Ergonomics Workplace Analysis
Prof. Urmi R. Salve
Department of Design
Indian Institute of Technology, Guwahati

Lecture - 04
Physiological Fundamentals of Workplace Evaluation

Welcome back to for one more class on the Workplace Ergonomic Analysis. Today we will be talking about Physiological Fundamentals of Workplace Evaluation. So, why we need physiological fundamentals understanding when we are talking about workplace analysis or ergonomic workplace analysis?

See when we are talking about ergonomic workplace analysis, the whole structure consists of a human being or more than one human being, the machine and the surrounding environments. So, how human being is interacting with the machine or the surroundings or the workplace; we need to understand, what is the physiological responses they are generating when they are interacting.

So, if we do not understand the basic physiology or work physiology, we will not be able to understand the responses or bio-feedbacks which is getting generated when people are interacting with the environment as well as machine. So, which is very important component when we are talking about the analyzing the workplace. Also, when we are talking about designing any ergonomic workplace equipment or product, we need to understand how those elements of designs are interacting with the human and how the physiological responses are reacting.

So, basis of physiological understanding is very very important, once we talk about the design and ergonomic workplace analysis. So, I will take you slowly to very basic components of work physiology and then we will try to understand how these are important for ergonomic workplace analysis. So, let me start.

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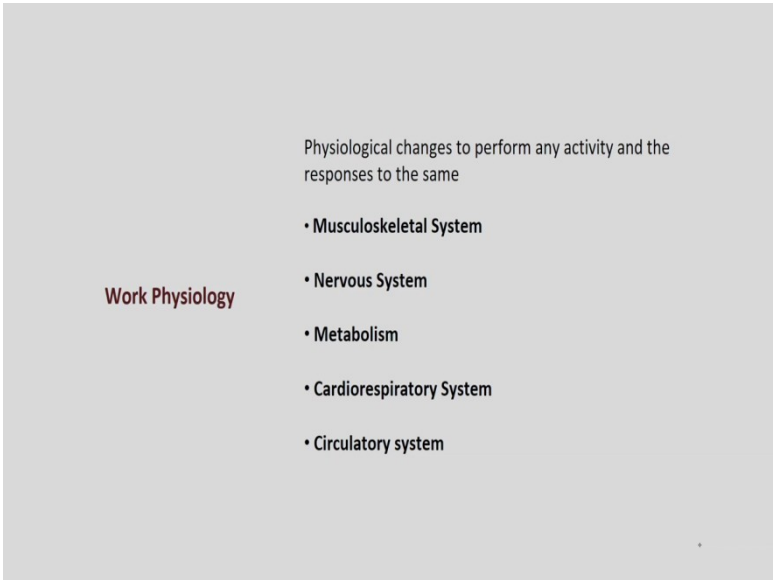

So, when we are talking about work physiology, few basic terminologies are coming into consideration first is musculoskeletal system, nervous system, metabolism, cardiorespiratory system and circulatory system. So, if we understand all these responses and basic physiology behind it, it will be very easy for us to understand when any product or any workplace equipment is interacting with the human being.

So, let us start with the musculoskeletal system. So, the basic component of musculoskeletal system is muscle; so what it is? So, this muscle basically helps you to do the movement. So, it has a very nice feature which is contractile in nature. So, it helps to shorten and then again develop a pulling force which you know lengthen the muscles. So, when it attached between two movable objects like bone and it can enable the motion.

So, every movement of human body both voluntary and involuntarily is controlled by varieties of muscles. So, we will be talking about different types of muscle, different types of movement in the later slides. Physiologically we have three basic types one is skeletal, another is smooth, another is cardiac muscles.

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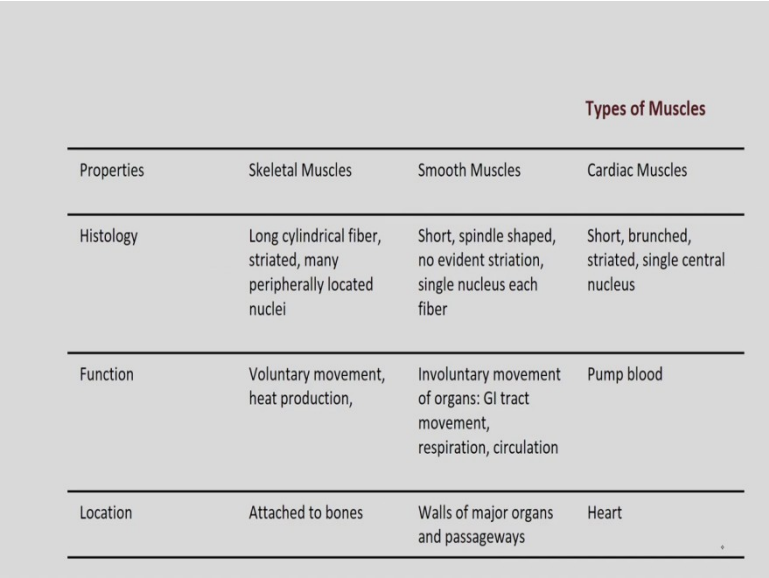

So, let us understand what it is. So, I try to give a brief description of the histology of all these three types of muscle, what are the basic functions of it and where they are located. So, if you talk about skeletal muscle, it mainly helps in the voluntary movement, heat production and mainly it is attached to any bones. So, that is the presence of skeletal muscles.

Smooth muscles, it is a helps in involuntary movement mainly these are present in the all inner organs, passageways and all those places like GI tract, respiration, respiratory movement, it helps in respiratory movement, circulation etcetera.

We have a very specific group of muscles in our body that is cardiac muscles. The feature of this particular group of muscle is you know partially that it has some relevant feature which resembles to skeletal as well as the smooth muscles and especially present in heart. So, it helps in blood pump.

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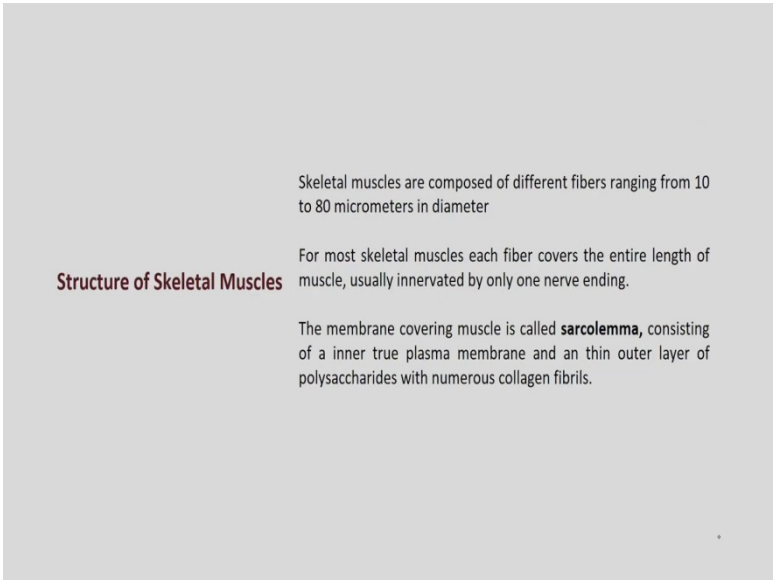

So, what is the structure of any skeletal muscles, you will get all these information in detail which are the books I am I referred in the last part of the like last section of this presentation, you can refer also just here I will be giving the main features and you can get the elaborate description from those books.

So, skeletal muscles are composed of different fibers ranging from 10 to 80 micrometres in diameter. So, when we are talking about diameter of the muscle, it helps to understand how the muscle will behave. So, for most skeletal muscle each fiber covers the entire length of the muscle, usually innervated by only one nerve endings. So, very specific feature that one muscle, one nerve ending. The membrane covering muscle is called sarcolemma, it consists of inner true plasma membrane and a thin outer layer of polysaccharide with numerous collagen fibrils. So, this is the basic structure.

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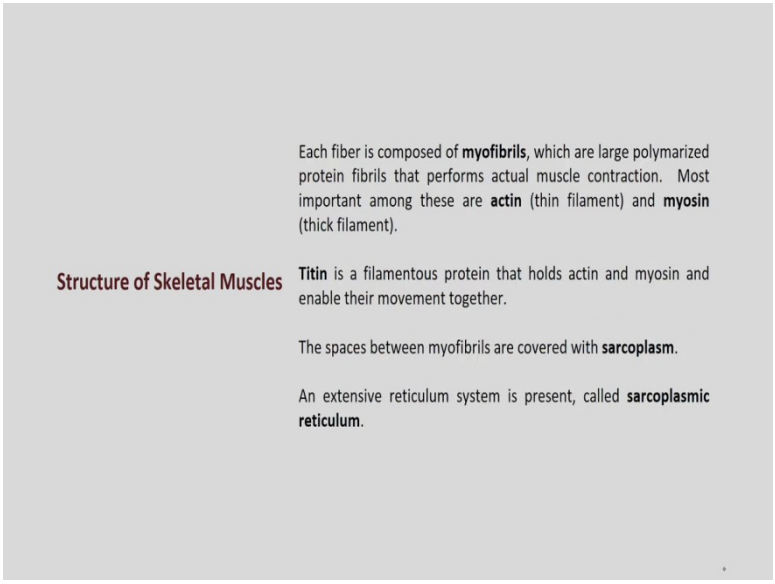

Also, it has two major component that is actin and myosin which helps the muscle to contract and relax. Also, we have titin in the muscle and sarcoplasm; what is sarcoplasm? The spaces between myofibrils are covered by a kind of plasmic material that is called sarcoplasm. An extensive reticulum system is also present which is called sarcoplasmic reticulum.

