Biomedical Signal Processing
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Lecture – 01
Motivation

So, today we are starting the subject Biomedical Signal Processing.

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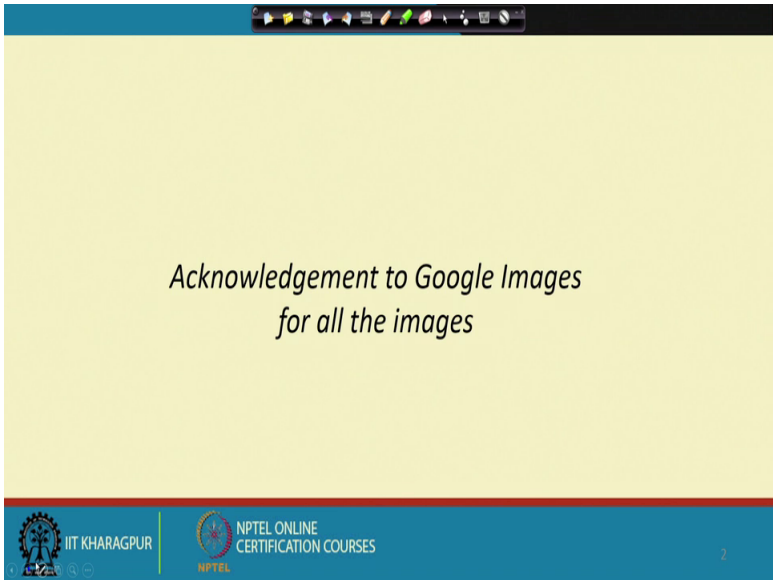

And the first, we would like to acknowledge that Google Images because we have used a lot of images here, and we should actually thank them for providing those images.

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Next, that I would like to firstly introduce you with the several books which would be very useful for this course. First, I would like to talk about the book that "Principles of Medical Electronics and Biomedical Instrumentation", is a very thin book. And it provides a very good motivation for taking up Biomedical Engineering or "Biomedical Signal Processing" as a, actually course in your curriculum. It provides a lot of applications and very nicely builds up the motivation to learn this all subject.

The next, the 3 books are there that "Biomedical Digital Signal Processing", "Biomedical Signal Processing" and the third one "Biomedical Signal Analysis: A case Based Approach". All these 3 books, they are on directly on this topic Biomedical Signal Processing. And I think each one of them can be taken as a text for this subject. Next week that "Introduction to Biomedical Equipment Technology".

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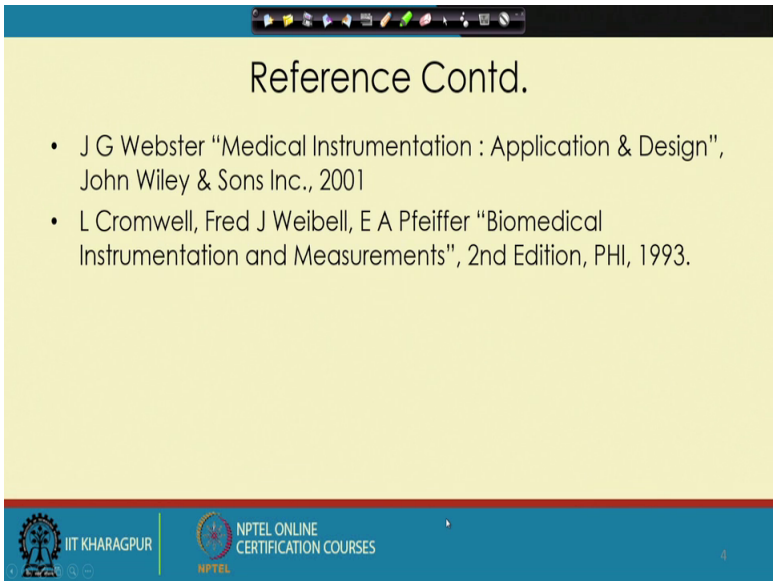

And the other 2 books, the "Medical Instrumentation" and "Biomedical Instrumentation and Measurements"; these 3 books, they could be used as a text, as a outside reference text, time to time we may need it to know that how the instrumentation need to be done though we directly will not cover that part. And more than that if anything more is required we will keep you updated about the requirement about the books.

