

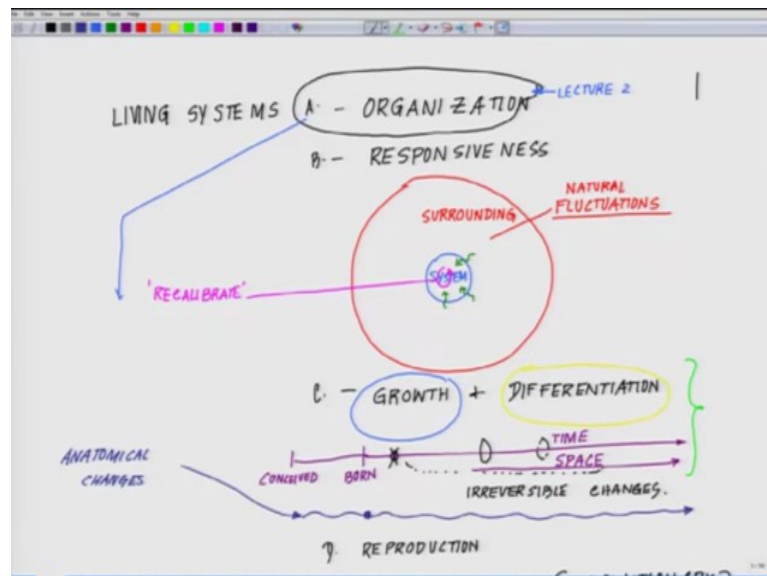
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**Lecture – 02**  
**Organization of Living System**

Welcome back to the second lecture in Physiology. So, in the first lecture we talked about the basic characteristics water living sustain should have, or the foundations what has been laid out during last 200 years how we define a living system. So, there we talked about they should have some basic criteria which includes organization, they should be able to grow and differentiate. They should have some movement feature they should be responsive to the external stimulus, it should be able to reproduce and above all there are irreversible changes which happen in the system.

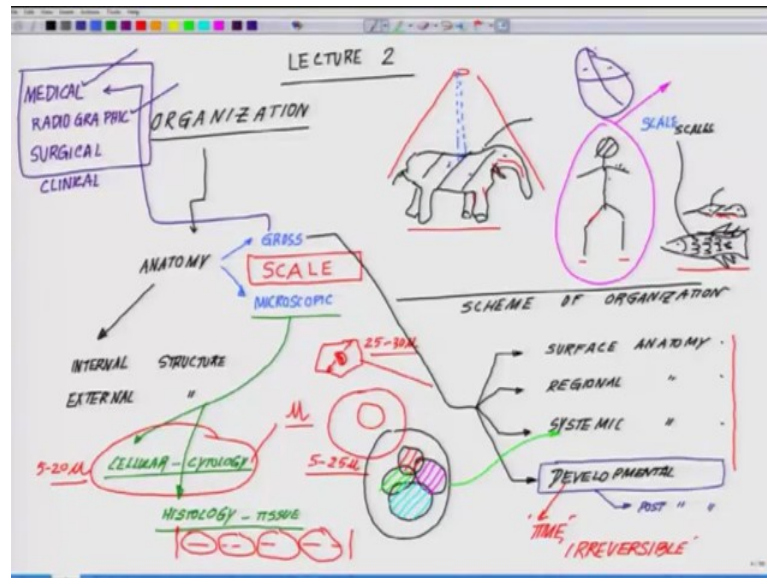
So, what today we will do we will start from those words and define the different terms anatomy and physiology.

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So, whenever we talk about, if you remember we talked about this word and I told you to highlight this word the organization. So, we will start from here we will be starting our lecture two essentially from here from this particular word. Let us move on to the new slide.

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So, today we are into lecture two; lecture two I told you remember that word called organization.

Now, whenever we took talk about organization. So, think of it. So, if you look at an elephant it kind of gives you a something, if you look about a human being something like this or we talk about a small rat or mouse something with something like this or we talk about a fish it will be like this. So, if you look at these different organizational setups you see different kind of structures. So, all living things have different scheme of organization. So, what we use the word is see for example, these are the different schemes what have been followed by living systems, scheme of organization.

And based on this scheme of organization they have different anatomical aspects or in other word their external structure. So, if I have to put it straight across it will be like this organization is nothing but is telling their anatomy and anatomy could be at two level their internal structure and their external structure; we will come to that internal structure and external structure. So, if we talk about the external structure you can already see this this has a different kind of external structure different kind of external structure, but inside this there are different kind of internal joints internal features which is making this to walk with four legs in the case of human beings two legs whereas, this does not have any leg it swims whereas, these have four legs arranged in a different way.