So, I am not going into detail of these structures, from the physiological point of view you can, if you are interested you can get going to detail through any textbook which I will be referring at the end of the slide presentation. But these are the very basic information we should understand when we are going for ergonomic workplace analysis.

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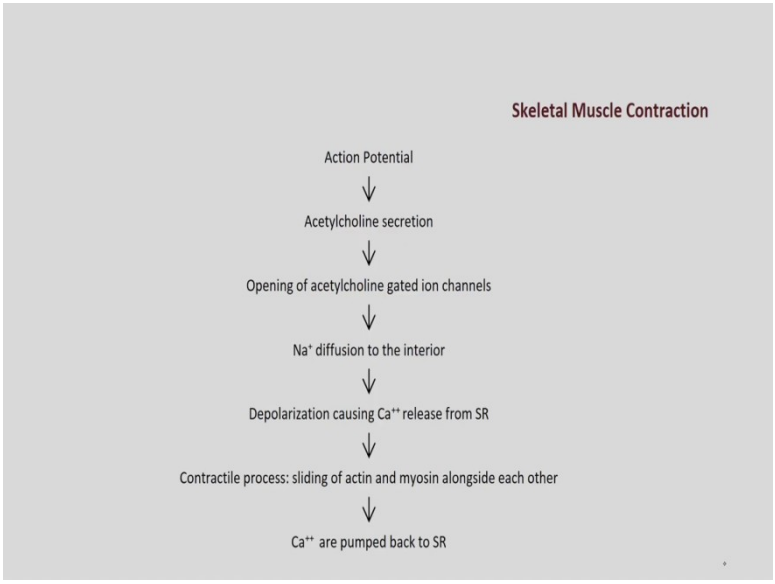

Now, this is the flow how a skeletal muscle contract. So, it starts from the action potential and it again ends back when calcium element are pumped back to the sarcoplasmic reticulum. So, this is the whole sequence we follow. So, that is why how our all the movements happen.

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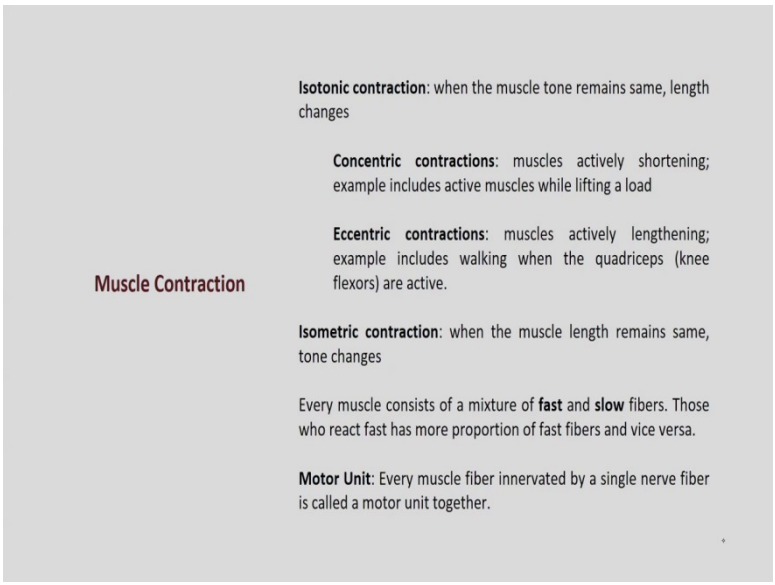

Now, let us talk about how the muscle contraction and what are the varieties are present. So, based on the type of contraction, we have isotonic and isometric. By nomenclature itself you do understand that what is isometric and what is isotonic; isotonic means when the whole muscle tone remains same, but length is changing. Whereas, isometric says when the whole

length remains same and tone changes. So, these are the two major types of contraction isotonic and isometric. In isotonic we have concentrate and eccentric, concentric means when muscle actively getting shortening and eccentric when it is getting lengthen.

Now, here one very important terminology is motor unit, what it is? So, every muscle fiber innervated by a single nerve fiber, we call this together as a motor unit. So, when we are talking about any muscle movement, we really need to understand how these motor units are functioning for that particular situation.

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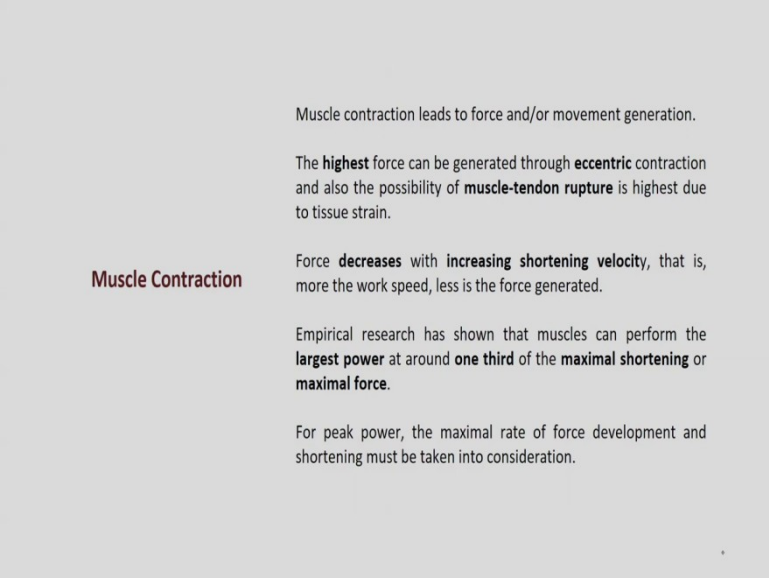

Muscle contraction, how it happens? After muscle contraction what happens? So, muscle contraction leads to force and or movement generation. So, it helps to generate force or any type of movement. So, the highest force can be generated through eccentric contraction and also the possibility of muscle-tendon rupture is highest due to tissue strain.

So, whenever we are talking about different ergonomic workplace analysis, interaction of human being with the different elements of the workplace like machine, pulling, pushing and many other you know gadget operation, we need to understand how the muscle fibers actually are reacting with the demand of the job.

So, if we understand that part we will be able to know the capacity of the human being and how the job demand and the capacity is you know is optimized or not. If it is not optimized,

how to get it optimized. So, these understanding only we will come into consideration when you understand, what this muscle rupture is and how it happens, why it happens.

So, force, what happens? Force decreases with increasing shortening velocity, that is, more the work speed, less is the force generated, very important feature for this particular muscle contraction theory. So, empirical research has shown that muscle can perform the largest power at around one-third of maximal shortening or maximal force. So, when you are talking about how much force a person should work on we should know, what is the maximum possibility by that particular group of muscle and based on that we need to calculate that what should be the working value.

So, we have different devices to understand all these, but if we do not understand the basic then we will not be able to work. So, for peak power, the maximal rate of force development and shortening muscle can be taken into consideration when we are talking about this type of analysis.

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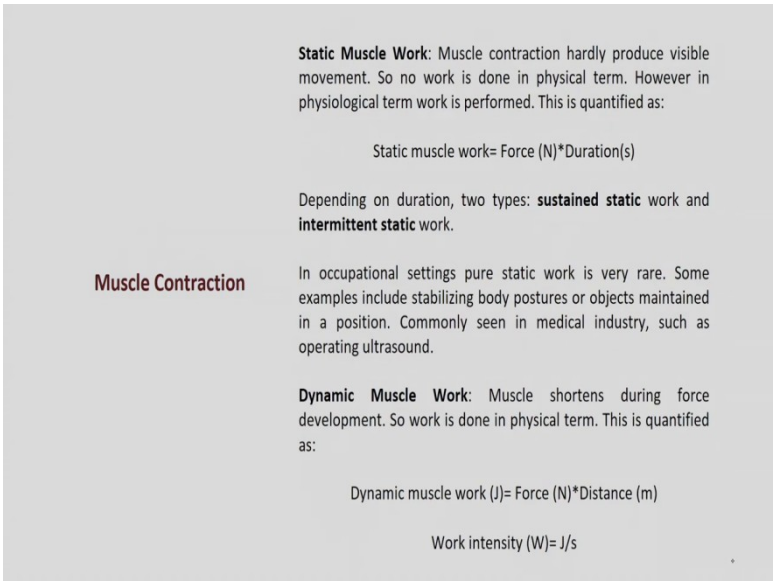

Further, I would like to introduce you to other terminology that is static muscle work and dynamic muscle work. These two terms are very important as far as workload is concerned in the in terms of posture, in terms of exerting force on to do a particular job.