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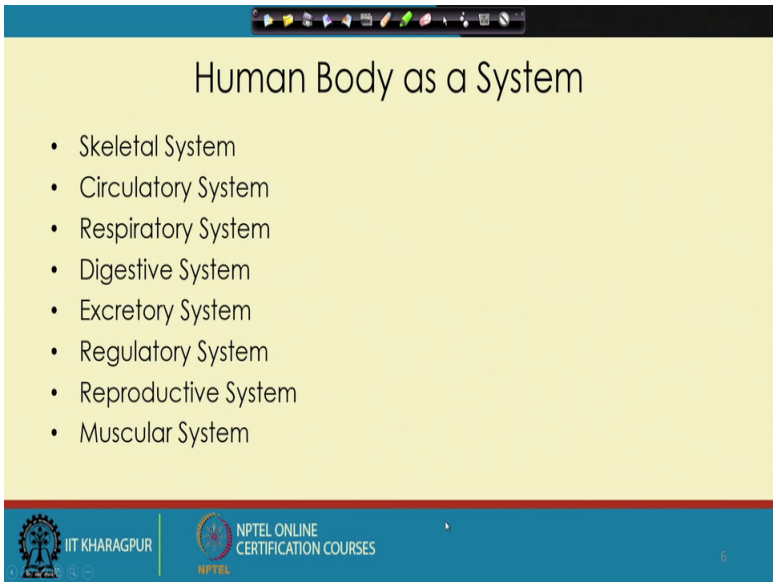

Now, for the; that getting into the subject, the first thing we would like to build the motivation about this course. And as a part of it, the first thing I would like to mention

that the, as we are engineers that we look at a Human Body as a System. And that is why we feel that it is possible to actually take it as an engineering way and we can study it as an engineer. And to understand that thing better, would like to go through some of the systems which actually makes it possible actually that human body to act as a system; that means, we would like to go through the constituent sub systems here and each one of them they were, they are also actually the system as in their own, right.

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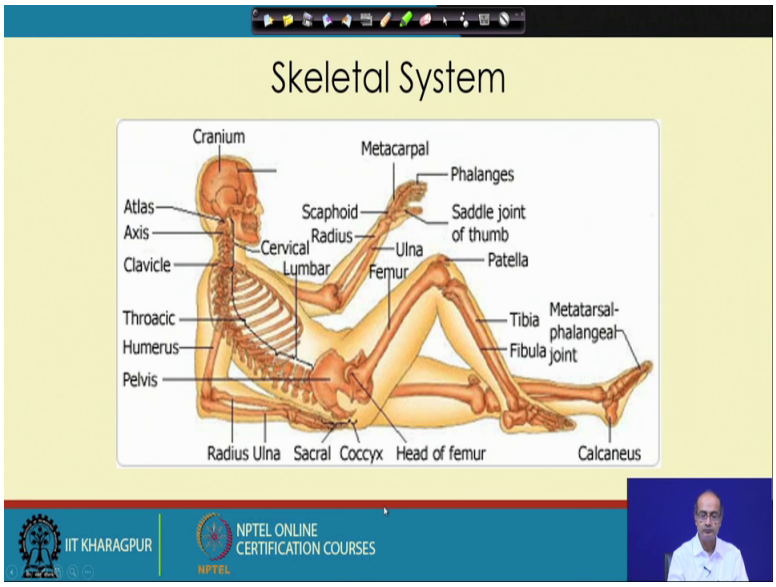

So, first we take the Skeletal System. So, within the Skeletal System, that the main purpose of the skeleton is to give a shape to this body; that means, a structural stability. That is the first purpose. Second is to protect actually the weak and vulnerable organs for example; if we look at here, that we look at the skull, that it is protecting our brain then the rib cage it is protecting our actually that the lung and the heart. So, these are the actually this the parts of the skeleton they are protecting the weaker organ. So, that is another main use of this the Skeletal System. And apart from giving it a shape or a structural stability, it has a different kind of joints, for example, the knee if you look at; it is a joint like a hinge. And if you look at this joint it is a ball and socket joint ok.

