see out here or what I have. So, in the next slide what we will do we, will name all these layers what they stand for.

(Refer Slide Time: 08:57)



So, lowermost layer: so if we call it 1, so that lowermost layer stand for striatum and that will be column, that will be common striatum. So, this spelling be very careful germinativum. This is first layer and underneath you see this kind of epidermal ridges and dermal papillae and it is attached. This is also called the basement membrane. It is attached to the basement membrane. We will come to that layer. So, if this is 1, let us use another colour to indicate layer 2 that is striatum. It will remain common striatum spinosum, ok. Whenever we talk spinosum, it means spinous structure.

Next, third layer which is called granulosum. Whenever we use this word granul, it means there are some kinds of granules which are present there. This is how we can remember spin; you know some kind of spin structure. This is the third layer. Next let us move on to the 4th layer. It is called striatum lucidum. And 5th and the final layer which is the top most layer which is called corneum.

Now, what we will do? Now, we will discuss each one of this layer in detail which is essential for (Refer Time: 10:57). So, the lowermost layer which forms the epidermal

ridges, I have already mentioned to you and it increases the surface area by forming those ridges and the cells out here. All the cells which are present here, they anchor to each other by hook like projections which is called hemidesmosomes. Hemidesmosomes anchors the cells to the basement membrane.

Now, this layer has different cell types, the different cell types which are present. There one is called basal cells. These basal cells are nothing, but those cells what we call as a stem cells and these helps in replacing the keratino sides which are the skin cells. The second cell type in this layer is called Merkel cells. This is very important. These Merkel cells are the cells which are present. If you ever forget Merkel cells are present in this layer in this flip layer of these kinds of skins over does that signify. It is not present here that signifies the Merkel cells are the once which are present in those skin surfaces, where there is no hair, ok.

So, this is how you have to remember. The Merkel cells are those specialized cells which are present their and these Merkel cells are very sensitive to touch and they secrete chemicals or I can call this new transmitters or chemical like stuff which stimulate the sensory nerves. So, this Merkel cells are very interesting kind of cells epithelial as well as neuronal origin. The third cell type I will use a different colour here purposefully. So, I talked about the basal cell 1, I talked about the Merkel cell 2.

Now, let me talk about the third cell type of this layer which gives the brown tones of the skin. In other word, the pigment cell or melanocytes, it is these melanocytes which give all that dark coloration what is there in the skin or these are the pigment cells. For the time being, this is what you have to understand about striatum germinativum.

Now, next we will go to spinosum which is the spinus layer or spiny layer which I have already mentioned. Spiny layer and this layer these cells just like here, they are attached to hemidesmosomes here. These are attached to each other by spiny structure called desmosomes and these cells contain unique cell type which is called cells of Langerhans, and this will come later the digestive system. We will talk about these Langerhans cells are the one which leads to immune reaction against the microbes and prevent the skin from superficial skin cancer.

These Langerhans cells are very interesting. We will talk about eyelet of Langerhans in the pancreas. We will talk later about this, but these Langerhans cells are present from

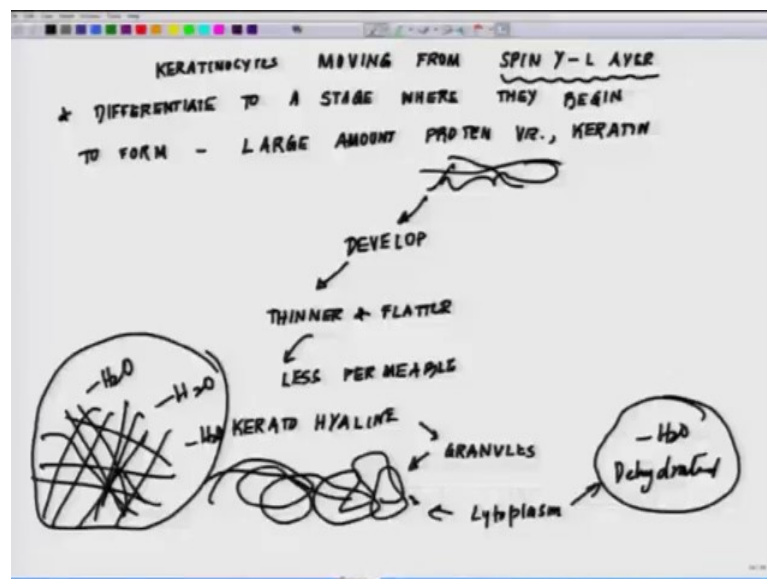
the lower side. The second layer that is striatum spinosum surface and they act as immune cells of the skin. So, this is what offers. If you remember the last class, we talked about it offered protection from micros and all those things and I told you will talk individually how they offer this protection. This is how they offer this kind of a protections next layer which is called the granulosum layer.

As the name indicates, it has lot of granules in its grainy layer. You can call it like grains of a photograph. It is a grain or grany layer. Now, this grany layer is very interesting. So, keratino cytes from the spines layer let me go to the next slide talking about. So, keratino cytes moving from the spiny layer and differentiate stage, where they begin to form large amount of protein keratin. So, what is happening is that from the spiny layer, this keratino cytes.

So, I told you from the lowermost layer, the keratino cytes or epidermal origin cells, they are moving. So, once they move to the next layer which is the spines layer, from there they attain a stage of differentiation when their concentration of keratin molecules which is a protein keeps on increasing and that is where they started to getting all those pigmentations.

So, let me put it down for you guys and then, you will understand, ok.