So, what is static muscle work? It says, muscle contraction hardly produces visible movement. So, muscle is contracting, but there is very less movement or negligible

movement. So, no work is done in terms of physics definition; work is done only when there is a movement, but here actually no physical movement is happening; however, in physiological term, work is performed because the muscle is getting contracted for a certain period of time. So, that we will call as static muscle work and the how we are going to calculate that, the static muscle work equal to force that we are applying into the duration like how long I am continuing the job.

Now, this static work can be two types, one is sustained static work another is intermittent static work. So, when we go for any ergonomic workplace analysis, we will try to understand different body parts the like suppose our back muscles or trunk muscle groups, your forearm muscle groups or leg muscle groups or neck, those group of muscles how they are behaving with the work in the particular ways.

So, then we will try to understand, is this a static work or it is a dynamic muscle work. If it is a static work then how it is static, sustained work or it is intermittent. If you try to gather examples, we will find mostly in industry we will get examples of intermittent static work, but many times there are possibility to get example of sustained muscle work as well. Very important example for this particular sustained static work is when somebody is operating an ultra sound. When somebody is doing so, how the person is really maintaining a static posture.

So, if there is a minute movement, there will be huge effect within the organs. So, it will be very difficult to justify that. So, to maintain that the nurse or the operator is maintaining a very static posture for a particular duration of time, you will we will get some incidences, but mostly intermittent static word is available in the industrial situation.

Now, come to the dynamic muscle work, the muscle shortens during force development so, it has a very visible movement. So, what it says? Dynamic muscle work that we denominate as J is equal to force into distance and work intensity will be calculating as J per second. So, dynamic muscle work per second, we will be calculating and it is very easy to understand this particular part, when we will be applying those.

So, once you understand all these thing, what will be the home task for this particular part will be that, try to find out various task or various interaction in any workplace and try to understand, what are the varieties available. So, is it static, is it dynamic. If it is static it is

sustained or intermittent, try to analyze it, try to segregate it, categorize it. If you have any question, you can again come back and get the clarification from us.

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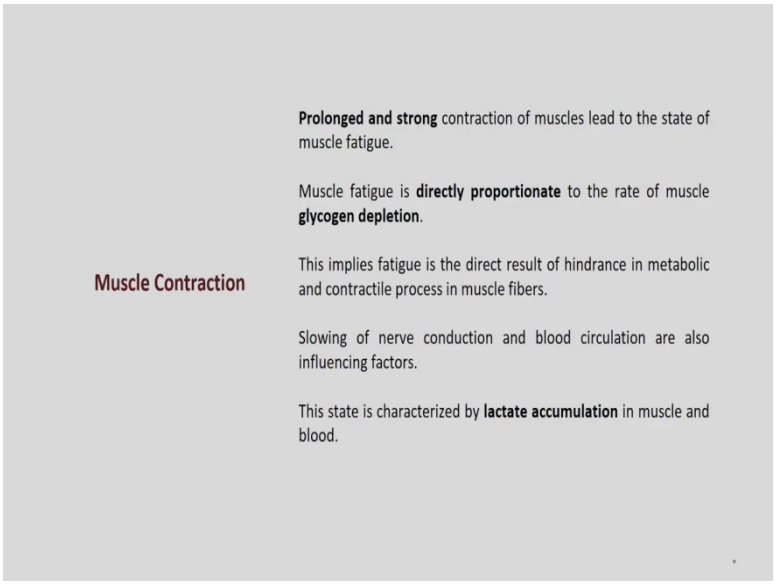

Now, let us understand what is the effect of prolonged and strong contraction of muscle which can lead to muscle fatigue? So, what happens? When there is a long duration of exposure and there is a strong contraction, what happen? There is a chance that a lactic acid will be accumulated and there will be a generation of fatigue sensation.

So, muscle fatigue is directly proportionate to the rate of muscle glycogen depletion. So, now, it goes for the metabolism that we will partially discuss, but it is not that important so, we may skip it. So, this implies fatigue is the direct result of hindrance in metabolic and contractile process in muscle fibers.

So, slowing of muscle; slowing of nerve conduction and blood circulation are also some of the influencing factor to develop fatigue. In this particular state is characterized by lactate accumulation, what I mentioned earlier in muscle and the blood and then we start feeling pain or discomfort.

So, when we understand, from the physical observation or open observation through checklist or through some questionnaire we come to know there are some discomfort or pain at this particular time when people are interacting with that particular machine or equipment we will say, why it is happening. So, we need to really understand to go back that what the muscle

physiology is saying and how we can redesign the system. So that lactate accumulation is less and the person can continue the job for longer duration or more efficiently; so, to do so, we really need to know, what is the physiology behind it.

Now, once we understood muscle, the other component of the whole musculoskeletal system is ligaments and bone tendon, other component is bone. So, let us first go by the ligaments and tendon and then I will talk about bone as well.

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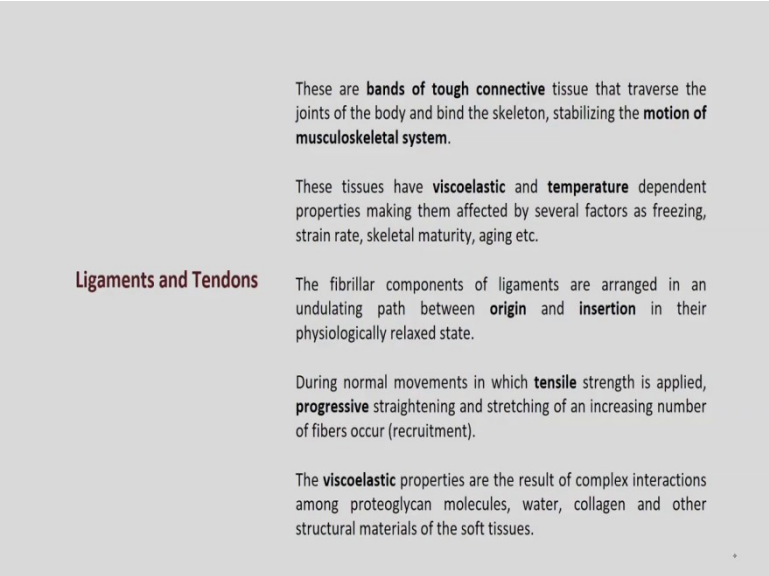

So, what is this? These are the bands of tough connective tissues that transfers the joints of the body and bind the skeleton, stabilizing the motion of musculoskeletal system. So, when we are talking about the movement, how the motion is happening it helps to stabilize those motions.

So, these tissues have visco-elastic property and it is temperature dependent, it has a temperature dependent properties and which makes them affected by several factors such as freezing, strain rate, skeletal maturity, aging etcetera right. So, you must have heard about you know frozen shoulder or you must have heard about many other disorders or changes that happens in the muscle when we are in extreme temperature. So, why that happen, because there are effect on the ligaments and tendon and it interrupts the movement of the body.

So, the fibrillar components of ligaments are arranged in an undulating path between origin and the insertion in their physiological relaxed state. So, during normal movement in which

tensile strength is applied, progressive straightening and stretching of an increasing number of fibers occur, so we call it as recruitment. So, one fiber is working and slowly other fibers are getting recruited. The viscoelastic properties are the result of complex interaction among proteoglycan molecules, water, collagen and other structural materials of the soft tissues so, this is the basic physiology.

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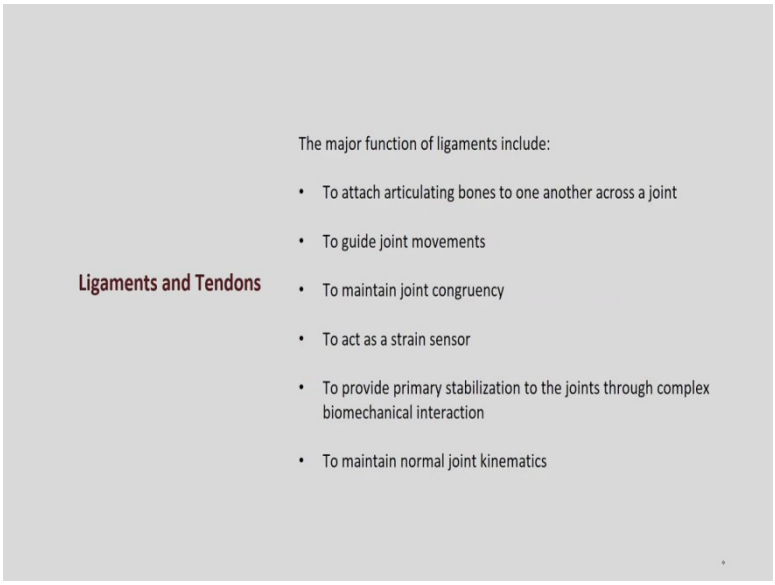

Now, let us understand, what are the major functions carried out by the ligaments, what it does? It helps to attach the articulating bones to one another across a joint, to guide joint movements; it helps to understand the joint movement, to maintain joint congruency, to act as a strain sensor, to provide primary stabilization of the joints through complex biomechanical interaction and to maintain normal joint kinematics.