So, we can rotate this part or you think of hand we can rotate it. So, there are ball and socket joints at there. So, this different kind of joints also allow us different kind of movements. So, it is not just a fixed structure, but we can move and if you look at this part that spinal cord, the spinal cord if you look at, the spinal cord the; it is consists of a

number of bones and it is hinging in such a way that we can actually bend it. It is not possible to bend any bone, but as they are hinged with each other they have some limited amount of flexibility and we can actually bend it forward or backward or side wise. And if you look at the bones, that there are 206 bones in the body. Primarily it consists of calcium and phosphorus. And within the bone, that in the core of it the bone marrow is there, from there that the blood cells are generated; specially that red blood cell. They are generated from the bone marrow. And that if you look at the biggest bone, this is the femur is the biggest bone in the body.

So, that is in short I would suggest about the bone. And 1 more small information, that each bone is covered with a fibrous layer called that peristoneum. And which contains actually different kind of vessels like nerves, the blood vessels which provides an nourishment to the bone; and that helps to for the growth of the bone as well as it helps in our actually, that in case of fracture or cracks that for healing up of the bone. So, this is about the Skeleton System. So, we should move for the next system.

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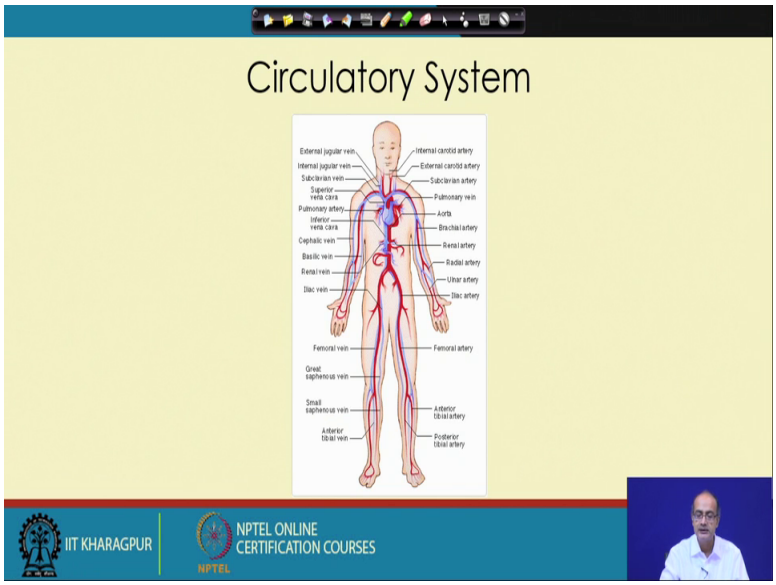

The next we have taken the Circulatory System.

Circulatory System, we know that we have a pump in our body that is the heart. And we have 2 different kind of actually the pipes or vessels that; one is called artery which pumps out the blood from the that heart and there are another kind of actually vessel that is called veins, which takes back the blood actually from the different parts of the body.

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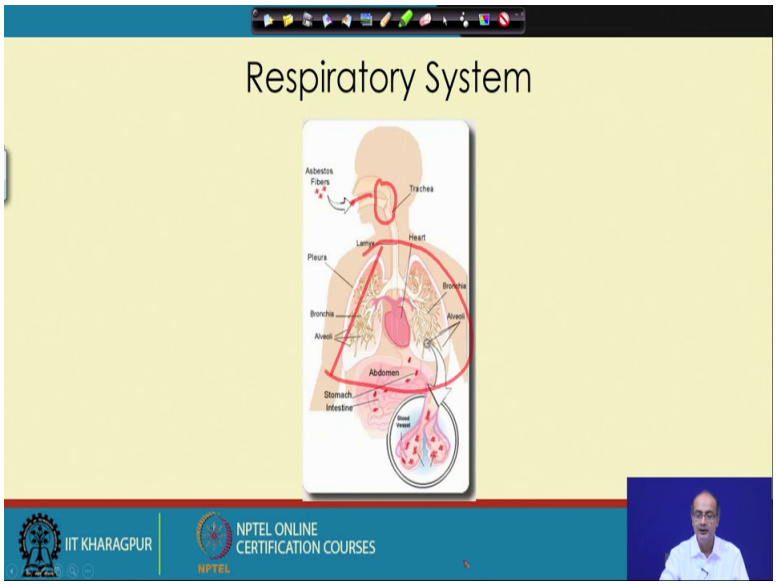

