

Animal Physiology
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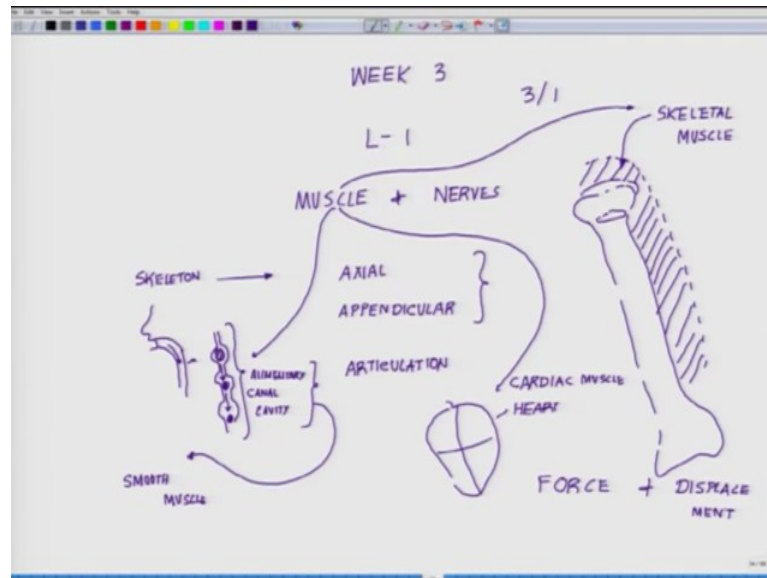
Lecture - 11
Introduction of Muscle

Good morning, and welcome back to the lecture series in Animal Physiology. So, we have finished two weeks, the very first 2 weeks and in the last week, we talked about the introduction of the course where we talked about the different level of organization from the molecular level to cellular level to the tissue level and in the very next week, we went on to study two systems; the integumentary system and the osseous tissue or the bones, bone and the cartilage or rather other way it is the cartilage and the bone because formation of bone is from the cartilage. So in that whole process, now we are well versed with the framework on which the shape of our body is being determined which is the bony framework.

Now, from here we will move on to the next level which is the muscle which is covering the bone. So, we talked about the surface, the skin, epidermis, dermis, and then we went on to the bones where we talked about the dermal bone if you remember it, right. Now, we will be talking about the muscle and the nerves. So, next 15 classes, precisely next 3 weeks, we will be devoting on the nervous system and part of the muscular system. So, we would talk about the muscular system.

There is one small tail piece of the skeletal system which I did not cover last week was our skeletal bones. So, our whole skeleton is from bones, right. So, these bones, they were finite number approximately 206 bones are there and depending on their position and certain other functionalities, they are divided into two categories is called axial system, axial skeleton and appendicular skeleton, fine.

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What are the two axial and the appendicular let me just. So, we are into week 3 lectures 13 slash 1 and we will be talking about muscle and nerves and before I talk about the muscle residual of the skeletal, what I was telling you is axial appendicular system and there is another word which comes which is called articulations. So, these two axial and appendicular and these two are the broadest of classification of the bones which are present in our body. The reason why I skipped it while teaching about the development of the bone is because there is another system which is one to one correlation of the appendicular and axial system. That is called axial muscles and appendicular muscles.

So, what I will do? So, do not think that I have not covered it. Well I will be teaching about muscle, I will cover that part where we will you know have one to one correlation of this happened, but in not shall if you have to understand. It is very simple. Within your body, there are say 206 bones and these bones are divided into two categories; axial bones appendicular bones and the muscle which form.

On these different axial bones and appendicular bones falls under axial muscles and correspondingly appendicular muscles, but this is purely from the point of view of anatomy which I will only in French when I think that you guys needed to know that basic an atomy, otherwise my goal will be to give you overall organization of the body and its fundamental physiological processes which you can correlate with the molecular mechanisms, fine and the articulations talking about the articulations, articulations are

those joints suppose here a look at my fingers like and I can move the fingers like this. I can bend you know bend the fingers like this is the part which move. So, those joints where all they are kind of splitting it up, those forms under articulation.