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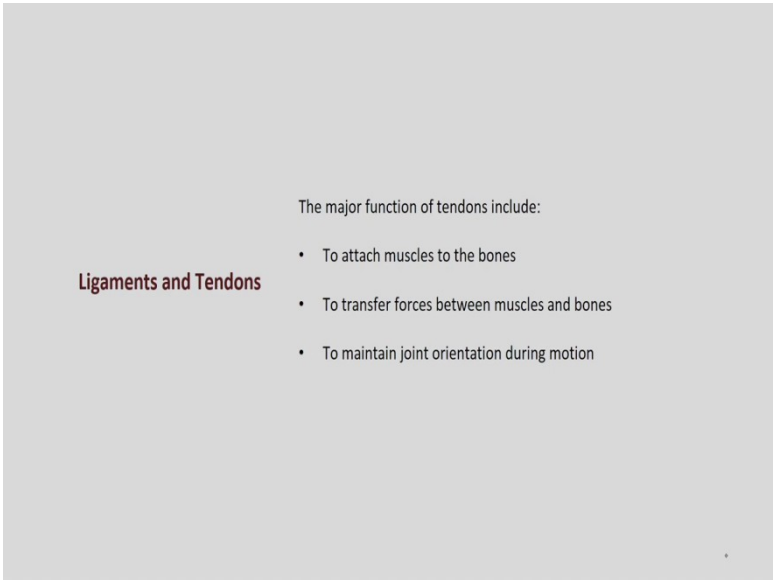

So, these are the functions of ligaments and these are the functions of tendons, to attach muscles to the bones; it helps to attach the muscle to the bones, to transfer forces between muscles and bones and to maintain joint orientation.

The ligament helps to maintain the joint complexity and congruity; here it may help to maintain the joint orientation during the motion. So, if we are talking about musculoskeletal movement. So, muscle and skeleton is definitely important, but without ligaments and tendon, we really cannot think of the proper alignment, proper movement of the whole body.

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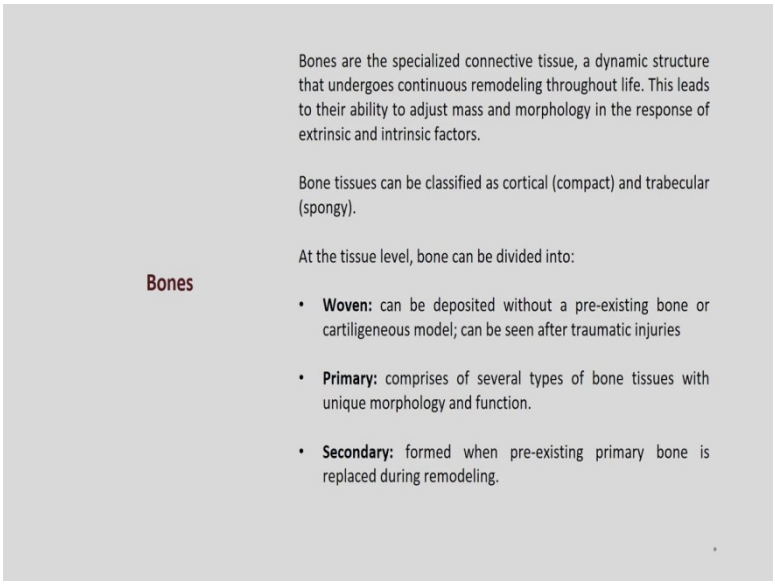

Now, let us understand one more pillar of musculoskeletal system is bone. So, what it is? Bones are the specialized connective tissue, a dynamic structure that undergoes continuous remodelling throughout life; it is very important keeps on changing. This leads to their ability to adjust mass and morphology in the response of extrinsic and intrinsic factors. Bone tissues can be classified as cortical and trabecular like how compact it is and how spongy it is. Also, it has three different varieties woven, primary and secondary. So, we will have all these detail in the books that I referred in the last slide.

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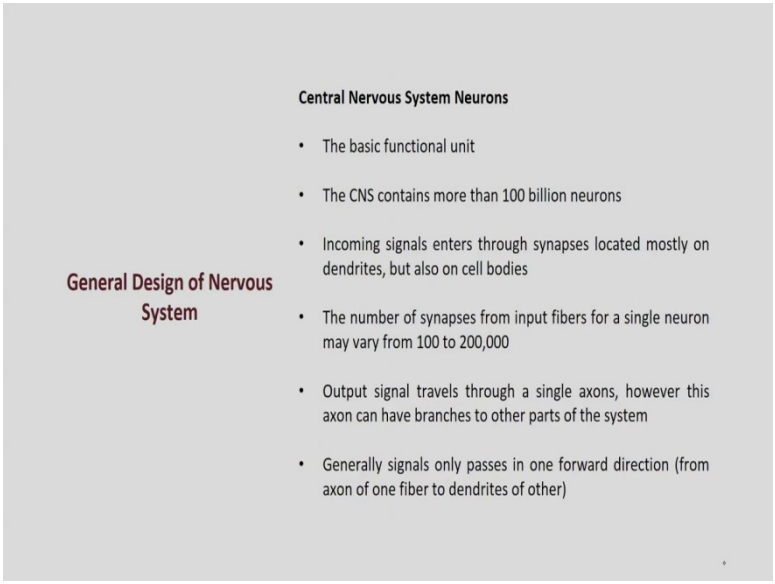

Now, when we talked about musculoskeletal system and we talked about the components of the musculoskeletal system, we really need to understand who controls them, then this nervous system comes into picture. So, let us first discuss about the central nervous system. So, what it is? Central nervous system is the basic functional unit, it contains more than 100 billion neurons, incoming signals enters through synapses located mostly on the dendrites, but also on cell bodies some time.

The number of synapses from input fibers for a single neuron may vary from 100 to 200,000. Output signal travels through single axons; however, these axons can have branches to another parts of the system. So, it is not very defined it can change also. So, generally signals only passes in one forward direction; here this is very important feature that if I receive a signal from one end, it will only go in the forward direction not in the backward direction.

So, if I need to send the feedback, I need to have one more loop altogether. So, the same neuron will not be functioning for the forward and backward information processing.

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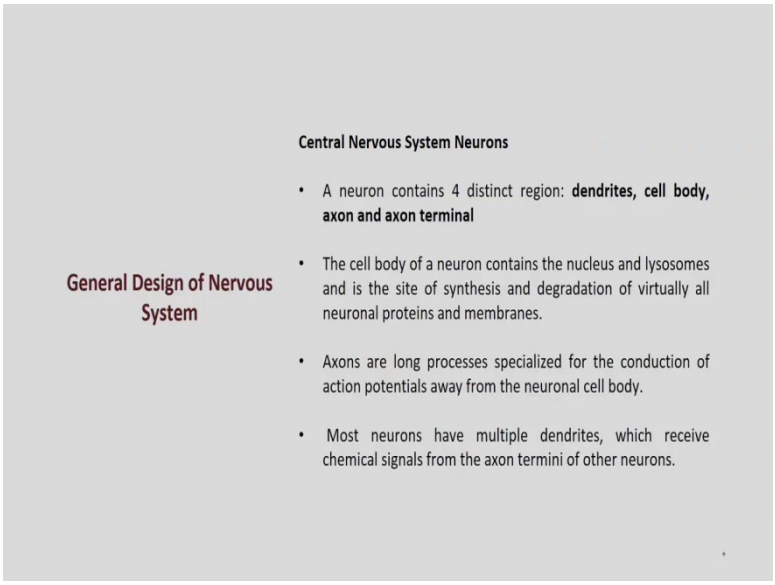

So, a neuron contains four distinct regions those are, dendrites, cell body, axon and axon terminal. So, these all terminologies are very important to understand when we are talking about basic morphology of the neuron.

Cell body of a neuron contains a nucleus and lysosomes and is the site of synthesis and degradation of virtually all neural proteins and membranes; so, it helps in synthesis and degradation. Axons are the long processes specialized for the conduction of the action potential away from the neuronal cell body. Most neurons have multiple dendrites, which receives chemical signals from axon termini of other neurons so it receives signals from other neuron and it passes through the to its own cell body.