The external features external shape determines its internal structure, and again at what level you are studying it. If you are looking at it this is called the gross anatomy. So, anatomy itself could be classified into different classes, it could be either gross anatomy or it could have if you bring down narrow down your zone of looking we started looking at the very cellular level at the cells which are making it, then we call it a microscopic anatomy. So, gross anatomy could be at different levels. So, what are the different levels of gross anatomy? Gross anatomy could be classified or at least could be studied at four different levels.

First level is the surface anatomy, surface anatomy where you studied the surface features see for example, in case of human we are having hairy bodies in the case of fishes we have scales in the case of elephants they are a different kind of a small hair like structure similarly in the case of rats, they have a fur like structure in the case of dog depending on which race which species we are talking about they have different kinds of fur structures. So, that is the surface anatomy followed regional anatomy regional anatomy means different aspects say for example, your digestive system of a human being as compared to a horse or as compared to cow or a fish; if you do a comparative physiology of these things these fall under the regional physiology of that particular part that particular system.

Next come systemic physiology systemic anatomy sorry systemic anatomy and then comes developmental anatomy. So, we talked about surface anatomy and we talked about the regional anatomy and we talked the systemic anatomy, where you see the whole system as the whole a different system. Say for example, here you have the cardiovascular system, nervous system, respiratory system, excretory systems. So, these different systems how they are placed along with the other one and how they interact with each other, what are the different levels of their interaction that is what we studied under the systemic anatomy.

Next come is the developmental anatomy or the developmental changes. So, if I take you back to the previous slide there in the last class we talked about the growth and differentiation. So, I told you over a period of time as a living system grows from conceiving it in a mother's womb, then taking birth, and then going and become aged. So, in that process there are several changes several anatomical changes which are taking place, and these anatomical changes are and these anatomical changes started in the

mother's womb starting from development of the body structure, development of the different organs. And then the systems followed by their cross tog, and then making a whole system and then with age how they are changing. So, these are all falls under developmental anatomy, the changes during the developmental phase.

And this also includes post developmental changes, which includes the changes which happens post development like you know once you are born. So, developmental changes followed by post developmental anatomy. So, as we grow old as we are ageing there are changes happening in the anatomical feature at the cellular level at the bone level those are post developmental anatomical changes which are taking place, sometime they are very very important from the perspective of studying the pathology studying the development of disease or how our ageing system changes with time, and what are the necessary precautions which you take to ensure the safety and integrity, and proper functioning of the system. So, that falls under the post developmental anatomy. So, these are the broad gross anatomy classification.

The next comes the microscopic classification anatomy there we talk about at different level. The first level is the cellular anatomy, when you are studying anatomy from the cellular prospective that includes different kind of cells within your body you have nervous cells they have a different structure, you have a liver cell which have a different structure, you have heart cell which is a different structure, you have a kidney cell which is a different structure you have reproductive organ cells which have different cells. So, you can study the anatomical feature from the very smallest functional unit which we call as cell.

So, cellular anatomy which is the microscopic level and then next level is histological; where you take a section of a whole tissue so, cellular or cytology pertaining to cell histology pertaining to tissue. So, what you do see for example, you want to study the tissue of the heart. So, you take a section small what we mean by section is see for example, all of you have seen cheese or say for example, the kind of you know removing a wrapper of you take a Cadbury or any kind of chocolates. So, you remove the wrapper it is almost like the thin wrapper, you are removing from something and you take that wrapper under the microscope and you study the anatomy. Those anatomical studies falls under histology, histological studies and they are one of the very powerful tools to give you knowledge about the next level of organization from cellular to the tissue level of

organization, how in the organ these cells are arranged together what are the channels of their cross talk between individual cells. And how they interact with the environment you get an idea about it before you move into the next level will be this systemic anatomy which is at the gross level.

So, if you see you can study the system depending on. So, what is important to understand the one critical word and that critical word is this one scale at what scale you are studying the system. If you are studying the system at the cellular level at the level of the cell then you are studying the system at micron level. So, cytology is we are talking about micron because average size of a biological cell if it is an r d c we talk about or so anything it varies from 5 to 25 micron.

A neuronal cell body say for example, a neuron we talk about which will be around 25 to 30 micron a standard one there are one switch have differences which are much more larger or smaller. So, at the level of cellular level we talk about anything between I would say 5 to 20 micron scale.