So, when we look at the arteries, they spread that in the head as well as the different parts of the body. They are taking the blood and the bloods are getting distributed by the sub divisions of the artery and ultimately there are some very small blood vessels. And so it reaches the each cell, its carrying primary the oxygen and as well as the glucose, it is taking to each of the cells and then again through that the blood vessels, the small blood vessels it is actually coming back to the that the veins and through that it is reaching again to the that the pump that is heart in our body. And it also helps for the control of the temperature. Because, it is coming from the core of the body; it is actually pumping the hot blood and trying to maintain actually the temperature in the periphery of the body as well as you can say that it is helping in cooling the core part of the body.

So, both the things it is doing. It is actually keeping a balance of temperature between the core temperature as well as a temperature in the periphery and dissipation of heat as well as the heating of the peripheral organs, it is doing. So, as you see that each of the system, they are not just doing one task, but a number of them. And another interesting thing to look at that we have actually copied a many a thing like from the heart, we learnt that the concept of pump; from the hinges in that human bones, we have learnt that to create the hinges what we use in our mechanical design. So, lot of things; we actually we learnt from the human body.

Now, next we look at the Respiratory System. It is another important system. Without respiration we cannot live. And that when we try to inhale, the first thing what you do that, we increase the volume of the; this chest, this chest region, that this chest region here. We are increasing the volume of it and it is creating a low pressure here. And because of that, from outside that is where the; that the air pressure is more the air is getting inside the body what we called inspiration. And this inspiration face as they are air is coming in, as you see here, we have shown on that asbestos fibers are they are. So, similar kind of, different kind of dots could be there suspended in the air. So, that will also can come in inside the body. To stop them, at the beginning of the nasal cavity here that we have some actually hairs in the nasal cavity, which tries to stop them.

The next part of it is actually moist. The wall is actually kept moist, which also help to actually stop these dots or catch these dots. And the intention is only the free air that means, dot free air should get into our lung. And as it is taking the; that the bronchitis and that 2 bronchitis and they are getting subdivided and at the end it is going towards the alveoli small actually such kind of thing that small, there it is ending this is vessels. And the air is coming there and through the wall of the alveoli, through the diffusion, they are actually helping to providing the oxygen in the blood and the blood vessel they are releasing the carbon dioxide in the air in the alveoli. And after sometime, that the chest is squeezed and that means, it increases the pressure inside the lung. And because of the high pressure, all the air that was inhaled, it is coming out of the body; that is, we call that acceleration.

So, we are actually giving breathing out. And the cycle keeps on going. That is the way that we take oxygen from that environment and give back the carbon dioxide and both are very much required for our actually metabolism. Now, let us go for the next system.