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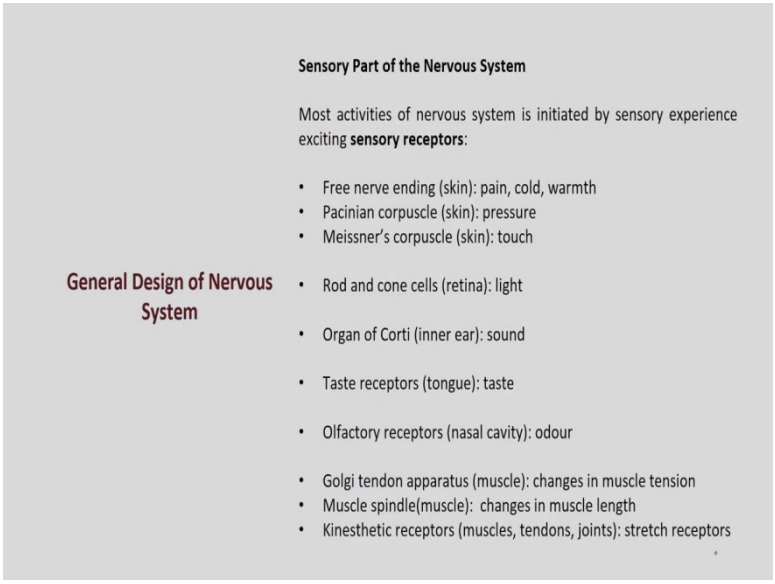

Now, let us talk about the sensory part of the nervous system, we talked about the central now we are talking about sensory nervous system. It has lot of variety like you know just I will explain it as location wise when we are talking about pain, feeling of pain or receiving pain symptoms, cold, warmth we are talking about free nerve ending. Then pressure sensor, touch, light; light we know the rod and cone cells, it helps to understand the colour and the you know black and white all these discrimination and the figuring out a object. Organ of corti, which helps to understand the sound, taste receptors, olfactory receptors and all so, these all are the sensory this all comes under the sensory nervous system.

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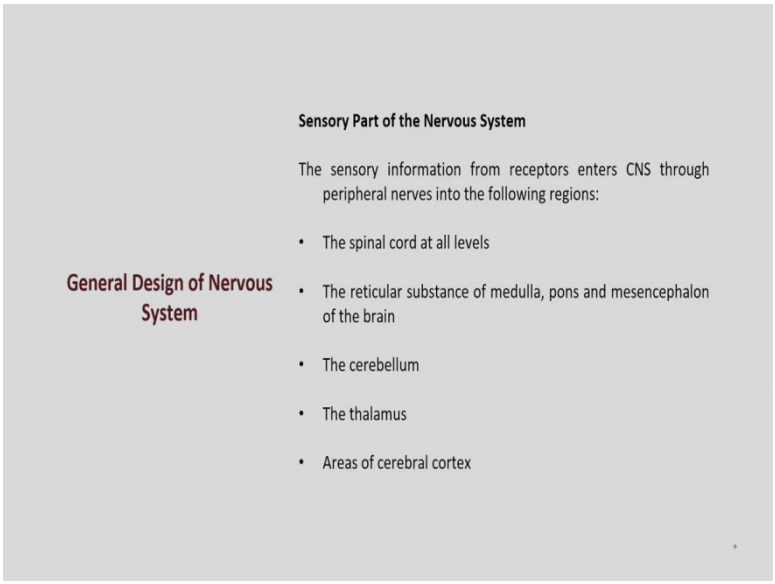

The sensory information from receptors enters the central nervous system through peripheral nerves into the following regions. So, I will just describe that what they are, they are spinal cord at all level. So, we have different levels of the spinal cord. So, all enters through that any level depending on the location. The reticular substance of medulla, pons and mesencephalon of the brain, the cerebellum, the thalamus and areas of cerebral cortex so, the all the information can come from any one of the root.

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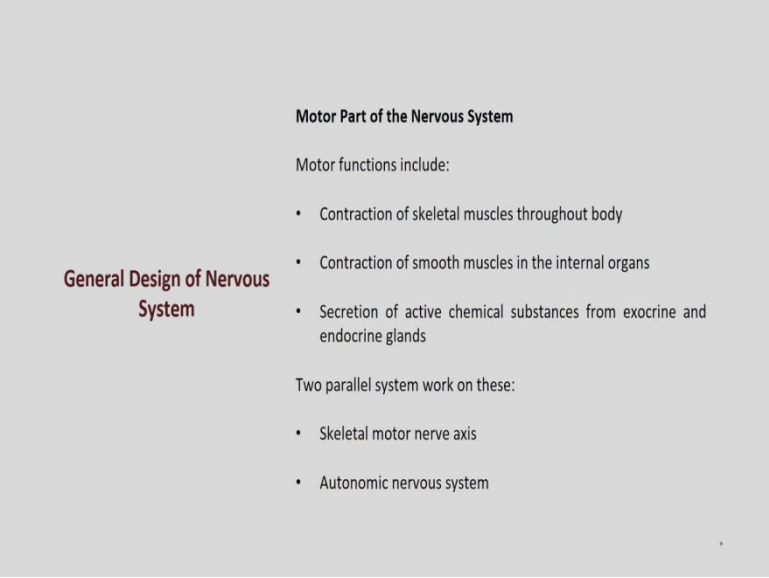

So, what is motor part of the nervous system? So, now, previously we talked about the sensory part like how we are sensing the information or messages from the environment and we are realizing then next is motor means how we are reacting towards that information. So, contraction of the skeletal muscles throughout the body, contraction of smooth muscles in the internal organs, secretion of active chemical substances from exocrine and endocrine glands. And what we understand two separate parallel system works on this particular system like to do all these job, what these two are? Skeletal motor nerve axis and autonomic nervous system.

So, one is skeletal another is autonomic nervous system. So, when we are talking about skeletal motor nervous system; here we have our own control over there, but as far as autonomic nervous system is concerned, it absolutely depend on the brains instruction and it happens automatically.

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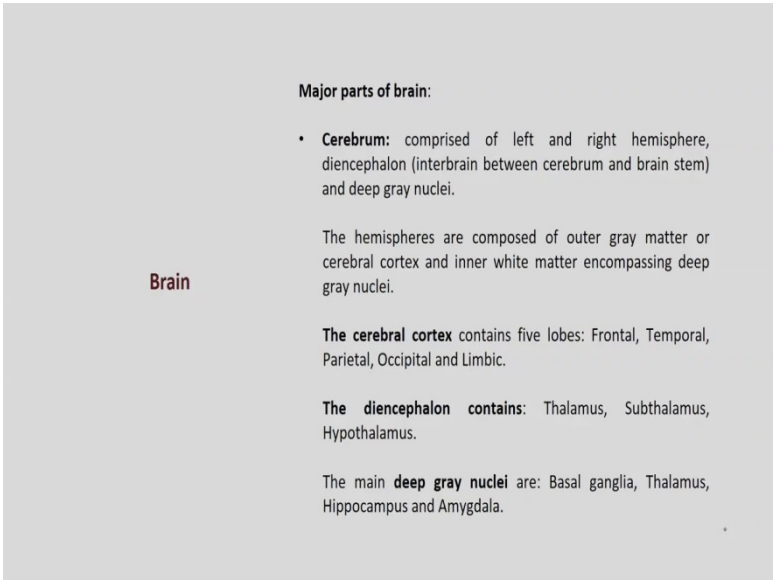

Now, once we talked about nervous system, the very important part of this is brain. And brain has three major component which helps to control all these they are cerebrum, cerebellum and brainstem. So, just a few terminology; here you can follow of course, these can be studied in detail. First is cerebral cortex and diencephalon and also deep gray nuclei. So, what are the basic functions and how they are actually help you know generating responses we can study in detail.

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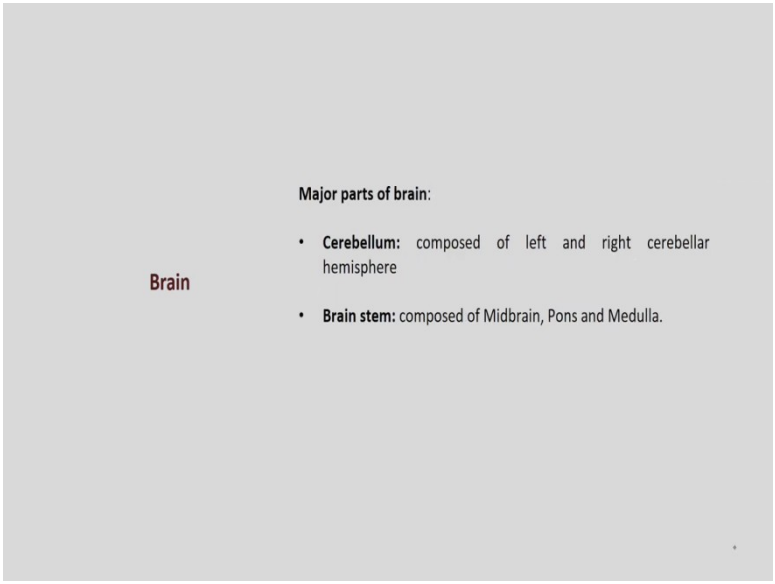

And what cerebellum does cerebellum has two component, left and right and these two component has different functions, we can discuss it in detail later and last one is the brainstem, composed of midbrain, pons and medulla.