Next come histology where you have studying lot of cells in one spectrum. So, here individual dimensions will still remain 5 to 20 micron, but you are getting a much more larger area to study. So, we move into the millimetre level something like you see the section in front of you know, 1000 microns sections in front of you. So, you increase the scale slightly higher then comes gross anatomy where you physically have to take a scale in centimetre or meter where you are studying these systems.

So, it is all about scale and when you talk about development it is all about time with respect to time. So, when we talk about scale we talk about space, what level in a space what is the smallest unit in space you are measuring and when we talk about the changes in that space we talk about time. So, in other words the real time anatomy is the study of time and space of a system, at what dimension of the space you are measuring and at what time you are measuring, because all these system if you remember my previous lecture I mentioned it very clearly these are all changing in an irreversible manner.

In other words these are all following something called non equilibrium thermo dynamics where a system is changing permanently, you cannot go back to its original point because from original point it has deviated there are changes which are happening into it and those changes are permanent. You cannot really reverse the clock to go back that ten

years back this is the situation I wanted to go back, that will never going to happen it will be a reversible system which initially organized itself and then it is started increasing it is complexities over a period of time, it develop it differentiate post differentiate and eventually a point come and it integrate itself at an optimal energy level and then a point comes where it disintegrates what we call as death.

And during this whole process anatomy of the system changes at different level whether it is at a cellular level, whether it is even if you go down, whether it is a molecular level whether it is at the cellular level whether it is at gross level in other word which is at the level of surface regional or systemic level there always changes happening.

So, next what we will do. So, by the way this gross anatomy is used by the doctors for another set of classification which is missed out let me put it together again. Where they use the medical anatomy is basically they the doctors initially look at the gross anatomy then there is something called a radio graphic anatomy, those goes through all sorts of radio graphic tests and then there is called surgical anatomy. All these three things have clinical relevance in terms of the clinical setting, because the doctor who has to treat you or has to give you say some gamma radiation some other radiation or something to remove say cancerous lump or a mass they have to know the exact location within the body where they are putting the radiation so that falls under radio graphic anatomy.

Medical anatomy is that how you are defining which part which tissue which angel and the three dimensional space say for example, just you will appreciate it. Say for example: this is how the heart looks like with four chamber hearts. So, now, say for example, there is a problem somewhere here or somewhere here. Now, this structure is three dimensions something like this.

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It is a three dimensional structure: now something is somewhere inside. So, with reference to a scale you have to know in three dimensions where the problem is then only you can target the problem. So, those things falls under the medical anatomy where you should have a three dimensional map of a structure of anatomical structure, you know exactly you should be able to pinpoint say for example, I have to give a radiation somewhere in this say for example, this is a mammary tissue or some other tissue where there are cancerous growth.

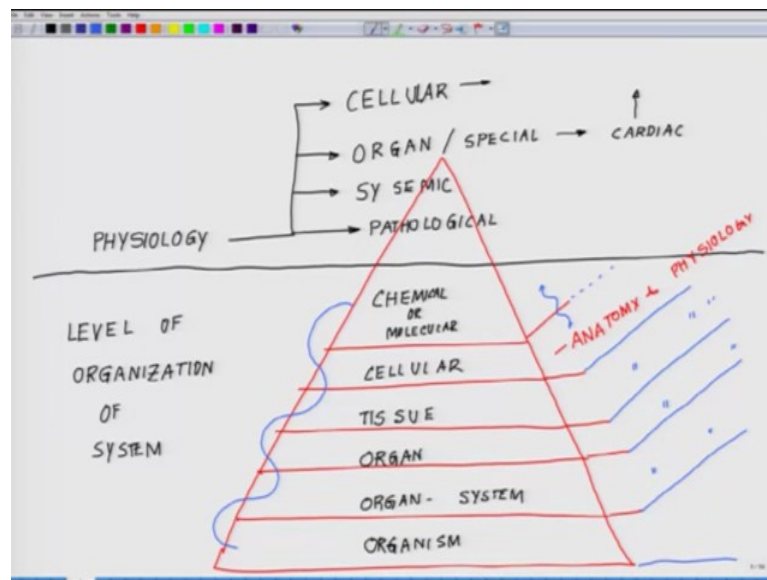
So, I should be know, and I suppose this is my radiation emitting probe. So, I should be able to know exactly where the radiation is reaching. If I move up and down or sidewise I am going to damage a whole lot of thing I may be able to lose track of my exact target and the patient may die because I am unable to locate pinpoint exactly where the tumor is where the cancerous cells are. So, this all falls under the radio graphic or surgical as a matter of fact even in in surgery.