(Refer Slide Time: 17:55)

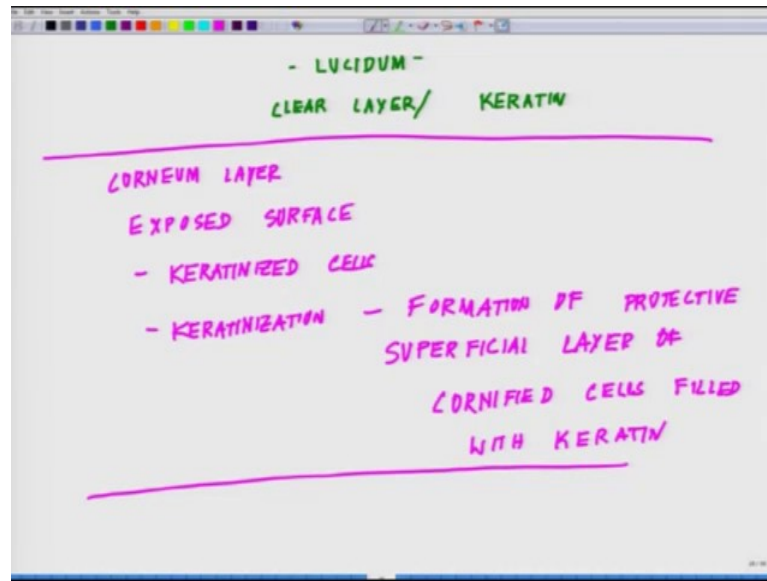


In the granulosum layer, keratinocytes moving from the spinous layer and differentiate to a stage where this is very interesting as let me just finish this writing for your understanding. As they begin to form large amount of protein which is called keratin and as keratin fibres develop, and as they keep on developing inside the cell, the cells become thinner and flatter and there is a modification which takes place and these cells become less permeable to water.

Now, these cells then convert into this, keratin convert into keratohyalin and keratohyalin form dense granular structure keratohyalin granules. Now, you see from where this layer got its name and as it becomes dense, the cytoplasm of these cells because of the presence of this keratohyalin cytoplasm gets dehydrated. So, they get completely dehydrated and there are lot of cross linking of keratohyalin fibres takes place and eventually what happened is, these cells in this layer form a huge mesh work like this which does not allow water to you know percolate down. It kind of creates a barrier.

So, granulos are layer what you see is a layer. So, if you remember in the previous class, we talked about that the skin prevents the water to really penetrate very easily and likewise. So, this is how it does. There is this layer keratinocyte or granular layer where it form very dark coating all over the place. So, now what we will do, we will move on. Once again we will move on to the next layer which is the lucidum layer. So, we are done with this layer, this layer and this layer. Now, we are moving on to the lucidum layer.

(Refer Slide Time: 21:33)



So, the lucidum layer is pretty much of upper layer and this layer is a very clear layer, almost transparent. I am saying not transparent and cells are only filled with keratin and here now I will give you an bit of an idea that days it takes for the cells to move from here to all the way up is around 15 to 30 days and this layer as well moving to the next layer which is the corneum layer. Here mostly there are lot of dead cells and these cells lost for two weeks. So, if this is 2 to 4 weeks which is 15 to 30 days the top, it last for 15 to around 30 days and the movement is like this and that is why I am coming from the bottom, ok.

So, now this is the lucidum layer followed by the uppermost layer which is the corneum layer. This is the final exposed surface contains a lot of keratinized cells or cells which are rich in keratin protein. Keratinized cells and keratinization is a process for those well of definition. Keratinisation is a process of a formation of protective superficial layer of cornified cells which are filled with keratin. So, this is the top most layer what we are talking about.

So, overall if you look at it with let me just again go back to the first picture which i did. So, overall if you look at it from the bottom all the way to the top, there is something very unique. If these are the water molecules outside, it creates a lot of abstraction for the water to get in, but then you observe something very interesting. If you dip your hand and your leg in water for a while, you see the skin becomes slightly more like you know

it looks like as if they are much more glowing and you know become much more clean and much more slightly inflated.

That happens because the movement of water is a function of what kind of water where you are putting your skin. If you put it in a fresh water, then there will be movement of the water from here all the way to the inside some degree of movement will take place which will kind of an enlarged cells, where as if you are in a sea water conditions, then sea water being very rich or very high concentration of sodium chloride which is hypertonic solution.

The fresh water from the body will move in the reverse direction. So, the direction here will be just the opposite and what will you observe is, your body will get dehydrated. Eventually that is why suppose somebody there is a shipwreck or somebody is in kind of you know swimming in the ocean, this is always a problem because your body continuously get dehydrated, because water moves from inside to outside because seawater is very high concentration of salt and it pulls the fresh water from your body outside because this is one of the major problems, where is on the contrary if you are in a freshwater and then, part of the water gets into your system, of course that you know enlarges the outer layer little bit, ok.

So, keep these things in mind and as we have already talked about, they are layers which prevent microbe infestation. They are layer which prevents water to kind of you know restrict the movement of water like you know I want let say they do not prefer the water molecules really do you know move through, but like kind of they prevent that it should not be that your body or the cells get inflated just because you are in water. So, there are always restrictions in the movement of the water molecules.

So, overall what we see is, skin is a very dynamic structure underneath this layer. So, what we will be dealing in the next class, we will talk about that dermal layer where we have lot of blood vessels enriching the blood vessels along with adipocyte tissues and everything and how these regulates different activities, but even at the top five layers, there are very interesting features to deal with.

Next, what we will do after this once we have with this part, we will be dealing with two interesting topic. One will be the skin colour and the second one will be the function of the dermis and some of the functions out here and then, of course we will talk about the

cyto architecture of the hair and the nails. So, these are the tail pieces which are left of the integumentary system that will be dealing in the next class, ok.

Thank you.