We will talk about it because there is a direct one to one relations with the bone, the cartilage and the muscle covering it and how all this articulations functions. So, that is the reason why I kind of did not went into the anatomical details of it, but we will come back while we will talk about muscle. With this let us move on to what muscle is.

Of course by this time, it must have been clear to you that suppose there is a bone like this and you have the cartilage out here and you have articular cartilage, articular cartilage and top of that you have the muscle growing. So, this is where the muscle is stopping it, right. Those of you are non-vegetarian they will be knowing it much better from the leg pieces of chicken. We can see the muscle covering a bone right, but is it that all. Those which cover the bones or muscles or muscle is something much more broader.

So, in order to visualize if you touch here, you will see something is lub-dub sound. Your heart is beating. What is that? That is also muscle right, but there is no bone. There you have never heard about cardiac bone or something of that sort. It is a mass of muscle which forms a structure, where we will be talking about this muscle while we will talk about the heart that is also a muscle you eat, the food, right. The food goes through your digestive tract. So, you must have heard that the food forms a ball like when we are very young toddlers or parent teachers ask them, when you chew the food, chew the food, chew the food. So, you are chewing the food. So, what you are essentially doing? You are grinding it.

In other word, what people do in a ball milling and all these kind of things where they grind or you go to a aata chakki or something you know where you know you get the grains you know grind them in to you know small finer particles. In other we can even correlate to the way people make nano particles. They take a big chunk of something xyz and you know grind it, grind it, grind it, grind it and goes to the smaller and smaller particle size, ok.

So, it forms a balls and that ball which is form in your mouth while you chew the food move through your elementary canal in a mechanism called peristalses. Just like a peristalses pump, it moves like this. So, it moves through cavity which is made up of

muscle that is also not bone, right. So, the first thing I wanted to put in a very simplistic way, a very crude way is not that wherever there is a bone, there has to be a muscle first and foremost thing. So, muscle can be in other places too and muscle can be standalone tissue systems which we will be talking about these in different other fragments. So, based on their function, based on their certain anatomical features, muscles are divided into three varied groups.

So, to talk about what I am just now talking about is the muscle that is out there, these kind of muscles which are covering the bones, these are skeletal muscles. So, in other words these are the ones which are covering the skeleton, but this is not the real definition. I will come to that, but this is just for your kind of you know making a brain map, how you can identify randomly if you should be able to answer if you go to enter you are somewhere you know wherever you should be able to you know you should strike this.

Second one what I talked to you in terms of the muscles on a muscle type, we are talking about this is one type, right. This is second type. What I told you is when you take, when you touch your chest here, you know chest that beating sound the lub-dub and that is what the second kind of where there are no bones, right. So, those muscles are called cardiac muscle, part two cardiac muscle. Third one, I told you when you eat the food, the food goes through the elementary canal. I told you and this movement is like peristalsis movement like a peristalsis pump, so a bolus. So, this is the bolus which is formed by change the food. It moves down like this.

So, this also forms the esophageal canal or a cavity elementary canal or a cavity whatever you call it, elementary canal or a cavity. The muscles which are forming it is called smooth muscle. So, there are three kinds of muscle broadly classified in our body; skeletal muscle, cardiac muscle and smooth muscles. So, your brain maps whenever suppose you forget you know or so, big deal. Just look at your own body. So, physiology can be best learnt if you know your own body. If you know your body, you will be able to figure it out.

Now, what is the difference between all these things? Now, how you remember it or how you kind of make a brain map of this? There has to be something unique, right. So, in order to understand the uniqueness of it, you look at your own body. These are our skeletal muscles, right. There are bones radius and all those kind of things and so, you do

all you like you know body building and all those things, you play football or you play you know hand bowl or you play hockey or whatever basketball whatever games cricket, whatever you like. The amount of force which is generated is amazing in this muscles, right or you do boxing and number of things. Now, if you compare the amount of exert forced using these muscles as compared to the way your heartbeats say, for example, for a very silent room take a stethoscope and place it here and try to hear the sound tuck, tuck, tuck, tuck, like this, ok.