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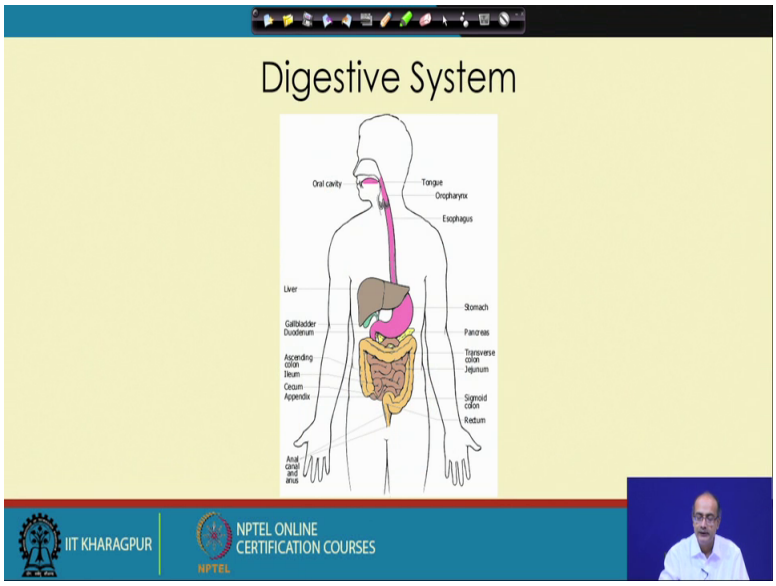

That next is a Digestive System. That is very important for the nourishment of the body. This, usually how tall we are? May be 1.5 meter to 2 meters! That is the usual length of actually length of an adult or height of an adult. But within that these alimentary canal, it is about 8.3 meters. So, it is coiled up within the body. And as we actually swallow any food, that it has a particular function, that is this pipe actually is made of lot of muscles. So, they keeps on pushing that actually that the food in a particular direction that means, it should go inside. It should not allow opposite moment whatever may be our orientation; whether we are standing or lying or whatever maybe the way. It should actually it would keep on pushing the actually the food towards from the mouth towards the anal.

So, that is the direction. And first it reaches our stomach where the acid secretion happens and the enzymes there can work on that. Then, as it comes out of the stomach in gets into the intestine where the rest of the digestion happens. And for that actually we get the secretions from that what we will call that the gallbladder, that from the liver we get to secretions and it makes it that changed the medium to basic because those enzymes cannot work in acidic environment. And as it getting digested, that the nutrients like glucose and the proteins and the water, they are actually taken out from this small intestine through osmosis to the blood vessel. And at the end of it, that whatever the roughage is there, that gets into this big pipe called big intestine and throughout at the end it comes out of the body.

So, this Digestive System it is very important for our body, for our nourishment. It is helping us to take the food and take out that proteins actually, that the fat as well as that the glucose that is the main source of the energy for the body and then gives out the thing which is not actually required for the body.

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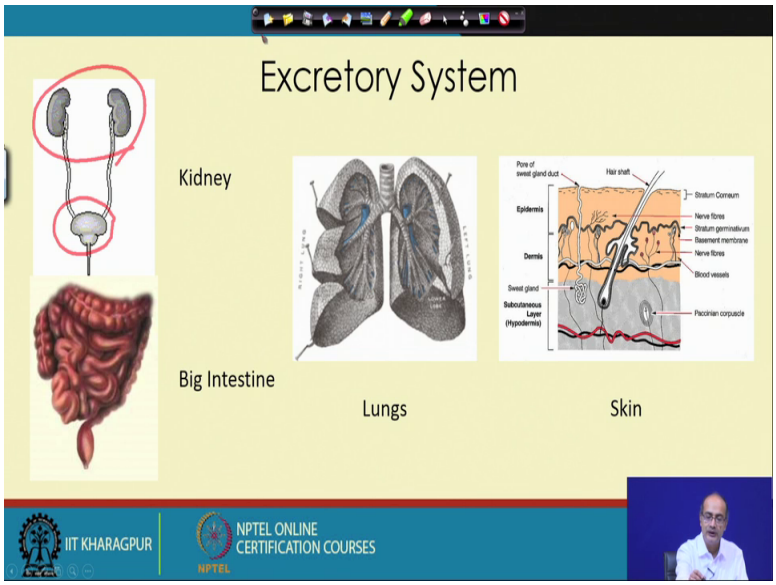

Next, we will go for Excretory System. When we are actually doing the metabolism or doing different kind of reactions, some of the things which are generated out as a byproduct of it, which are not good for the body or we can say that in this way, if we store them, it is going to harm the body.