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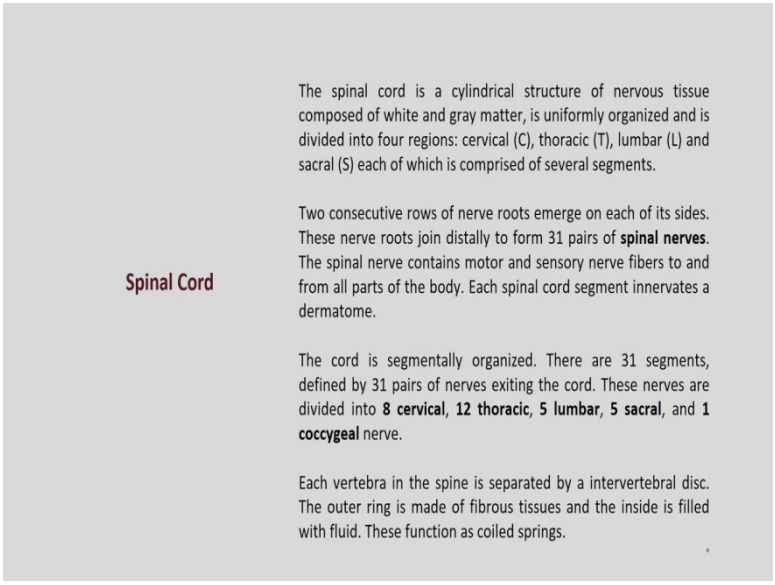

Of course we can study all these in detail, but that may not be very relevant in terms of you know ergonomic workplace analysis may be important if you feel then you can study it separately.

Now, other component is spinal cord, the spinal cord is a cylindrical structure of nervous tissue composed of white and gray matter, is uniformly organized it is uniformly organized and is divided into four major regions cervical, thoracic, lumbar and sacral. So, we have accordingly we have 31 pairs; so, we have 8 cervical bone, 12 thoracic, 5 lumber, 5 sacral and 1 coccygeal nerve so, it is associated with each segment. So, 31 segments, 31 nerves.

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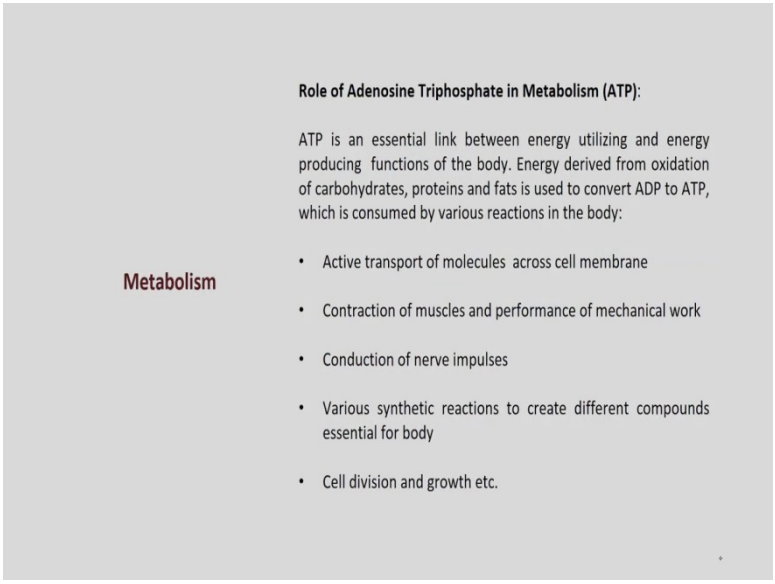

So, this distribution is very important when we are talking about pain at different location, how the trunk is behaving, trunk muscle is you know actually occupying different types of posture all those things. So, once we understand those strain formation, pressure generation on those you know segment of the spinal cord and then we can associate that how to correct those design to help the worker to gain a different neutral postures so, which is very important aspect of any ergonomic workplace analysis.

Now, let us talk about when we understood, how the whole musculoskeletal system works then from where the energy comes to work for those musculoskeletal system. So, when muscle works we need to have some energy to do the movement right. So, let us understand how these energies coming of course, it is absolutely depending on the metabolism.

So, what is the major component of it and how it actually works. So, major component when we are talking about metabolism and you know muscle and musculoskeletal system, the first terminology comes in mind is adenosine triphosphate, what it is? So, adenosine triphosphate is an essential link between energy utilizing and energy producing functions of the body.

So, energy derived from oxidation of carbohydrates, proteins and fats is used to convert ADP to ATP, which is consumed by various reactions in the body. So, it helps to active transport of molecules across cell membrane, contraction of muscles and performance of mechanical work, conduction of nerve impulses, various synthetic reactions to create different compounds essential for body, cell division and growth and many other thing.

So, Adenosine Triphosphate is very very important component when we are talking about any physiological activity. So, when I am talking about the body is interacting with the machine or equipment of the workplace, how these ATP plays and how this is actually reacting and how I am in a position to understand these detail is very important.

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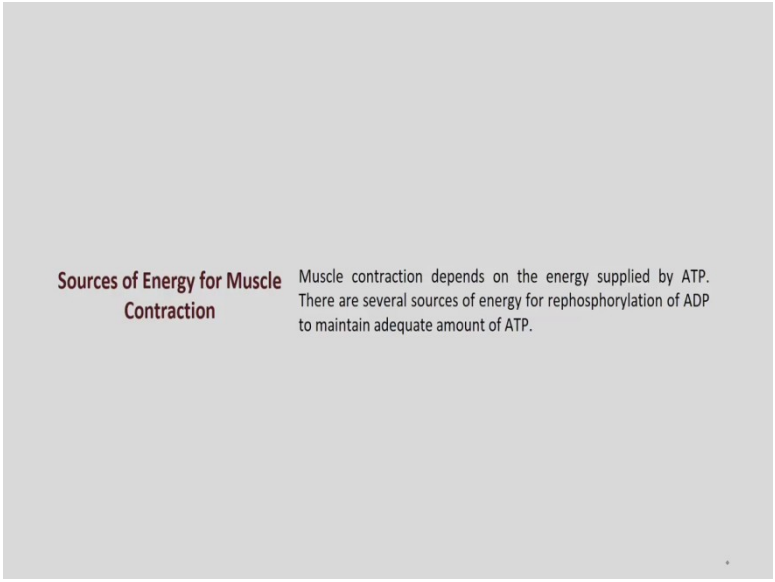

So, it ATP basically act as a source of energy for muscle contraction. So, muscle contraction depends on the energy supplied by ATP. There are several sources of energy for rephosphorylation of ADP to maintain adequate amount of ATP. So, those details you can definitely look for or you know you can read from different other books sources.

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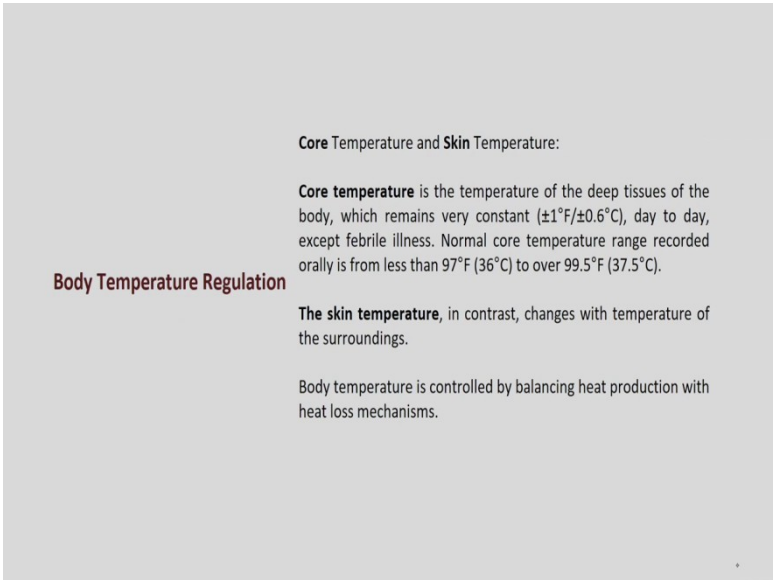

Now, when we are talking about human body or human being is in our workplace and it is interacting so, where we are talking about ergonomic workplace evaluation. So, body temperature how it is reacting again is an important component.