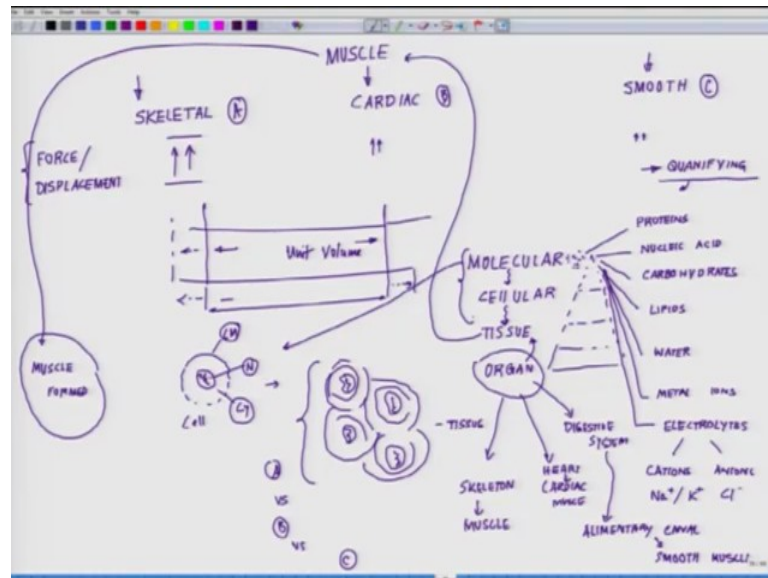
It will seem to you as if something is beating like this. So, in other word there is a finite displacement which is taking place like this as if you have a kind of a spring or something which you can stretch, but it does not go beyond it. So, there is out here, there is a finite stretch which is happening like this whereas, if you allow, when you allow the food to move, you do not even feel that something is moving unless otherwise you are one of those people who does lot of pranayama and all those things where you take lot of water you know saltwater and you know you form it out you really never feel that there is an elementary canal which is generating a certain amount of peristaltic force by virtue of which the food is moving.

So, what is the common in the three examples I gave you? The first one, I told you you are playing basketball or you are playing hockey, football, cricket, you are throwing the ball. The force which is generated say you take a spring or you take elastic, stretch it or you do you know pushups and everything you can do a lot of pushups and you can put the whole body back and if you are really fit, right. So, you will observe and the second, let me summarize, sorry say if you see your heart. So, if you compare the displacement, what you are doing while you are doing you know lot of those you know pushups and everything has compared to the displacement here. You will see the displacement which is taking place out in the cardiac tissue or in the heart is much more lesser has compared to the displacement which you never feel something in moving. Something is moving like that you do not even feel it, right.

So, common word, the one common word which is the merging out of it is called force and displacement. These are the common word force and displacement and when we talk about displacement, we talk about per unit area displacement. So, by default by your shear common sense, you do not study any physiology anything. You should be able to tell the maximum displacement you see. We will be in the skeletal muscle, right as

compared to the cardiac or as compared to the smooth muscle plus the force generation will be maximum in the skeletal muscle. So, based on the force generation that should you will be able to classify, but that is not enough, right. I will just say this is the very qualitative feature that there is. It can be a quantitative feature; sorry I will take back my word. Yes you can quantify the force.

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Force will not tell you say for example, let us go to the next slide. So, what all we talked about. So, we talked about classifying the muscle in terms of, so you have skeletal muscle, skeletal you have cardiac and you have a smooth muscle, right and then, we talked about the generation of force and displacement. I am keeping it all together. Displacement is per unit. You know displacement taking place in the fibers. We will come about what we call as fibers and everything. So, we see here we are having maximum amount of force generated as compared to this. Of course, I would say slightly smaller arrow here and even smaller arrow here [FL], fine.

So, here we see maximum force generation. So, yes you can quantify this parameter. These is a quantifiable parameter and always remember something quantifying, something which you cannot quantify something which you cannot measure is very irrelevant in terms of any kind of analysis. I can see a qualitative thing, but with whom I can compare that how I can develop a scale out of it, without that scale is nothing; makes sense? I mean everything. So, always remember unless we can quantify, there is no

point. So, force or displacement, yes you can quantify. It is a quantifiable product, but then when you see the muscles, see for example, a muscle tissue like this and you say that if you and this is the muscle tissue and you say this particular say x unit area unit mass or unit volume generate maximum force say if it is a skeletal muscle or lesser in.