Suppose I am doing a laser based surgery I wanted to you know wipe out that particular part. So, unless I know in a three dimensional structure, where I have to really point the laser I would not be able to do it. So, you realize that understanding anatomy is very very critical from multiple walk of life. Those who are interested in physiology has to understand anatomy back and forth without that starting from clinical applications to

other changes you would not be able to figure out. So, these are some of the clinical classifications of anatomy.

Now, we talk about a system as of now we have talked about a wonderful system like you know this whole system, now this system has certain governing dynamics or certain rules of functioning. So, before we get into those rules of functioning what we will do is we will do a bit of a classification of physiology as a unit. So, what are the levels of physiology we can study? So, we talked about anatomy.

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Now, we will talk about physiology and it is level physiology. So, you can study physiology at the cellular level we talked about cellular anatomy now we are talking about cellular physiology, you can study physiology at the level of organ like you know organ level physiology then we can study at the systemic level physiology or we can at the pathological level.

So, these are different level where you can study at cellular level, systemic level or at pathological frontier and when you talk the organ level this is also sometime we use the word called special physiology. Where you talk about say for example, I want to study the cardiac physiology. So, I am exclusively studying this. So, when we talk about the cellular say for example, within cardiac physiology I wanted to specifically study the cellular nature of say cardiac myocytes or ventricular myocytes. We will come to that do not worry about these words or within the kidney I wanted to study the cellular structure



of a nephron. So, that falls under cellular physiology or a systemic physiology where you are seeing the interaction of different systems or pathological physiology this is one way you can classify it.

So, then what you can do what are the level of organizations. If you remember we talked about the organizational level. So, let us draw the organizational chart level of organization. So, the level of organization could be organization of system could be at multiple level, the first level what we talk about is chemical or molecular level which is the top of the parameter chemical or molecular level of organization. Next is cellular level of organization at the level of the cell you can study a cellular physiology third higher organization is the tissue level of the organization where you talk about the histology. Fourth is the organ level of organization where the different tissues form an organ. Next is when different organs interact with each other organ system physiology and final one is the organism level of physiology and if you draw the pyramid it will be something like this, this is how the pyramid will look like.

So, now at what level you are studying it determines what kind of information you are going to get. You can study at these different level you can study the anatomy and physiology, you can go even further deeper a interaction where the current trend is study at this level some are at the cross road the chemical and the molecular and the cellular level next level comes if you are studying the physiology at the tissue level anatomy and physiology. Third at the organismic or at the organ level, fourth one is the interactive level organ system level and the final one is the organism level the whole system you are studying in one go.

So, whatever level you study you have to realize that you have to correlate it back in that pyramid from the chemical to the molecular aspect all the way to organism. So, this is how the system works. Now, there are certain governing rules. So, there are different level of control systems which are happening at different level at all these different level and those are called different feedback mechanisms. So, what we will do now and the next class we will discuss two aspect, one how a system respond what are the basic thumb rule for a system to respond; and once it responds how it react to it. In other word it has a responsive element and then it has a reactive element and we will come to that what are different feedback loop systems which are functioning which include a negative feedback and a positive feedback.

After that what we will do was a study about the reference say for example, what I meant by reference is say for example, I have to study a human body. So, what will be my scale reference how I am going to study it will I study say for example, you look me from the front there are certain features you see in my body you look me from the side you get certain feature you see me from the back you get certain feature. So, all the organs say for example, this is one organ.

Now, depending on which angle you are looking at it you are looking from that side my view also looking from that side I am looking from back say for example, I keep it like this. For you see it is a there is nothing alright if I show you the back it is like this, there is a huge hole out here. So, from which angle you are studying it are you studying it like this, are you studying it like this, are you studying it like this, are you studying it from my angle like this.

So, these brings us to different planes sagittal plane coronal plane and we will talk about that how you are studying the system in other word that brings us to the basic fundamental of what is the scale you are following, how you are determining the scale and where you are positioning your reference point, what is your reference point of looking at this system, are you looking at this angle, are you looking at this angle are you know dissecting the system like this or you are dissecting the system like this.

So, we will talk about next two things we will talk about the feedback controls of our system and then we will talk about the different sectional geometry by which you can study a system, and that will pretty much brings us the point that we can initiate to a study any of the organ systems.

Thank you.