So, what is body temperature? It has two major types one is core temperature, another is skin temperature. By nomenclature itself you do understand what is core temperature? It says that temperature of the deep tissues of the body which remains very constant. If you try to see the deviations, it comes hardly plus minus 1 degree Fahrenheit.

So, many cases we try to measure and we found that normal core temperature is range, the range recorded orally (Refer Time: 35:02). So, orally we measured and we found that it has been recorded that it lower range is 37 degree Celsius whereas, the upper range is 99.5 degree Fahrenheit.

Then what is skin temperature? Yes, skin temperature changes the temperature keeps on changing based on the surrounding environment. So, body temperature the whole body temperature is controlled by balancing heat production with heat loss mechanism. So, what are the heat production happening in heat is producing in within our body and how I am losing that heat. So, based on that mechanism balancing between these two mechanisms, our core body temperature always maintain a certain level.

So, we need to know little bit about the heat production mechanism and what is the heat loss mechanism. Because when we are talking about heat production mechanism and heat loss mechanism, we will come to know how we can what are the possibilities are there to control that or to balance that.

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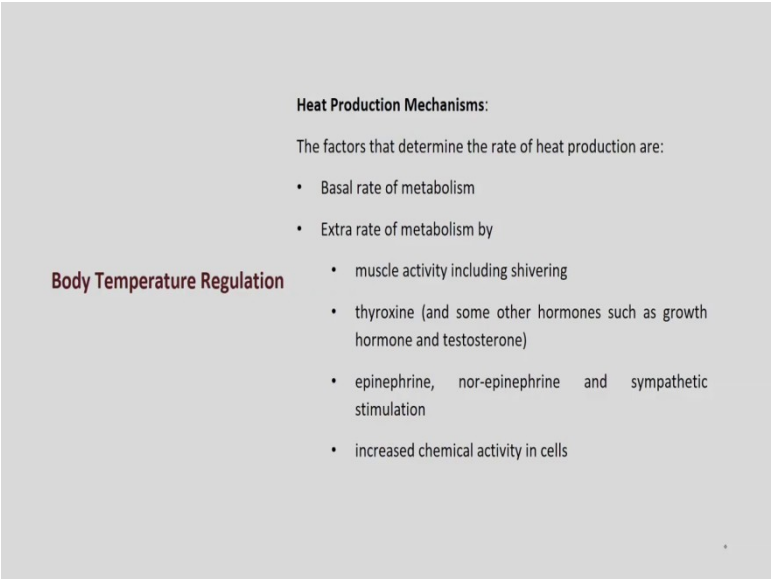

So, let us see, what is the heat production mechanism? So, mainly two sources one is basal rate of metabolism and another is the extra rate of metabolism. So, basal rate that is being automatically controlled by your other system of the body, but extra rate metabolism is influenced by the muscle activity, thyroxine that is a typical hormone, epinephrine, nor-epinephrine and sympathetic stimulation also, increased chemical activity in cell.

So, sometimes if there are changes, there are infections, if there are some other chemical changes are happening within the cell it can in produce different levels of body heat. So, these are the method through which heat produces in the body.

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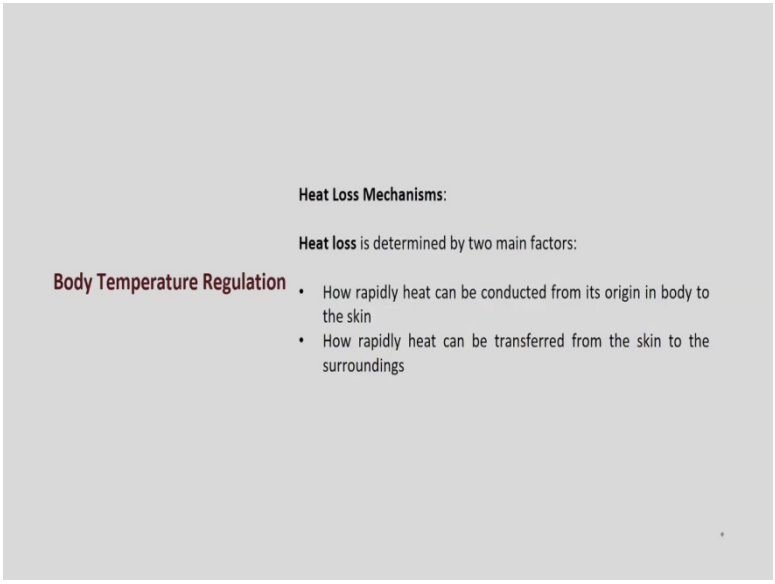

Now, let us talk about how heat is getting lost from the body. So, it has mainly two factors that how rapidly heat can be conducted from where the heat is getting generated in the body to the skin is one component; another is from skin to the environment. So, suppose it is getting generated at cell body at any cell. So, how that heat is coming till your skin and from skin to the environment. So, these two; this is the two major division, how body heat is getting lost.

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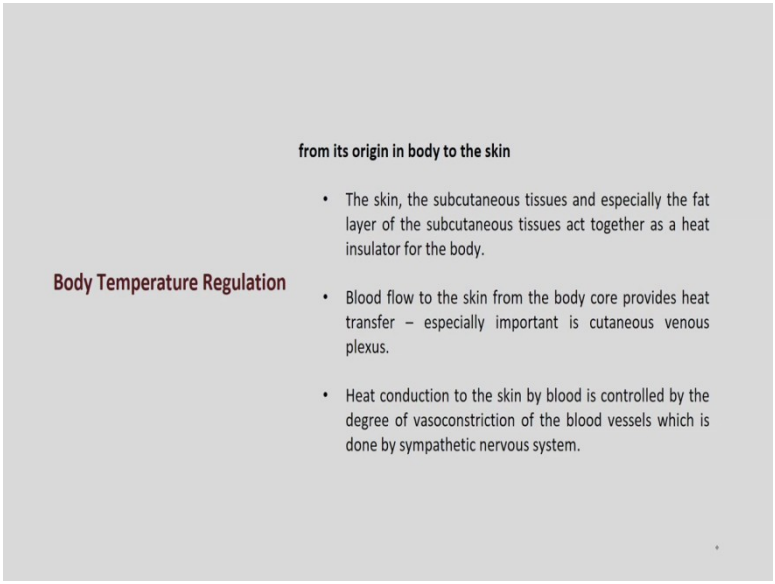

So, from origin in body to the skin, we have several insulations like subcutaneous tissue especially fat layer of the subcutaneous tissue act together as a heat insulator for the body. Blood flow to the skin from the body core provides heat transfer especially important in cutaneous venous plexus. Heat conduction to the skin by blood is controlled by the degree of vasoconstriction of the blood vessel which is done by the sympathetic nervous system. It is very very important when we will be talking about various thermal stress and impact of thermal stress on the performance.

So, how vasoconstriction and vasodialation affect the whole process or whole productivity or efficiency of the particular person and how the design intervention can help to maintain or improve that performance. So, if we understand all these mechanism, it is very easy; it will have a better direction to go for intervention.

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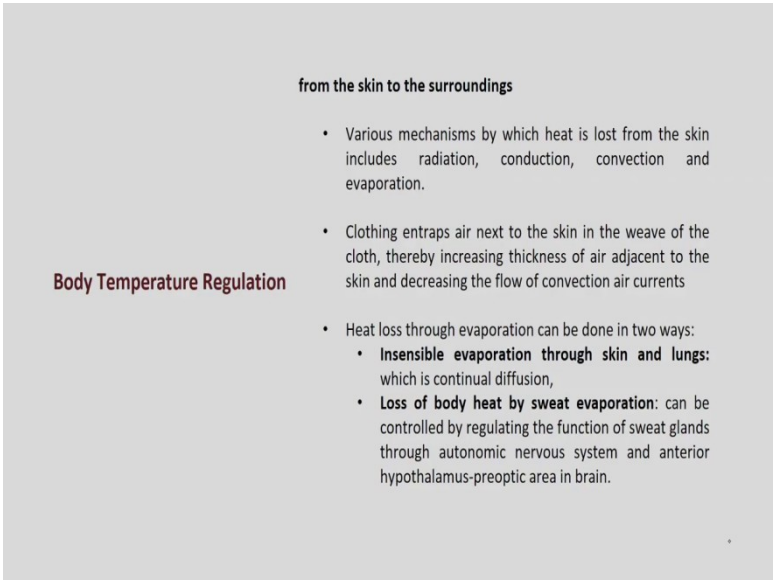

Now, let us talk about how the heat is getting transferred from skin to the surrounding. So, it has two major mechanisms one is insensible evaporation through skin and lungs; it is always happening we may not sense it another is loss of body heat by sweat evaporation. In summer season, we do realize this one or in any hot condition we always understand how it is happening.