So, those kind of byproducts which are harmful for the body, we need to give out. First of them is that carbon dioxide, we told that Lungs is responsible for the exchange of that, the carbon dioxide. And next I would say that important thing is the Kidney, that lot of blood vessels are there in the Kidney and it acts as a filter. And what it does? It does not allow the blood cells to get filtered. But only those things which are not required for the body and water to get out of that filter and those gets accumulated in this bladder. And time to time when the bladder gets full we fill the urge to urinate and we pass it on that liquid and we get rid of those things.

Next we, I told about the Big Intestine that is also actually help us to get rid of the roughage. And another thing is important which looks very small, that is the Skin. It has some pores; specially, where we have this the hairs are there; Along with that pores are

there. And there are some sweat glands, that that sweat glands actually helps to actually put some water out along with that it also sends out some that the byproducts which are not good for the body. And another purpose of the sweat gland, that as it is giving out the liquid or water in this case, that as it evaporates it is takes away some latent heat. So, it is also helping for the temperature control ok.

So, Excretory System that is a very important system. If one of them they get damaged or does not work, are the life is not possible. So, just because it is doing the waste management, we should not think that it is role is any way less than any other system in the body.

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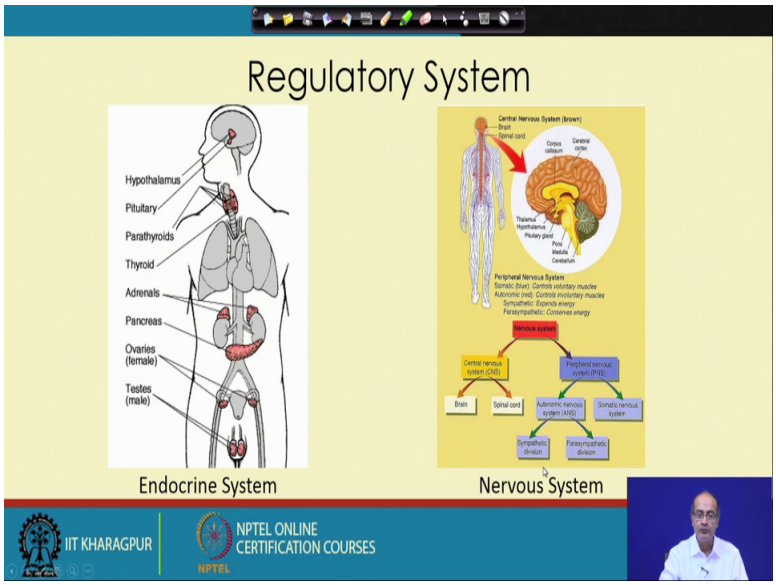

So, next we should look at that Regulatory System; that means, how we regulate the different operations within the body. The first which comes to the mind is our Nervous System. And in the Nervous System, we get 2 parts, one is central nervous system; another is peripheral nervous system. Central nervous system consists of brain and the spinal cord.

Now, this brain and the spinal cord, they are making a lot of decision. And that whatever effort we would like to do, for example, we take a decision or we want to move our hand or leg or we want to speak; those commands are coming from there. And there are other parts like these peripheral nervous system, they are having 2 parts that automatic nervous system and somatic nervous system. Somatic nervous system is helping for that volition

that we want to move our; that muscles like hand, legs and all. And automatic nervous systems are doing a lot of important task. For example, that our heart is working all the time in spite of our command. We are breathing all the time without giving any special command.

So, our peristalsis is going, that is pushing the food in one direction. And there are many other things; if a fly comes near our eye, automatically the eye leads will get closed. So, those are the act of auto nervous system. So, they are doing a lot of important things. So, for that nervous system I would say that, the main purpose or the main the treat is, it is actually working as a command and control mode. And nervous systems are taking the decision, the central nervous system is taking the decision and also sending that message or order to do something ok.