So, you can quantify. You can see how much it is stretching. You know based on the stretch, these dotted lines are showing that you are stressing the muscle like this. You know you are stretching it like this and you can calculate the amount of displacement in force you know of course you can quantify, but this does not tell you anything about the structural detail of the muscle because if a muscle is stretching some x muscle is stretching more than y muscle, it means there has to be some molecular differences between them.

Do you agree with me or not? Think over it and where the molecular difference will come, now go back to the fundamental the first week, whole week what I spent I told you that there are different level of organization. What are those organization level? Recall you have molecular level of organization, you have cellular level of organization, you have tissue level of organization, and you have organ level of organization. These are the level of organization and the reason why I put a pyramid like this, these are the smallest ones.

So, it means that within the molecules, what are the molecules which matters for us in biology, proteins, nucleic acid, carbohydrates, lipids water and metal ions and different electrolyte which constitute the cations and anions. So, these are the molecular level of organization details based on that we moved onto the cell. Now, when you talk about a tissue, so here what we are dealing with is the muscle tissue. So, there are three kinds of muscle tissue we talked about.

So, what we are essentially telling is that when you talk about tissue, what we see, this is a molecular level of organization that leads to the formation of some form of self-assembly which leads to the formation of a cell and which has a nucleus. I am just putting n here which is a cytoplasm. I am putting c y and which has a cell membrane CM, right and there are different of these cells which comes together. These are individual cells which comes together to form what we call as tissue, right.

Now, we say this tissue A versus this tissue B versus this tissue C and ABC here say for example, I say skeletal muscle as A, cardiac muscle as B and smooth muscle as C. They generate different kind of force. Now, that boils down that force generation is taken care by some of the molecules which are present in these individual cells which are forming this tissue mass. It means there are certain molecular differences in them and from where this molecular difference arises. So, we are all convinced based on our day to day experience, where this different muscle tissue generates different level of forces, but then how these molecular differences get orchestrated.

Now, that brings us to the next level of organization. In order to understand the muscles from molecular to the cellular to the tissue level, but in order to appreciate that what is most important is that we understand the process of formation of muscle, muscle formation. How muscle is formed? Without understanding the muscle formation, we will never be able to appreciate those molecular players who are dictating that how much force will be generated from individual muscles. So, at this point I will close in with this class that your first and foremost idea should be whenever you study assistance, you have to understand the broad spectrum of it and from there once you understand the broad picture of it, then you have to slowly narrow down to the molecular players.

So, what we did here? So, we talked about the different kind of organs today, we talked about the skeleton and we talked about the muscle covering the skeleton, right. So, I started with that example. Second what we did? We talked about the cardiac system or your heart talked about the heart which is an organ and we talked about the cardiac muscle, then we talked about the digestive system or essentially we talked about the elementary canal and there we talked about the smooth muscle. So, you see from the organ, we went back to the tissue level and now we wanted to understand the cellular and the molecular players who are orchestrating this different force generation.

So, in order to understand as I am telling you, one has to understand how these different muscles are formed and what are those molecular players and how this force generation is being dictated and here, let me tell you one more thing. This whole muscle biology what will be in dealing here today will be dealt at different parts like we will talk about the cardiac muscle while we will be talking about the heart system, we will talk about the smooth muscle while we will talk about the elementary system or the digestive system and we will talk about the skeletal muscle in the next class and thereafter because that is

the first one will be dealing with which is kind of you can call, you can say that is the model system based on which all these others are derivatized, but we will talk about the molecular players initially and the cellular development and then, we will you know classify.

So, this whole muscle thing we will continue for a while in the nerve muscle men for the cardiac and then, into the digestive system. So, this be a long journey of muscle, but this is the beginning where from a lay man perspective, you should be able to appreciate that how these muscles are located at different part of your body, not only they are covering the bones, they stand alone in conjunction with the nerve system from structures which help in blood circulation terms of the heart health, in your digestion of food, in terms of the elementary canal and several other critical function and one of the underlying theme of classifying muscle is force and the displacement which it execute. How it does?

So, in the next class, we will talk about the muscle differentiation, muscle formation and the different force generation.

Thank you.