So, once we understand the how the heat is producing within the body and how that is getting transferred from body to the surrounding environment, it becomes very easy for us to evaluate the workplace condition. Also ergonomically evaluate those elements of impact and

also it helps to give a proper direction for design intervention. Now, when we talked about musculoskeletal system and the thermoregulatory system now, let us understand this cardiac system. Because once we are working, we are alive our cardiac system need to be functional and it really helps us to do all these job like you know when we are talking about muscle contraction.

So, oxygen supply to the muscle, heat transfer from the particular cell to the skin everything is depending on the cardiac muscle activity and the cardiorespiratory system. So, let us understand what it is and how it is effective.

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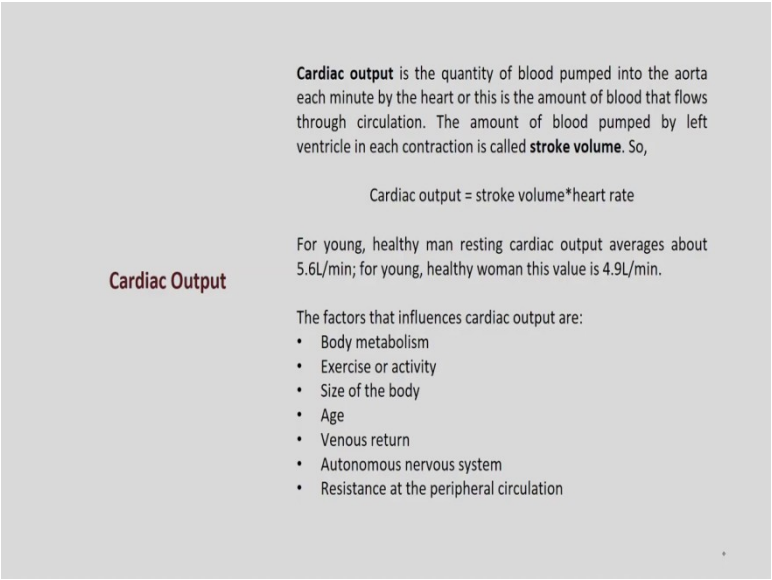

So, first I am talking about what is cardiac output. Cardiac output is equal to stroke volume into heart rate. So, at one stroke how much blood is coming out from the heart into your heart rate. So, the factors that influence the cardiac output are body metabolism, exercise or activity, size of the body, age, venous return, autonomous nervous system, resistance at the peripheral circulation etcetera and what is the amount of it? So, if we are talking about male young adult, it is 5.6 litre per minute whereas, for female it is 4.9 litre per minute. So, when we are talking about cardiac capacity to which is required for a particular job, we need to understand what the cardiac capacity of that particular person is and what the demand of the job is and if there is a mismatch and how we can you know bridge that gap. So, if we can bridge that definitely we will be able to do a better ergonomic workplace design.

So, if physically demanding jobs are there in those cases, understanding the cardiorespiratory system and their responses are very important; we have different measuring method or evaluation method that we will be discussing later. Now, when we talked about musculoskeletal system, we talked about how the thermoregulatory system you know is working, how cardiorespiratory system is working, what how these all are related to occupational health.

I believe you already understood because we I am giving you know each example for all these you know previous slides, that when we are working in a particular workplace, our whole body is reacting right so, interacting as well as reacting. So, it is very much clear that whenever we are in a particular occupation, all these system we interact and there will be some responses.

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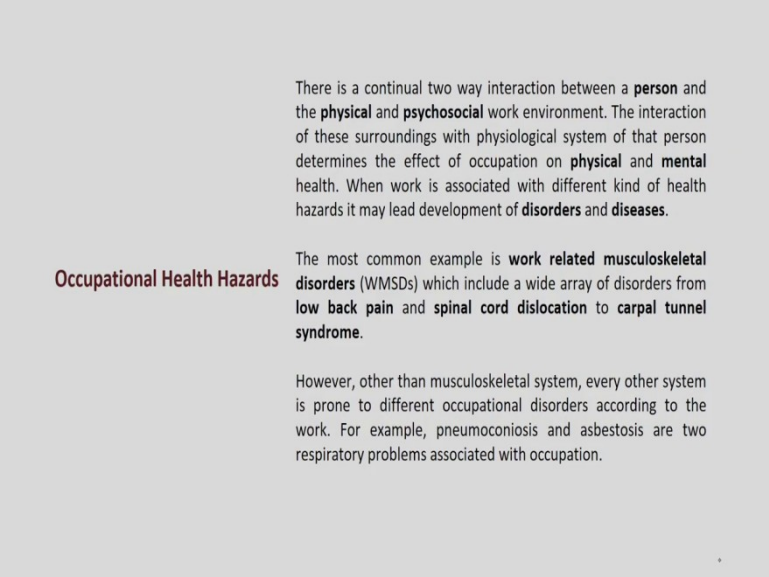

So, there is a continual two way interaction between a person and the physical and psychological; psychosocial work environment. The interaction of these surroundings with physiological system of that particular person depends on the effect of occupation on physical and mental health. Yes, it depends on the physical and mental health.

When work is associated with different kind of health hazards it may lead to development of disease or disorder. So, again we are coming back the same concept that is the if there is a mismatch between the capacity or capability of that particular person and the job demand there will be a disease or disorder.

The most common example of this disease or disorder is work related musculoskeletal disorder which include a wide array of disorders such as low back pain, it sometimes it is spinal cord dislocation, even a small wrist injury that is carpal tunnel syndrome and many others. However, other than musculoskeletal system, every other system is prone to different occupational disorders according to the work.

So, when we are talking about only respiratory system, we may discuss pneumoconiosis, asbestosis and many other respiratory related problems. If we are talking about only thermal then we have cold stress, heat stress and all those things so, thermal stress right. So, all these are very important when we are talking about ergonomic workplace analysis.

Now, once we understood that how the human physiology is, how these components are working basically basic fundamentals of those components and, the occupational component of that particular workplace and how they are interacting, we have a very fair chance to have a design modification or design intervention.

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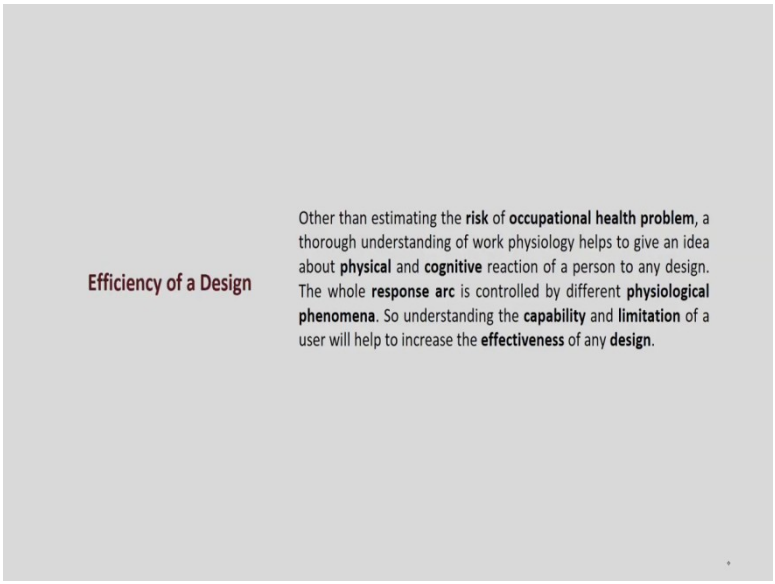

So, other than estimating the risk of occupational health problem, a thorough understanding of work physiology helps to give an idea about physical and cognitive reaction of a person to any design.

So, the whole response arc is controlled by different physiological phenomena. So, one machine is giving a signal, the human being is in giving a response back and it has a loop. If

this whole thing you need to understand you need to and how the machine is getting operated all the muscles, muscle physiology, your thermal, your cardio respiratory system and many other physiological parameters, you really need to know and you need to have a proper physiological phenomenon arc.

So, understanding the capability and limitation of the user will help to increase the effectiveness of any design because through design intervention finally, you are going to help the user or help the operator to do a better job. And, what is the goal of ergonomic? The goal of ergonomics is improve productivity keeping the human being or human well being in a better position right.

So, when we are talking about all physiological responses, we are discussing and we are analyzing in detail and we are trying to match those demands, those capacities with the job demand and we are bridging that to an optimum position to get the productivity then of course, our design will be successful and acceptable for the users.

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So, this I thought today I will be discussing, these are the books you can refer for this particular class and if you have any query as I asked you to do little bit of homework. And you know referring all these physiological responses, try to understand them in a practical ergonomic workplace evaluation situation, you can note down and then come back to us for more clarification if you really need it.

Thank you.