So, it is taking the decision as well as it is providing the actuating the action. So, that is the main part of it. There is another kind of system that is the Endocrine System. It is made of different kind of glands. And their action is a bit peculiar, though they are not directly giving command and control kind of thing, they are actually setting the phase of that the metabolic rate. And they are the hormones are secret, that from their secretion, they regulate that metabolic system that what would be the rate of it. They may prohibit some of the actions or accelerated some of the actually reactions. So, that way, they though they are not actually, I would say directly giving command and control, but how the body will react to the command and control, that is entirely determined by the Endocrine System. Or we can say the mood of the body that is determined by the Endocrine System ok.

In fact, that if the secretions are not proper, it not only create problem in your metabolism, it can change your mood. So, that is very important. And so Regulatory Systems, that is without that we cannot actually live, because heart will stop, our digestion will stop and we would not be able to protect ourselves.

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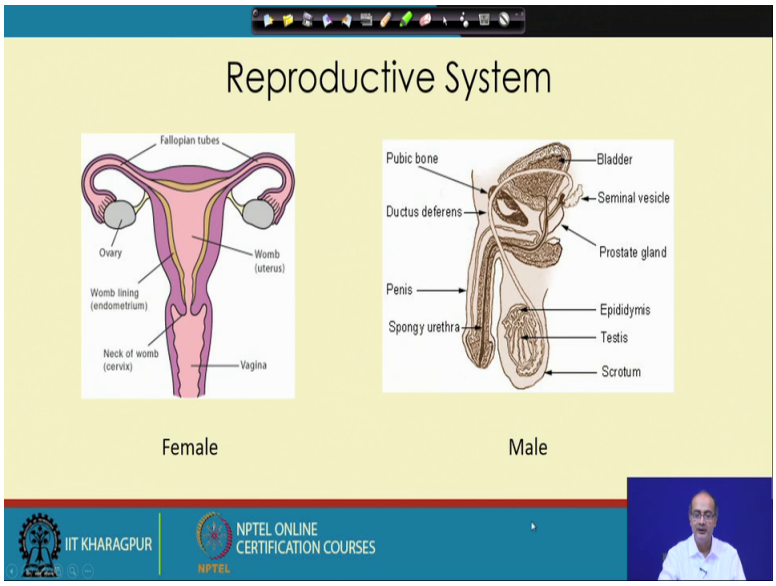

And now, let us look for the next system;, that is Reproductive System. Again, Reproductive System is very important and interesting system. The importance of it, when we try to differentiate between a living being and an inert object. That the main difference we get, that is that the human being or an a living being it can reproduce it is replica. That few things that we find that inert object cannot do, for example, it does not take food for nourishment one, second many of them they cannot move, but these first 2 conditions are violated by some of the creations likes say, automobiles. It takes the petroleum, it gives out a exhaust, we can which we can actually compare with our taking nourishment and it can move.

So, we cannot actually differentiate a automobile or a train in that way in the first 2 categories. But, unlike the human being or even a small ant, that the automobile cannot take actually that the inputs required for producing a car and reproduce a small replica of it. It cannot give birth to it. Only the animals can do it and human being can do it. And the male organ, it gives the sperm. And that that female organ, it has actually the eggs are generated here and they come through the fallopian tube and the sperm actually meets their here. And once they get fertilize that, they settle somewhere on this wall in the womb. And you know that, both the cells they come together, they merge. And then we have a special kind of cell division that is called that meiosis. And it cell actually subdivides in 4 parts. And the constituent, the chromosomes they are shared and that becomes a new subject that we call that genetic algorithm and what we learn in

engineering. And there is another topic in biomedical called genetic engineering, which talks about that how that the genes are shared and if there is some imperfection, can we actually take care of them, remove some of the faulty part or so.

So, that is the main thing about the Reproductive System which helps to procreate and get the child. And here another interesting engineering design, I would like to mention which you may not find in the book, that you see that, the sperms are actually stored here in the testis. And this part, the scrotum, it is outside the human body and for the animals also we will find that the scrotum is actually outside the body. And that is for a particular reason actually it is done. That for this, that preservation of the sperm that it is getting stored here for some time and for their preservation a particular temperature is there. Now if they are kept within the body that is near the core temperature of the body, they would not survive. For their survival for a long time, a much lower temperature is needed.

So, that is why it is by design, it is thrown out of the outside the body. So, that is one interesting design of the, you can say the nature, that how that is made the human actually reproductive system or for any animal you will find that the Reproductive System, this principle is followed.

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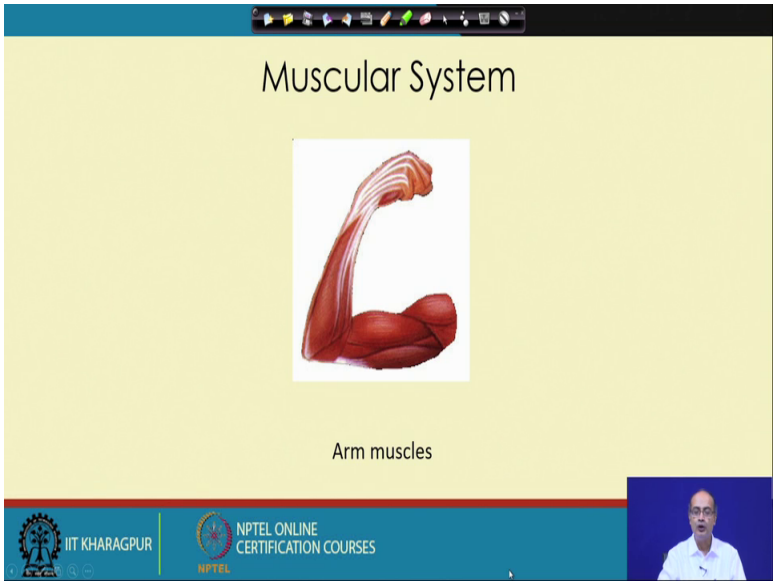

Next, we go for the Muscular System, where we are showing the arm, but muscles are present not just in the hands and legs, they are present almost everywhere; in the

alimentary canal we told, in the heart and in many other places where you can think of any movement the muscles are there. Then knobs are giving the command for that the muscles and when they get that command, they contract and gives rise to the movement when it get relaxed again, again you get a moment.

So that is the way, the different muscles, they pull and then they get relax. So, opposite side the muscle if it get, actually contract and then we can see that the hands are unfolding, that is the way it work.

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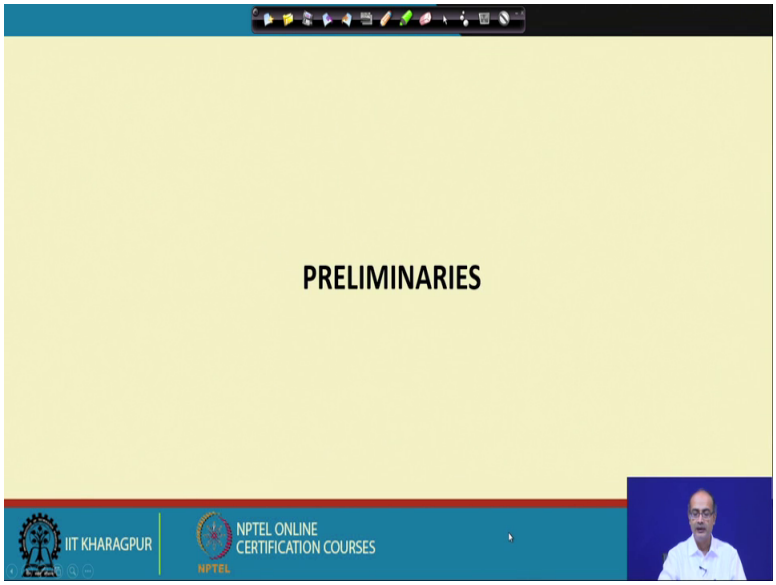

So, this is the way we covered actually the first part of the motivation. And we get, that the whole system, human body, it acts as a combination of number of systems and the proper, the regulation of them, the proper action of them gives rise to a smooth running system which is our human body.

Thank you.